REGULATING CAR OWNERSHIP GROWTH IN CHINESE MEGA CITIES

by

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Abstract

Overpassing the United States, China has become the world's largest automobile market causing transportation problems as traffic congestion. Various congestion mitigation policies have been adopted and this thesis focuses on the policy curbing car purchase in Shanghai and Beijing. Shanghai was the first Chinese city to implement a vehicle quota control policy using monthly auction in 1994. In 2011, Beijing started curbing car purchases through car license lottery policy requiring no cost. Focusing on Shanghai's policy, this thesis evaluates the two car ownership policies and their public acceptance.

License auction policy in Shanghai is effective in dampening car ownership growth as well as generating large revenue. Despite these successes, the degree to which the public accepts this policy is relatively low. Although the public perceives the policy to be effective and indicates an increase in acceptance, they are negative toward affordability, equity and the implementation process. Local car owners in Shanghai's policy show the highest support and most positive attitude. This suggests that giving lifelong license entitlement, local car owners in Shanghai become an interest group in supporting the policy and the policy may gain more support as more people own local license.

There are also many residents getting non-local license outside Shanghai for cheaper price. High penetration of non-local vehicles in Shanghai causes problems in traffic management and waters down effectiveness of the policy. Shanghai is facing the dilemma between banning non-local vehicles for congestion mitigation and remaining open for economic growth. Compared to Shanghai's auction, Beijing's lottery is similar in effectiveness but less efficient. Learning from Shanghai's experience, Beijing's lottery policy is designed to address the equity issue of favouring the rich, but the equity obtained from the lottery policy is superficial.

Policy recommendations are also provided to improve both policies. Shanghai could consider sub-categorize the auction, forming dedicated policy web site, and set different parking charges for non-local vehicles. Beijing should set entry cost to lottery, and treat people at different locations differently. Both policies should reduce the privilege for government vehicles, limit the license entitlement period, and supplement with usage control.

Preface

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For any errors or inadequacies that may remain in this work, of course, the responsibility is entirely my own.

To My Family

1 Introduction

1.1 Motorization in China

The world has more than one billion motorized vehicles driving on the road today. The growth of motor vehicle population continues and is projected to increase to more than 2.5 billion in 2030 (Figure 1.1). The road structure cannot sustain the two billion vehicles as they exist today and they are causing serious problems in traffic, environment, and energy conservation. Today's billion vehicles are pumping extraordinary quantities of greenhouse gases, are draining petroleum supplies, and are overwhelming city roads in the world.

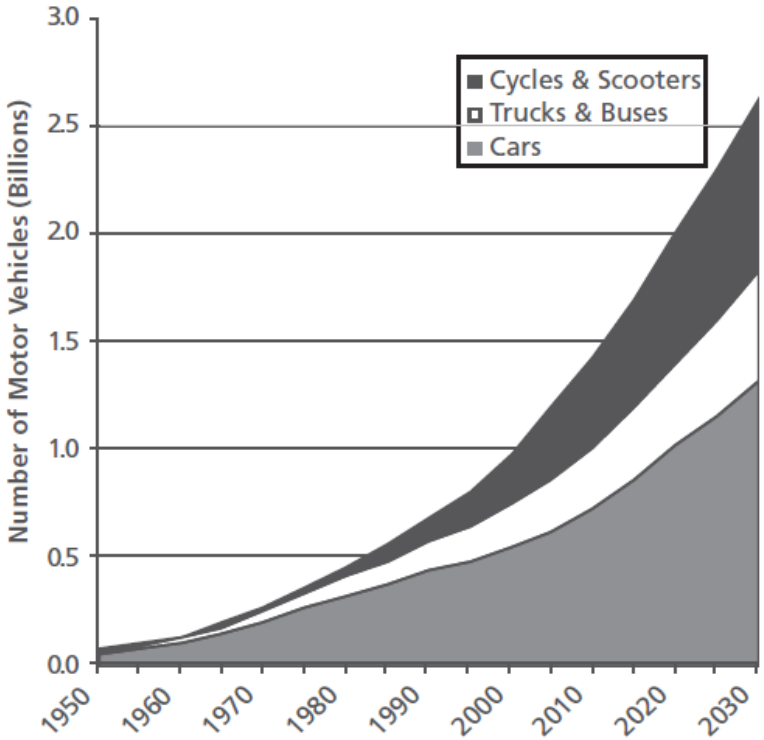

Figure 1.1 Historical and projected increases in global motor vehicle population, 1950 – 2030 (Sperling & Gordon, 2008)

The desire for cars and private vehicles is pervasive as cars could bestow many individual benefits to their owners compared to other transportation modes. Driving provides more freedom,

flexibility, convenience, comfort and sometimes a sign of social status. Due to these untold benefits, more and more people buy cars and the number of motor vehicles around the world is expected to increase by 3 percent annually with the highest rate of increase occurs in the developing countries. The rate of increase will be likely 1 to 2 percent in the United States, but more than 7 or 8 percent per year are expected in China and India.

Cars are also becoming more affordable to people as the ever-cheaper price whetting the desire for the middle class family to own cars. Cars are no longer a luxury good for the high income class but a daily travel mode. Despite the benefits provided by cars to the individuals, the problems brought by high car ownership and traffic congestion as oil consumption, carbon dioxide emission, and traffic congestion are soaring globally. Transportation accounting for one half of all oil consumption in the world, and transportation-related carbon dioxide emissions have more than doubled since 1970 which is much faster than that from any other sector (Sperling & Gordon, 2008). Vehicle travel has also outpaced population growth as Sperling and Gordon mentioned in Figure 1.2 below using United States as an example. Nevertheless, road construction is much slower and more expensive that cannot keep pace with the demand. Cars have dominated the transportation system. As roads worldwide continue to be clogged with cars, road use congestion costs create the most significant externality associated with road travel. A recent study by the Texas Transport Institute had quantified these costs and found that waste associated with traffic congestion summed to $101 billion of delay and fuel cost in US (The Urban Mobility Report, 2011). The cost to the average commuter was $713 in 2010 compared to an inflation-adjusted $301 in 1982. Traffic congestion caused aggregate delays of 4.8 billion hours and 1.9 billion gallons of fuel were wasted because of traffic congestion.

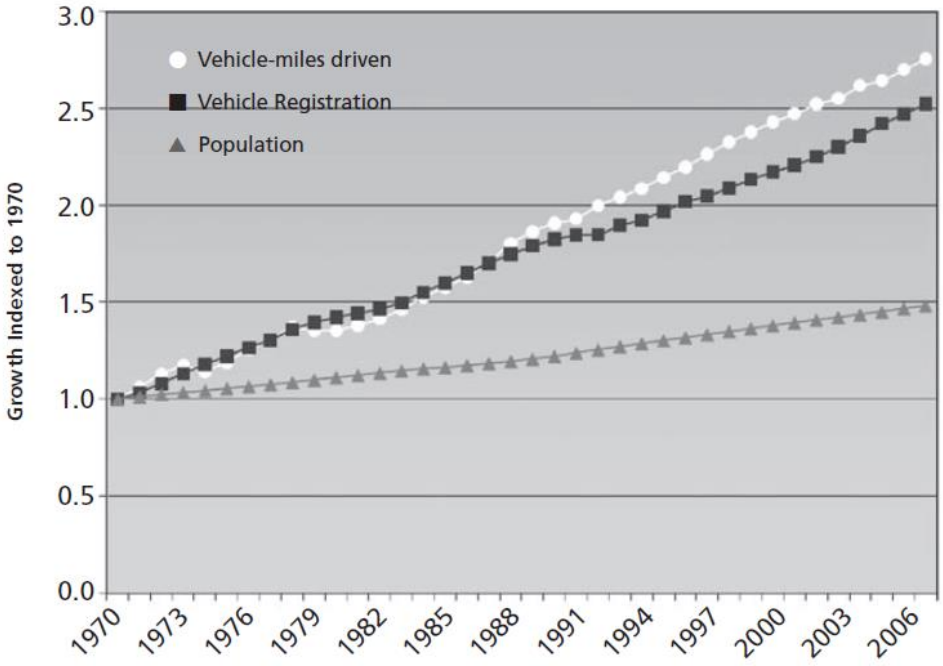

Figure 1.2 Growth of vehicle miles travelled, vehicle registration, and population in the United States since 1970 (Sperling & Gordon, 2008)

Auto companies are trying hard to invent more environmental friendly cars and clean energy. However, solely relying on these auto technology and fuels would be hugely expensive and cannot solve the continuing growth in vehicle ownership and use. The human society faces a dilemma between satisfy private desires to own cheap and easy mobility and the public interest of the overall environment. Policy interventions from the government are necessary to reconcile the tensions as all individuals want to travel in comfort if without control

Among all countries, the United States leads in the total number of vehicles as a result of the size of the domestic market and the use of mass-production. However, automobile production in the United States was overtaken by Japan in the 1980s and subsequently by China in 2008. As Table 1.1 shows, car production in the United States showed a reduction of 51% from 2000 to 2010 while that in China had the largest growth of 1470%. Majority of the world growth are contributed by the automobile growth in China. Number of cars registered in the United States at

the end of 2010 (Table 1.3) was still the highest but only in the absolute term (118,947 cars registered in the United States which was three times more than the cars registered in China) when compared to other countries. Although cars in the United States still took up 16.8% of the world total, U.S.'s share of world cars had declined over the years from 1990 to 2010 (Table 1.2 and Table 1.3). Cars registered in the United States showed a decline of 0.4% from 1990 to 2009 while that in China had the largest increase of 15% (Table 1.3). All these have evidenced that China has become the world's largest automobile market both in terms of production and consumption. As this trend continues and giving China's high population density, transportation problems as traffic congestion would become more severe and affect everyone before majority of the population own cars.

Table 1.1 World production of cars, 2000-2010 (thousands) (Davis, Diegel, & Boundy, 2012)

Cars	2000	2010	2000-2010
China	605	9,494	1470%
Japan	8,363	8,307	-1%
Germany	5,132	5,552	8%
Brazil	1,362	2,828	108%
U.S.	5,542	2,731	-51%
India	605	2,317	283%
Spain	2,366	1,951	-18%
France	2,880	1,914	-34%
Mexico	1,130	1,386	23%
UK	1,641	1,274	-22%
Russia	969	1,208	25%
Czech Republic	428	1,070	150%
All other countries	10,205	11,006	8%
Total world	41,229	51,040	24%

Table 1.2 Car registered for selected countries, 1990-2000, (Davis et al., 2012)

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	2000
Argentina	4,284	4,335	4,418	4,856	4,427	4,665	4,784	a	4,950	5,060
Brazil	12,127	12,284	12,975	11,613	12,024	12,000	12,800	a	14,700	15,393
Canada[b]	12,622	12,578	12,781	12,927	13,122	13,183	13,300	a	13,887	16,832
China	1,897	2,025	2,262	2,860	3,000	4,179	4,700	a	2,940	3,750
France	23,550	23,550	24,020	24,385	24,900	25,100	25,500	a	26,800	28,060
India	2,300	2,954	3,205	3,361	3,569	3,837	4,246	a	4,820	5,150
Indonesia	1,200	1,416	1,575	1,677	1,871	1,900	2,409	a	491	650
Germany[c]	35,512	37,609	37,579	39,202	39,918	40,499	41,045	a	41,674	43,772
Japan	34,924	37,076	38,963	40,772	42,678	44,680	46,868	a	49,896	52,437
Malaysia	1,811	2,000	2,215	2,291	2,477	2,560	2,946	a	3,517	4,213
Pakistan	738	721	732	732	750	770	800	a	323	375
Russia	[a]	a	[a]	a	[a]	a	[a]	a	[a]	20,353
South Korea	2,075	2,728	3,461	4,271	5,149	6,006	6,894	a	7,581	8,084
United Kingdom	22,528	22,744	23,008	23,402	23,832	24,307	24,864	a	22,115	27,185
United States	143,550	128,300	126,581	127,327	127,883	128,387	129,728	a	131,839	127,721
U.S. % of World	32.3%	29.1%	28.0%	27.1%	27.0%	26.9%	26.7%	a	27.5%	23.3%
World total	444,900	456,032	469,943	469,460	479,533	477,010	485,954	481,755	478,625	548,558

Table 1.3 Car registered for selected countries, 2001-2010, (Davis et al., 2012)

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	% Change 1990-2009
Argentina	5,377	5,445	5,380	5,450	5,340	5,745	6,004	6,244	6,706	7,605	2.9%
Brazil	15,800	16,576	16,650	17,600	18,370	19,446	20,430	21,884	23,612	25,500	3.8%
Canada[b]	17,055	17,544	17,755	17,920	18,124	18,739	19,199	19,613	19,877	20,121	2.4%
China	4,325	4,950	6,789	7,900	8,900	11,000	13,758	18,270	25,301	34,430	15.6%
France	28,700	29,160	29,560	29,900	30,100	30,500	30,550	30,850	31,050	31,300	1.4%
India	5,750	6,945	6,669	7,300	7,654	8,100	8,595	9,400	12,125	13,300	9.2%
Indonesia	3,150	3,235	3,556	3,700	3,850	4,100	4,355	4,750	10,364	10,800	11.6%
Germany[c]	44,383	44,657	44,023	45,376	46,090	41,020	41,184	41,321	41,738	42,302	0.9%
Japan	53,300	54,540	55,213	55,994	57,091	57,521	57,624	57,865	58,020	58,347	2.6%
Malaysia	4,490	4,625	5,590	5,955	6,402	6,600	6,804	7,190	8,506	8,900	8.3%
Pakistan	378	381	390	405	411	425	428	445	1,658	1,726	4.3%
Russia	21,200	22,100	23,383	24,208	25,285	26,800	28,300	32,021	33,187	34,797	[a]
South Korea	8,889	9,737	10,279	10,621	11,122	11,607	12,100	12,484	13,024	13,632	9.9%
United Kingdom	27,790	28,484	29,008	29,378	30,652	30,995	31,225	31,252	31,036	31,258	1.7%
United States	128,714	129,907	130,800	132,823	132,909	135,047	135,222	135,882	119,292	118,947	-0.4%
U.S. Percentage of World	22.9%	22.6%	22.2%	22.0%	21.5%	21.4%	20.9%	20.4%	17.4%	16.8%	
World total	561,652	575,847	589,272	603,274	617,914	630,043	645,837	667,630	684,570	707,764	2.3%

[a]Data are not available
[b]Data from 2000 and later are not comparable to prior data. Canada reclassified autos and trucks prior to 2000.
[c]Data for 1990 and prior include West Germany only. Kraftwagen are included with automobiles.

1.2 Congestion Mitigation Policies

Automobile is the heart of China's economic growth as the state government designed cars a pillar industry in China in 1994. For that, the state government formulated its *Automotive Industry Policy* which included four key objectives and one of the objectives was to encourage individual car ownership (Holweg, Luo, & Oliver, 2005). On one hand, China is boosting domestic auto consumption. On the other hand, China is also struggling with the downsides of rapidly increasing motorization. Chinese government has just beginning to realize the problem of rapid motorization and develop innovative policies that could spread internationally (Sperling &

Gordon, 2009). China is contributing to pollution and energy pressures, but it could also emerge as a world leader in easing those pressures due to the government's capacity in implementing strong and effective intervention as Sperling and Gordon suggested (Sperling & Gordon, 2009).

Congestion mitigation policies could take different forms as restricting car usage or car ownership. Car usage restrictions include congestion charges, fuel tax, driving ban, and parking charges to increase cost of driving or reduce car use directly. Car ownership policy, on the other hand, is designed to curb car purchase. Singapore was the first place controlling total car volume in the world. Car ownership policy had rarely been frequently adopted in other cities due to its low acceptability among the public. However, car ownership control becomes inevitable among Chinese cities having low road capacity but high population density and rapid increase in car ownership. Policies curbing car purchase also gain popularity in Chinese mega cities. This thesis focuses on the car ownership policies implemented in Chinese cities.

Even though car ownership growth is high in all Chinese cities, this car growth conceals great variation among cities due to the different policies implemented. For example, Shanghai and Beijing both had about 2 million private cars each in 2004, but by 2010, Beijing already had 5 million private cars whereas Shanghai had only 3.5 million. Growth was very fast in both cities, but Shanghai's growth rate was about half that of Beijing. This difference can largely be attributed to Shanghai's very active vehicle control policy implemented as early as in 1994 which uses monthly license auctions to limit the number of new cars, an idea adopted from Singapore. Learning from Shanghai's experience, Beijing also started curbing car purchases in January 2011. Following Shanghai and Beijing, two more Chinese cities later controlled car registration as Guizhou, and Guangzhou. Different from Shanghai's auction format, Beijing adopted a new mechanism in allocating license through lottery drawing. Guiyang started

controlling car ownership in August 2011 also using lottery. Moreover, Guangzhou uses a hybrid model in August 2012 combining license auction and lottery from Shanghai and Beijing. This thesis focuses on the car license auction and lottery policy in Shanghai and Beijing.

Using economic measure to control car ownership, license price in Shanghai has gone over CYN 50,000 in 2011 and CYN 80,000 in 2013 (Shanghai Jinwei Automobile, 2013). The policy appears to be effective: in addition to dampening growth in car ownership, it generates annual revenues of 4 to 6 billion CNY which are supposedly channeled into support for transportation development. But important questions must be answered: Do Shanghai people accept the policy and to what degree? Beijing, on the other hand, was mainly focused on the limitation of vehicle use through administrative means until the end of 2010. The first car use control policy was introduced during the 2008 Beijing Olympics and Paralympics Games. Road access was limited based on car license plate numbers which only vehicles with odd(even) license plate tail numbers are allowed to be used on odd (even) days (Hao, Wang, & Ouyang, 2011). In 2008, 2009, and 2010, the municipal government followed up with a modified driving restriction banning vehicles to be used for one certain weekday per week depending on the tail plate number. At the beginning of 2011, Beijing issued a car license lottery policy. To what extent do these two car ownership policies in Shanghai and Beijing differ from each other? What is the focus for each policy? This thesis tries to answer these questions with a primary focus on Shanghai's license auction policy.

Majority of the prior literatures focused on Singapore's car license auction policy since it was the origin city of the policy. Phang (1993,1996) reviewed Singapore's car quota policy and evaluated the implementation process. He concluded that the policy achieved its goals of restricting the numbers of cars to a certain fixed number, and improving the quality of cars

imported. Han (2010) and Chin and Smith (1997) supported Phang's findings and noted that Singapore's car quota shifted car owners to public transit. Willoughby (2001) and Muthukrishnan (2010) noted that Singapore's quota policy generated substantial funds for government to invest in transportation and infrastructure. Phang (1996) also discussed the unintended consequences of Singapore's policy (e.g., speculation) and public concerns that resulted in policy fine-tunings. Phang's suggestion that transport policies need to reach certain social equity standards to be publicly acceptable is important for Shanghai. Koh and Lee (1994) and Seik (1998) also discussed the equity and affordability issues that affected public acceptability of Singapore's car quota scheme.

Among the literature on Shanghai's car license auction policy, majority targeted the effectiveness of the policy rather than public attitude. Liu (2008) reviewed auction policy in Shanghai and suggested that Shanghai's auction policy had generated large revenue and eased traffic congestion to some extent, but the policy also suppressed automobile sales and caused negative effects on economy. He also suggested that the auction policy caused existing vehicles to be used more intensively which partially offset the effect of ownership control. Wang (2010) concurred with Liu that Shanghai's policy failed to address the relationship between vehicles ownership and use, and resulted in additional use of the vehicles available.

Different from previous studies, this thesis focused on the public side of the policy by conducting questionnaire survey to collect first hand data. Empirical studies found the policy to be relatively unpopular and this research aims to answer the following questions: Do local residents accept car license auction policy in Shanghai? How do policy attitude vary among different segments of population in Shanghai? Previous literature also studied the two auction policies in Singapore and Shanghai separately, but few compared them together. Various studies

have shown how differences in policy context can significantly influence policy performance and the success of policy transfer. Hu (2004) stated several problems that Shanghai's car license auction policy was facing, including the large number of non-local vehicles which causes problems in Shanghai's traffic management. To what extent does this affect the effectiveness of Shanghai's auction policy? How does Shanghai deal with the problem? Beijing's car license lottery is a new policy first implemented with few literatures discussing the policy specifics and public attitude. Shanghai's high license price raises equity concern on the policy favoring the rich. On the contrary, Beijing's car license lottery policy is designed to address this equity concern by allocating license for free. Does the lottery policy address the equity issue effectively and are there any other equity dimensions that are missing in the policy?

1.3 Research Objectives

Car ownership in China has recently exploded bringing serious urban transportation problems to Chinese cities. This thesis will investigate Shanghai's car license auction policy and the public's acceptance towards the policy. Four dimensions will be investigated: the degree of acceptance by the public; preference variation towards the policy; issues involved in nonlocal vehicles in Shanghai; and the equity dimensions addressed in Beijing's lottery policy.

1) Policy Acceptance. This thesis develops an analytical framework for evaluating public acceptance of Shanghai's car ownership policy; design a questionnaire survey called "*Car License Auction Policy and its Public Acceptance*" based on the framework; conduct the survey in Shanghai; use the survey data to benchmark the level of public acceptance of the license auction policy.

2) Preference Variation. Disaggregate analysis is important as people's attitude may vary quite differently among different subgroups. This thesis also aims to examine local residents' preference variation towards the policy along different segments including socioeconomics, car ownership and license types, and locational variables.

3) Nonlocal Vehicles in Shanghai. This thesis examines the non-local vehicle phenomenon as unintended and unanticipated consequences of transferring Singapore's policy to Shanghai; it investigates the degree of non-local vehicle penetration in Shanghai and its associated problems in traffic management; it also discusses the responses to non-local vehicle problem from various perspectives: government, market, and the public.

4) Fairness in License Lottery Policy. Equity is a large concern in Shanghai's auction as the policy favors the rich. Beijing's car license lottery policy, on the other hand, is designed to address the equity problems. This thesis performs an equity analysis of the lottery policy and compares the lottery policy to Shanghai's auction policy in terms of transport equity.

1.4 Significance

This thesis focuses on China, one of the developing countries with highest rate of increase in automobile ownership. Various innovative congestion mitigation policies have been implemented in Chinese cities and car ownership policy was often questioned by its low public acceptability. This thesis takes this opportunity to study public acceptance towards car ownership policy.

This work develops an analytical framework targeting at public acceptance of car ownership policies in transportation research. It also forms a framework for equity analysis in China's context and applies that to Beijing's car license lottery policy. Policy recommendations

are provided in the thesis after examining detailed policy specifics. Recommendations are made available for policy makers to improve the policy and design policies that are locally suited, more effective, efficient, and publicly acceptable in the future. In transportation research, the frameworks developed in this thesis can also be applied to study public acceptance of transportation policies elsewhere.

Moreover, this thesis also uses Shanghai's policy as an example to evaluate the possible implementation problems that might occurs when car ownership policy is applied in China's context. Non-local vehicles are one example of unintended consequence policy transferred to China's context. Although the penetration is high in Shanghai, the government does not have formal statistics on the amount of non-local vehicles. The first thing practitioners need to know in any transport policy is the total amount of vehicles in Shanghai but unknown non-local vehicles' penetration adds uncertainty to the total car volume. Through questionnaire survey, this thesis also examines the degree of non-local penetration in Shanghai which provides statistics for future policy control.

Findings from this study are also useful for practitioners to smooth the implementation process and better control leakages from the policy. Beijing learned from Shanghai's experience to implement a similar car ownership policy. Both policies are similar in terms of effectiveness but differ in the allocation mechanisms designed, which made them a good comparison in this thesis. Furthermore, Beijing has implemented the policy recently and few literatures have focused on comparing the car ownership policies between Shanghai and Beijing. This thesis takes this opportunity to evaluate and compare both policies. Furthermore, it also uses the policy specifics as examples to reflect each city's characteristics and preference. Moreover, learning

from Shanghai and Beijing's policies, both positive and negative, can be useful to other Chinese and western cities seeking suitable solutions to mitigate congestion.

In addition, this work conducts questionnaire survey and provides primary data source to study public acceptance and attitude towards car ownership policies. The questionnaire survey serves as an information dissemination and public education tool for local residents enabling them to better understand the policy and the key trade-offs involved in transportation policy design. This work also serves as an information exchange channel between the public and policy makers. Individual public opinions are synthesized into the results and findings to be more likely included in policy decision making process for policy makers to consider.

1.5 Methodology

1.5.1 Framework of policy analysis

When evaluating a public policy, five major factors are often analyzed as illustrated in Figure 2 below: effectiveness, efficiency, equity, implementation, and public acceptance. The prior four factors can be evaluated by the researchers systematically. Has the policy achieved its goals? Is the current design efficient in the way it is or is there better mechanism to use in order to maximize the overall social benefits? Does the policy seek to enforce individual rights or is any party worse off under the policy? Are the externalities people received being compensated? How is the policy implemented? Are there any loopholes or leakages that need to be taking care of? All these questions are frequently asked by researchers when evaluating a public policy, but public acceptance is a factor that could not be evaluated by examining the policy specifics subjectively. Policy acceptance is a complex issue that may be affected by all the prior four factors.

Acceptance is the key to realization of the policy. One policy could be very effective and economically efficient from researchers' point of view but not be accepted by the major part of the population because of the unequal distribution of benefits. Even one policy satisfies both effectiveness, efficiency, and equity could fail in its implementation and resulted in policy failure and not being supported by the public.

This thesis examines the car ownership policies in Shanghai and Beijing from the five dimensions and Table 1.4 below shows the factors that have been addressed in each policy. This work focuses on Shanghai's car license auction policy including its effectiveness in dampening car growth, its efficiency in allocating licenses, equity concerns reflected by the public, the types of implementation loopholes and leakages the policy has, and it also benchmarks the current policy acceptance level. In Beijing's car license lottery policy, this work focuses on the equity aspects. It also describes the policy in terms of effectiveness and efficiency. However, it does not evaluate the implementation process and public acceptability of Beijing's lottery policy. Elaborating from this, a more detailed framework is provided in Chapter 2 targeting at car ownership policy.

Table 1.4 General framework to study car license auction and lottery policies in Shanghai and Beijing

	Effectiveness	Efficiency	Equity	Implementation	Public Acceptance
Shanghai	X	X	X	X	X
Beijing	X	X	X		

1.5.2 Data collection

To understand public acceptance and attitude towards car license auction and lottery policies, we have conducted questionnaire surveys in Shanghai and Beijing. A short description

of the questionnaire design and implementation strategy is provided below. Detailed descriptions of the survey and sample statistics are provided in each chapter.

1.5.2.1 Questionnaire design

To benchmark public acceptance and attitude towards the policy is the main goal for the questionnaire. It includes seven sections: (1) policy awareness; (2) car ownership and car information; (3) car usage and travel behavior; (4) policy attitude and evaluation; (5) non-local vehicle attitude; (6) car attitude and behavior; and (7) personal information.

Section 4 is the main section collecting public attitude towards various specifics in the policy including current congestion level, acceptance, effectiveness, affordability, equity, and implementation process based on the framework developed. Likert-scale psychometric indicator statements were used to measure attitude toward different specifics. Each statement has five response levels: strongly agree, partially agree, neutral, partially disagree, and strongly disagree coded from +2 to -2 respectively. Similar questionnaire is used in Beijing's survey with the questions designed to target at car license lottery policy. Both English and Chinese versions of the questionnaire were developed with the Chinese version distributed to the participants. Questionnaires for each survey are included in Appendix B.

1.5.2.2 Survey implementation

Two sets of survey data are collected in addition to the pilot survey as described below:

1) *Pilot study:* Two pilot surveys were conducted in Shanghai and Beijing test quality of the questionnaire. Pilot survey in Shanghai was conducted in March 2011 with 48 responses collected. Another pilot survey was conducted in May 2012 with 58

responses collected. Online survey platform "SurveyMonkey" was used for distributing the questionnaire to local residents. Questionnaires were revised and updated based on the pilot results for full implementation.

2) *Shanghai survey 2011:* Questionnaire survey was conducted among nine local companies in Shanghai in May 2011. Both online and paper based questionnaire were used. Two stage sampling methods were used. Local companies were purposefully selected to obtain diversity in participants. Employees in each company were then randomly selected. In total of 827 responses were collected and filtered down to 524 valid responses. Detail description for the survey implementation strategy is provided in Chapter 2. Chapter 2 to Chapter 4 use this survey data focused on the working population. Sets of invalid patterns were developed to filter the responses and Chapter 2 describes the filtering methods used.
3) *Beijing survey 2012:* Questionnaire survey was conducted in June 2012 through online survey company "51 poll" and 1000 responses were collected. Sample distribution was controlled along six dimensions: age, gender, education, income, hukou status, and location. Because car ownership was not controlled and the questionnaire attracted more car owners than non-car owners comparing to city statistics, additional booster survey focusing on non-car owners was conducted in January 2013 to collect 600 more responses. In total of 1600 responses were collected and filtered down to 1505 valid responses. This data set is used in Chapter 5.

1.5.2.3 Weighting

Iterative proportional fitting (IPF) was used to weight Beijing survey 2012 data sets. Weighting is especially important for disaggregate analysis and the purpose is to make our sample representative of the overall population in Beijing (Solon, Haider, & Wooldridge, 2013). Detailed procedure for IPF is described by Hunsinger (Hunsinger, 2008).

1.5.3 Analytical methods

In addition to the basis statistical tools for analyzing the survey data, two specific methods will be used:

1) ANOVA tests – to investigate the preference variation towards policy attitude (Chapter 3) and non-local vehicles (Chapter 4) among different population segments (eg. Socioeconomics, household characteristics, location and transit accessibility, car ownership and license types); and
2) Structural equation model (SEM) (Kline, 2010) – to specify and quantify the relationships between the socioeconomic determinants and policy attitude in Chapter 3 and to quantify the determinants of attitude towards non-local vehicles in Chapter 4.

Detailed description of the analytical methods used is provided in each chapter.

1.6 Thesis Structure

Figure 1.3 below illustrates the structure of the thesis with six chapters in total. Chapter 1 provides an introduction to China's context and background information of the car ownership policies implemented in Shanghai and Beijing. It also explores previous research on the topics and how this thesis differs from the other studies and the objectives this thesis intends to achieve. It then provides an overview of the general methods used in achieving the research goals.

Organization of this thesis is a bit different than the traditional format having one overall introduction, literature review, and methodology sections. Instead, each main chapter (chapter 2 to chapter 5) has its own introduction, literature review and methodology. Each chapter in this thesis explores various topics in the car ownership policy which deserves its own literature part and uses different methods and data. Two sets of survey data are used with Chapter 2 to Chapter 4 using Shanghai survey data collected in 2011 by the researchers. Chapter 5 uses the Beijing survey conducted from 2012 to 2013 through online survey company. Due to the variety of data used in different chapters, each chapter describes its own sampling method, survey design and distribution method and the models used to conduct the analysis. Each chapter is a stand-alone chapter that has its own discussion and conclusion.

Following the introduction in Chapter 1, Chapter 2 to Chapter 4 focuses on Shanghai's car license auction policy while Chapter 5 discusses Beijing's car license lottery policy. Chapter 2 develops a framework to study car ownership policy acceptance and collects local data to benchmarks the current license auction policy acceptance level in Shanghai. It also provides a general overview of the auction policy specifics and public attitude towards the core specifics: perceived congestion level, perceived effectiveness, affordability, equity concerns and implementation process. Moreover, it places Shanghai's car license auction policy in context with other congestion mitigation strategies as congestion charges, parking charges, and fuel tax. To design a better policy and to improve public acceptance, it is also necessary to segment the population and examine attitude among different groups of people. Thus, Chapter 3 examines the preference variation towards the license auction policy in Shanghai. In addition to the attitude variation, Chapter 3 also develops a structural equation model to find the key socioeconomic determinants of Shanghai policy acceptance.

Shanghai referenced the auction policy from Singapore. In addition to the similarities both policies share, there is also a unique phenomenon that occurs under Shanghai's policy: the high penetration of non-local vehicles in the market. Chapter 4 describes the non-local phenomenon as the types of problems exerts on local traffic management and effectiveness of the auction policy. It also discusses responses to the non-local vehicles from various perspectives: government, market, and the public. Government's treatment of non-local vehicles are discussed, market response in further facilitating the behavior is described, and public attitude towards Shanghai's dilemma of congestion mitigation versus openness as a city is presented.

Beijing also implemented a car license lottery policy in 2011 and such policy is designed to address equity. Chapter 5 examines the various equity dimensions in the lottery policy with some comparison to Shanghai's auction. Beijing residents' attitude towards different equity dimensions are also presented using Beijing survey data collected from 2012 to 2013.

Chapter 6 of the thesis then summarizes the behavior findings in the previous chapters and compares the auction and lottery policy in a broader scale of difference in city characteristics between Shanghai and Beijing. Car ownership policy is a new policy that has recently gain popularity. Many aspects in both the auction and lottery policy cannot be covered in the thesis. Other Chinese cities like Guangzhou also borrowed the experience from Shanghai and Beijing to implement a hybrid policy very recently. Chapter 6 also provides directions for future research.

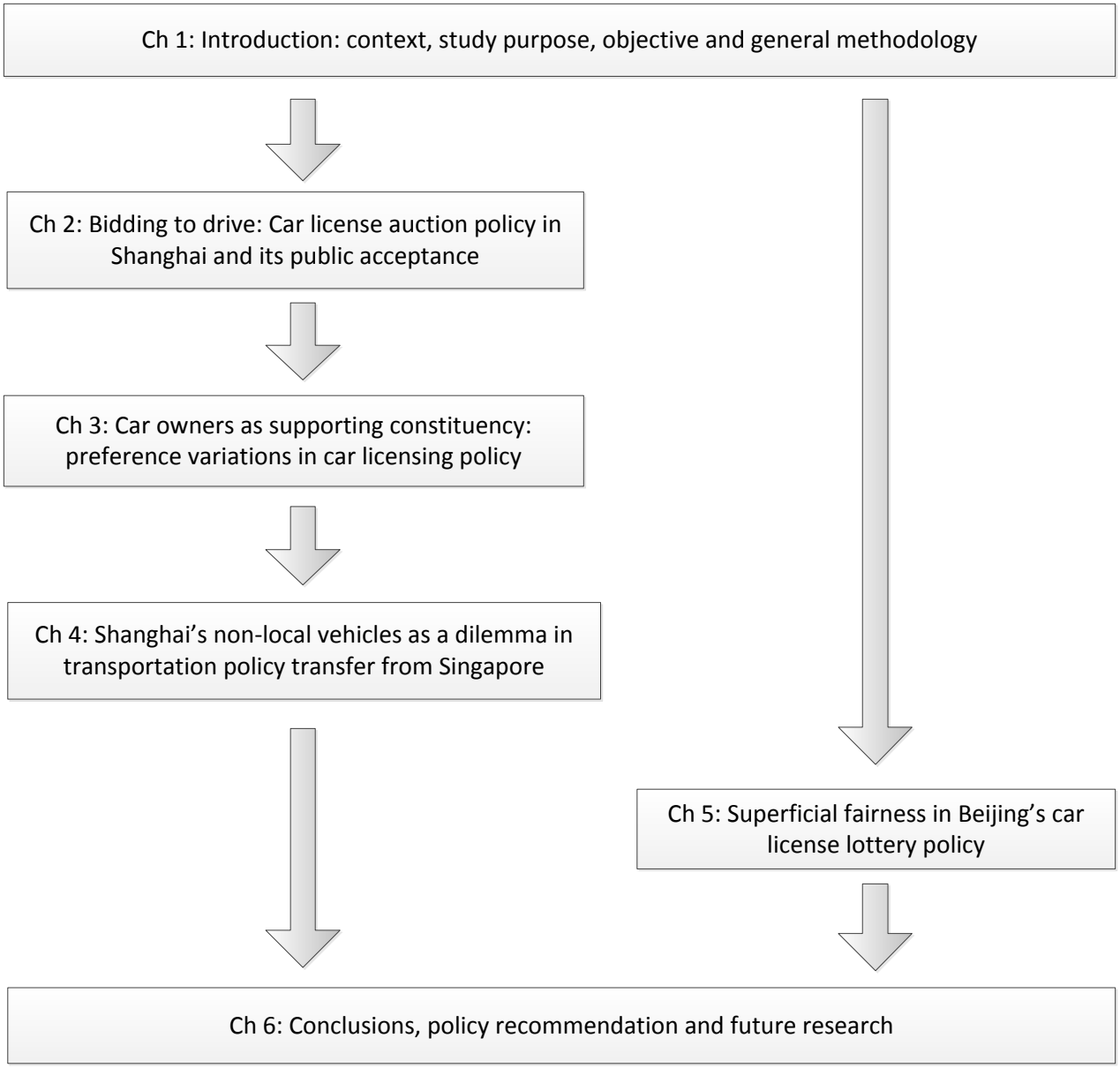

Figure 1.3 Thesis structure

2 Bidding to Drive: Car License Auction Policy in Shanghai and Its Public Acceptance

In the first quarter of 2009, in no small part due to government measures to stimulate the automobile industry, China overtook the U.S. to become the largest automobile market in the world. Total automobile sales in China reached 13.8 million in 2009 (Xinhua, 2010). In 2010, both automobile production and automobile sales reached 18 million, including 13.8 million passenger cars, most of which were used domestically. Not surprisingly, Chinese cities now face serious transportation problems such as traffic congestion, high gasoline consumption, severe air pollution, and excessive carbon emissions.

The countrywide growth in car ownership conceals great variation among cities. For example, Shanghai and Beijing each had about 2 million motor vehicles in 2004, but by 2010, as shown in Figure 2.1, total motor vehicle ownership reached over 3.1 million in Shanghai (Shanghai Statistic Bureau, 2011) and 4.8 million in Beijing in 2010 (Zhongshang Data, 2011). Growth was very fast in both cities, but Shanghai's growth rate was about half that of Beijing. Among the factors contributing to this divergence is Shanghai's quota control for passenger cars. In 1994, when private vehicle ownership was still low in China, the Shanghai government referenced Singapore's car quota policy and began to use monthly auctions to limit the number of vehicle licenses issued (J. Jin, 2009). As a result of the growing population and economy, the demand for vehicle licenses has continued to increase. The price of a lifetime car license averaged CNY48,600 ($7,600) in 2011. The policy appears to be effective: in addition to dampening growth in car ownership, it generates annual revenues up to 5 billion CNY - reportedly channelled into support for transportation.

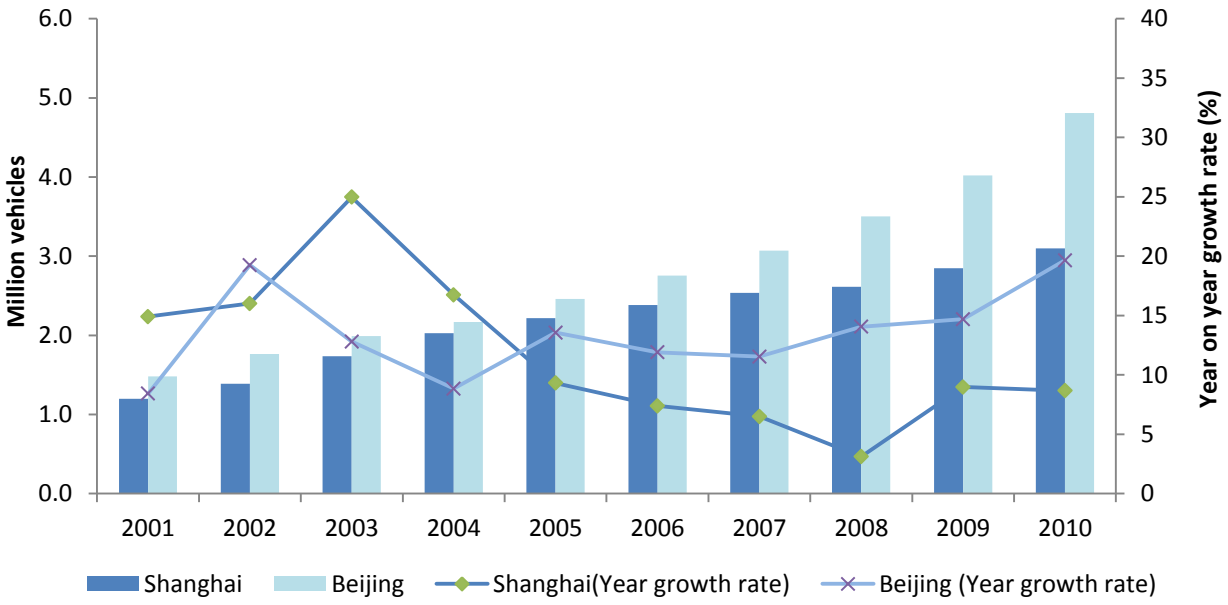

Figure 2.1 Total motor vehicle ownership and annual growth rate in Shanghai (Shanghai Statistic Bureau, 2011) and Beijing (Beijing Statistic Bureau, 2010) (Zhongshang Data, 2011)from 2001 to 2010

Despite these apparent successes, the degree to which the public accepts this policy is unknown. Vehicle licenses in Shanghai cost more than 100 times the price of licenses in Beijing, and can be more expensive than the car itself for many smaller models. This has not only led to affordability and equity concerns, but also to speculative activities. Many Shanghai residents are obtaining non-local licenses from other jurisdictions for lesser cost. These responses complicate the situation, exacerbate implementation and trust issues, and thus negatively affect public acceptance of the auction policy. It is this acceptance which must be studied in order to improve the policy and to increase its effectiveness.

This chapter presents the findings of a survey designed to investigate public acceptance of Shanghai's car license auction policy. The three primary objectives are: 1) to benchmark license auction policy acceptance levels among Shanghai residents; 2) to investigate key determinants of public acceptance, including perceived policy effectiveness, affordability, equity concerns, trust in the policy and government, and the implementation process; and 3) to evaluate

the effectiveness and acceptance of the policy in comparison to other congestion mitigation instruments such as congestion charges, parking charges, and fuel taxes.

2.1 Literature Review

The literature that follows provides an overview of past research into the car quota policy in Shanghai, with reference to experience elsewhere. Although the works cited vary in context, method, and conclusions, most note that transport policies and public acceptance are location and context specific. However, none of them offers a thorough evaluation of the specific determinants of public acceptance of the license auction policy. The public acceptance of Shanghai's license policy is an empirical issue to be tested in a local setting with local data.

The discussion is organised as follows: 1) the origin of the car quota policy in Singapore, 2) the implementation of the policy in Shanghai, 3) public acceptance of such policies, and 4) the determinants of public acceptance.

2.1.1 Experiences from Singapore

Singapore implemented its car quota policy in 1990, 4 years prior to Shanghai. Phang et al.'s (1996) review of Singapore's car quota policy and implementation indicates that it achieved its goals: absolute certainty in the numbers of cars; and improving the quality of cars imported. However, Phang notes that the policy suffered from unintended consequences - including speculative activities - that caused significant public concern. Based on their evaluation of policy measures to curb speculation, they suggest that transport policies must be perceived as fair if they are to be acceptable. They also propose the creation of an asset market for vehicle licenses.

2.1.2 Implementation in Shanghai

Wang (2010) compares Shanghai's car quota policy and Beijing's driving restriction - among other existing and possible policies - with the experiences of each policy in western cities. He notes that Shanghai's car quota policy failed to address the uncertain relationship between vehicle ownership and vehicle use. Wang also notes that the policy had a distortional impact on the vehicle market, affecting the auto industry. He thus concludes that the local context can significantly influence policy performance and must be carefully considered before any policy is implemented. However, he does not evaluate public acceptability

Hao et al. (2011) also focus on Shanghai and Beijing's auto policies. They model the growth of fuel consumption by passenger vehicles in Shanghai and Beijing with and without the policies then in place. They find that in Beijing the increase in vehicle ownership has offset the fuel consumption savings of limiting vehicle use. In Shanghai, the vehicle ownership policy has significantly reduced aggregate fuel consumption by passenger vehicles, but the average fuel consumption rate and the average vehicle distance travelled has increased. The results suggest that while Beijing's policy provides a short-term energy conservation solution, Shanghai's policy offers a long-term solution. They thus recommend that a balance must be struck between traffic conditions, energy consumption, vehicle markets, and social equity.

Liu's (2008) historical overview of Shanghai's license auction policy finds that it eased traffic congestion to some extent, and generated large amounts of revenue to spend on transportation infrastructure, but that the resulting reductions in automobile sales negatively affected the economy. The high price of licenses in Shanghai led to speculative activities and car owners obtaining non-local licenses. Like Hao et al. (2011), Liu concludes that Shanghai's policy encouraged more vehicle usage, partially offsetting the policy's effect. Liu suggests that

Shanghai should restrict vehicle usage rather than continue to restrict ownership through the license auction policy.

2.1.3 Public acceptance of car ownership policy

Chen et al. (2008) investigates public perceptions and acceptance of various congestion mitigation policies including congestion pricing, parking charges, and fuel taxes in Shanghai. The responses from a survey of academics, interest groups, and local authorities (187 valid responses) show a common resistance to charging schemes and vehicle restrictions, especially towards congestion pricing. Chen et al. suggest that car restriction policies - such as license auctions - are necessary to generate government revenues, despite low public acceptance. To increase policy effectiveness, they recommend that the government educate the public about the costs and causes of congestion prior to implementation. While their study collected first-hand data on public acceptance, it was limited in size and scope. There was also no detailed assessment of Shanghai's auction policy or the key determinants of public acceptability.

2.1.4 Determinants and variation of public acceptability

Jakobsson et al. (2000) investigate the factors that determine car users' acceptance of road pricing via a survey of 524 car owners and their spouses living in central Sweden. The study includes an assessment of perceived fairness, infringement on freedom, and expectations of others' car use reduction. The resulting model indicates that road pricing acceptance is negatively affected by perceived infringement on freedom and unfairness. Lower income is associated with lower acceptance of road pricing. The expectation that others would reduce car use is positively related to a personal intention to reduce car use and further to the acceptance of road pricing. Similar to road pricing, factors such as perceived infringement on freedom, unfairness, and income levels may also influence the acceptance of a license auction policy.

2.2 Methodology and Data

2.2.1 Framework

We begin by measuring the respondents' perception of congestion in Shanghai and their views on the need for policy intervention. The respondents' awareness of the policy is tested to ensure that they have sufficient understanding of the policy to make a meaningful evaluation. We then investigate the current acceptance level, changes in acceptance, and respondents' expectations of others' acceptance. Using the literature review and firsthand knowledge of Shanghai, we have developed a framework (Figure 2.2) to organize the possible determinants of public acceptance. These determinants are investigated under three broad topics: core policy specifics, implementation, and preference variations.

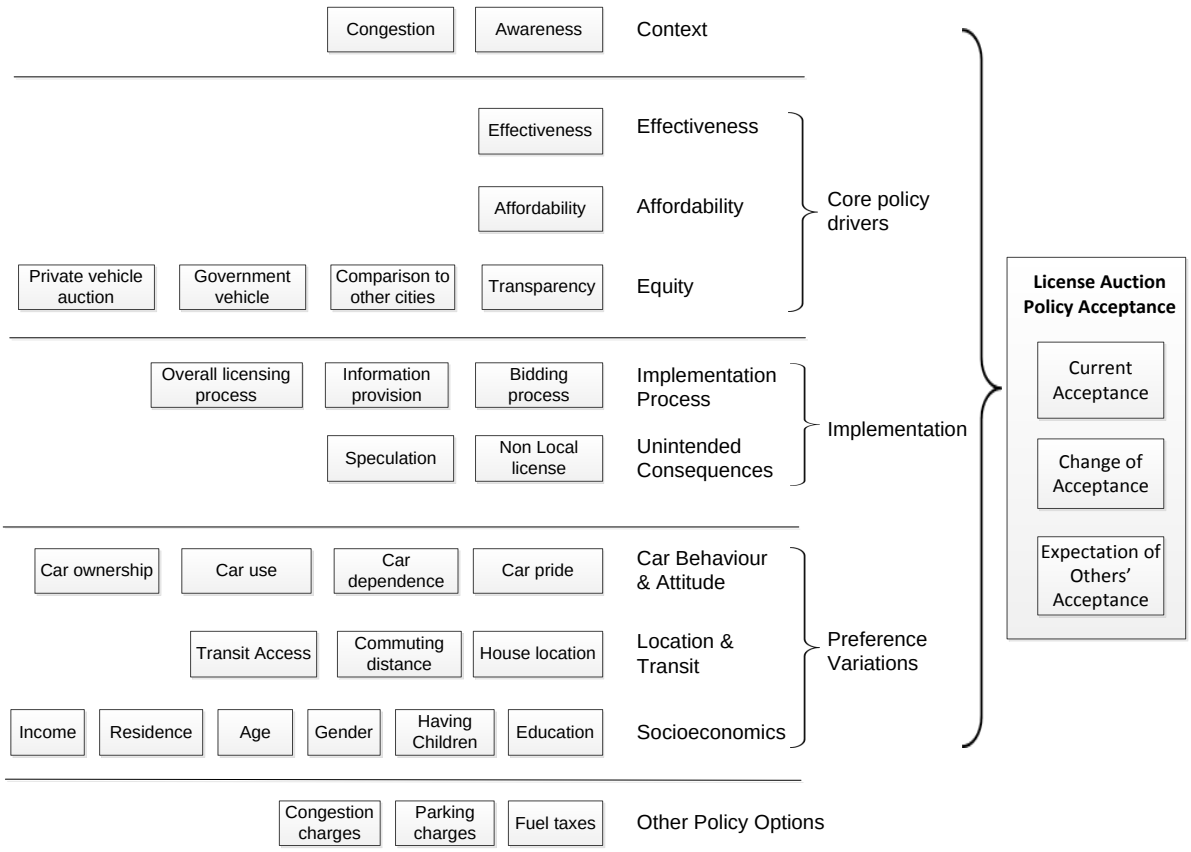

Figure 2.2 A framework for evaluating key determinants of public acceptability

The core policy determinants of public acceptability in Figure 2 are perceived effectiveness, affordability, and equity concerns. Equity is assessed on four dimensions: equity within private vehicle auction policy, equity regarding government vehicles, equity compared to other Chinese cities, and transparency in government revenue usage.

Three components of the implementation process are measured: convenience of the process of obtaining a Shanghai license, policy information provision, and technical issues in the bidding process. Unintended consequences, including speculation and non-local licenses, are also expected to influence public acceptability.

Preference variations include car behaviour and attitudes, home location and transit accessibility, and typical socioeconomic variables such as income, age, gender and education. Car dependence and car pride (pride in car ownership and use) are included in order to capture the impact of attitudinal factors on public acceptability of the policy.

Shanghai has investigated various other congestion mitigation policies that might replace or supplement the license auction policy such as congestion charges (Tong, 2012) and parking charges (S. Li, 2012). This study investigates Shanghai residents' attitudes to the license auction policy in comparison to congestion charges, parking charges, and fuel taxes.

2.2.2 Questionnaire survey

2.2.2.1 Sampling frame

This chapter focuses on the employed population in Shanghai including both local and migrant workers. The sample represents the middle-class population who are well-off enough to consider having a car, but not too rich to disregard the cost of a license. They are thus likely the group most affected by the car license auction policy. Such focus limits the study from being

generalized to represent the acceptance of the whole population - particularly those who are unemployed or very low-income.

We used a two-stage sample: purposeful sampling for the selection of companies in Shanghai and random sampling for the selection of employees in the chosen companies. In the first stage, we selected nine companies varying in business type, location, size, and ownership (government and private).They included four engineering companies, two design companies, one research institute, one trading company, and one chemical plant factory. They were distributed from the central district (within the inner ring road) to the outskirts (outside the outer ring road), and ranged from 20 employees to 500 employees. Five of them are government owned and four are privately owned. Appendix A lists the companies. The second stage randomly sampled employees in each company. In companies with less than 200 employees, all employees were invited to participate. In large companies, 200 employees were randomly selected to participate. Overall we distributed 1,100 questionnaires to employees.

2.2.2.2 Questionnaire design and survey implementation

The questionnaire design and survey implementation consisted of three stages:

1) After the initial questionnaire design, the authors used email and telephone to interview Shanghai residents and the contact person in each company, and to evaluate the quality and suitability of the questionnaire. The questionnaire was revised as necessary.

2) A pilot survey (March 25, 2011) was then conducted online among 62 employees in one company, with 48 valid responses. The pilot data were analysed to verify the length, language and sequencing of the questionnaire, and the reliability and validity of the attitudinal

indicators. The questionnaire was again revised. The pilot data are not included in the reported survey results.

3) The full survey was implemented over three weeks in May 2011. Respondents could choose an online or paper-based questionnaire. A cover letter explaining the study objectives was sent to the company contact person who then distributed the survey to the employees. The contact person explained to employees that the survey was entirely voluntary and anonymous. The letter also explained that no incentives or disincentives were offered, and respondents could end their participation at any time. Respondents who chose the online questionnaire received the web address at their company email address. Paper-based questionnaires were used where Internet access was not available or where employees preferred a paper-based survey. A drop box at the company collected paper responses. Employees at four companies completed the online questionnaire, three completed the paper-based questionnaire, and two used both methods.

2.2.2.3 Questionnaire structure and contents

The final questionnaire includes seven sections: (1) policy awareness; (2) car ownership and travel behaviour; (3) perceptions of congestion and necessity for policy intervention; (4) attitudes towards the license auction policy; (5) attitudes towards non-local licenses; (6) attitudes towards other congestion mitigation policies; and (7) location and socioeconomic background. Section 4 is the core of the survey. It assesses overall acceptance of Shanghai's auction policy, perceived effectiveness, and attitudes towards affordability, equity, and the implementation process. The questionnaire includes 102 Likert-scale psychometric statements as indicators of people’s attitudes and perceptions. Each statement has five response levels: strongly agree, partially agree, neutral, partially disagree, and strongly disagree, coded 2, 1, 0, -1 and -2,

respectively. The questionnaire was developed in both English and Chinese, with the Chinese version distributed to the sampled employees.

2.2.3 Survey data

The 1,100 questionnaires distributed produced 827 responses (75%). After cleaning the data and removing inconsistent responses and missing values, the number of valid responses was 524 (48%). Table 2.1 reports the sample characteristics. Compared with Shanghai city-wide statistics, the sample skews to young, male, highly educated, and relatively higher income residents. 42% of the sample own a car and 28% drive as their main mode of travel. The great majority of respondents live within one kilometre of a subway (71%) or bus service (91%). Commuting distances vary greatly: 28% commute less than 5 kms, 33% commute 5 to 14.9 kms, and 39% commute more 15 kms or more.

Table 2.1 Survey sample characteristics (demographic, socioeconomic, land use and public transit access) (N = 524)

Variables of samples	Values	Survey sample (%)	City Statistics (%)[e]
Demographics			
Gender	Male Female	67 33	50 50
Age [a]	18–34 35–59 60+	69 30 1	24 43 23
Have children	Yes No	37 63	
Household size	1 2 3+ Average household size =	13 24 63 3	 2.93
Residence	Born in Shanghai Resident for • < 2 years • 2–5 years • 5–10 years • > 10 years	34 9 22 14 21	
Socioeconomic			
Education level	High school or below College/University	7 79	70 26

Variables of samples	Values	Survey sample (%)	City Statistics (%)[e]
	Masters+	14	4
Household income (monthly)	Low (< ¥ 4k) Middle (¥ 4k–10k) High (>= ¥10k) Monthly household income	14 38 49 ¥8,500	 ¥7,041
Car ownership	Yes • 1 car • 2+ cars No	**42** 37 6 **58**	14
Location and public transit access			
House location [b]	Zone 1 Zone 2 Zone 3 Zone 4	31 28 39 13	Zone 1 20 Zone 2&3 34 Zone 4 46
Public transit access (Subway)	Low (> 1 km) Middle (0.25–1 km) High (< 0.25 km)	29 46 25	
Public transit access (Bus)	Low (> 1 km) Middle (0.25–1 km) High (< 0.25 km)	9 39 52	
Travel behaviour			
Commuting distance	Short • <1 km • 1–4.9 km Middle • 5–9.9 km • 10–14.9 km Long • 15–29.9 km • 30 km+	**28** 7 21 **33** 18 15 **39** 19 20	[c]Average trip distance (whole city) = 6.5 km Average trip distance (central city) = 5.4 km
Commuting time	Short • <5 min • 5–15 min Middle • 15–30 min • 30–45 min Long • 45–60 min • 60–90 min • >90 min	**18** 4 14 **40** 22 18 **42** 24 13 5	[c]Average commuting time (central city) = 40.8 min
Mode share	Driving Car sharing Motorcycle Taxi Bus Subway Bike Walk	28 4 4 2 11 15 9 29	[c]Private motor vehicle 20 Motorcycle 4.6 Taxi 6.6 Bus 12.9 [d]Subway 5.7 Bike 13.5 Walk 26.2 Electric bike 15.2

[a] The age groups used in Table 2.1 allow comparison with city statistics. The age grouping used in the study analysis (<=30, 30–50, 50+) better reflects the sample characteristics of the survey respondents.

[b] Figure 2.3 below highlights the ring roads in Shanghai that separate Shanghai regions into four zones. Zone 1 is mapped within the Inner Ring Road; Zone 2 is between the Inner Ring and the Middle Ring Road; Zone 3 is between the Middle Ring and the Outer Ring Road; and Zone 4 is outside the Outer Ring Road.

[c] Data as an average for the whole city obtained from the Fourth Travel Survey conducted in 2009 in Shanghai (Shanghai Municipality, 2010).

[d] City statistics for subway mode share is based on the 2009 Travel Survey. Shanghai metro has undergone dramatic expansion after 2009, and therefore subway mode share in 2011 is expected to be higher.

[e] (Shanghai Statistic Bureau, 2011)

Figure 2.3 Map of Shanghai ring roads

2.3 Results

2.3.1 Congestion level and need for policy intervention

Shanghai's high level of traffic congestion is clearly recognised by the survey respondents. Figure 2.4 shows that over 85% of respondents agree/strongly agree that Shanghai is very congested, and 90% agree that the Shanghai government should take further action. These findings suggest a potentially solid basis for public acceptance of the auction policy.

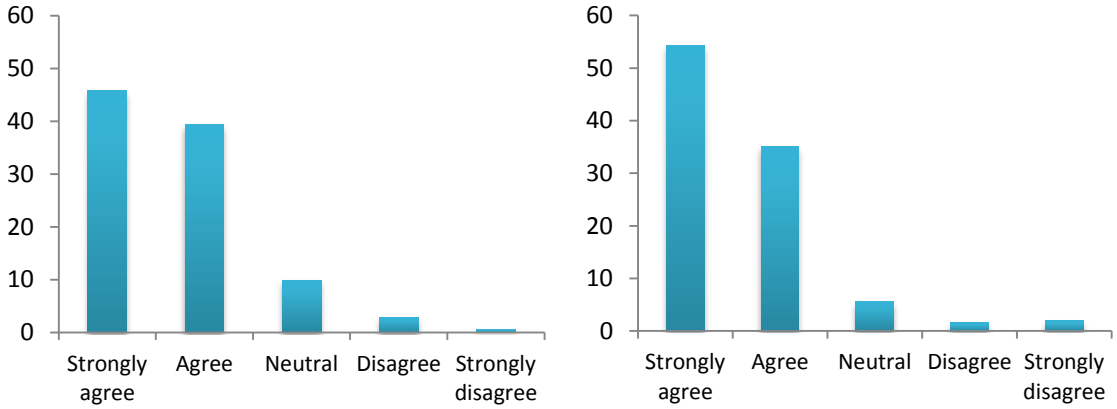

Figure 2.4 Perception of current congestion levels (left) and need for further government actions on congestion mitigation (right)

2.3.2 Auction policy awareness

Awareness of auction policy is evaluated as a confirmation that respondents' ratings are meaningful, and as preparation for the policy questions. Table 2.2 shows that awareness of general and specific policy is very high. More than 70% of the respondents know about the policy to a very specific level. For example, 72% are aware of a photographic system recently installed on elevated roads to enforce the non-local license policy (question X4). Overall, it appears that the respondents have enough policy knowledge to answer the attitudinal questions meaningfully.

Table 2.2 Policy awareness

General Policy Statements		Respondents aware of policy (%)
X1 -	Shanghai municipality uses a license quota auction policy to control and limit the number of licenses being released every month.	83
X2 -	The price for the license in February 2011 has increased to more than ¥40,000.	75
Specific Policy Statements		**Respondents aware of policy (%)**
X3 -	Vehicles with non-local plates are prohibited from driving on elevated roads during rush hours (Monday through Friday between 7:30–9:30 a.m. and 16:30–18:30 p.m.). Vehicles caught violating the rule will be fined ¥ 200.	76
X4 -	Beginning on February 25, 2011, the Shanghai government has installed Traffic Control Photographic Systems on elevated roads to apprehend drivers with non-local plates driving during rush hours.	72
X5 -	Shanghai vehicle licenses include urban plates (Plate A/B/D/E/F) and a suburban plate (Plate C). Car owners who want to register urban plates must go through the public auction; Plate C, however, does not require public auction, though vehicles with Plate C are only allowed to drive outside the Outer Ring Road.	68
X6 -	Shanghai license quota auction takes place on the third Saturday of each month.	46
X7 -	When the vehicle has been scrapped, the car owner can apply to keep the original plate quota for new vehicles, but the car owner needs to operate the vehicle for at least 3 years before it can be scrapped.	43
X8 -	Car owners must apply to keep the license quota within 6 months after the old vehicle has been scrapped; otherwise, the government will put the quota back for auction.	35

2.3.3 Overall policy acceptance

Current public acceptance is measured using the five indicators presented in Table 2.3 (X9 to X13). The five indicators are highly correlated (Cronbach's alpha is greater than 0.7, indicating a high internal consistency of the data). Figure 2.5 graphs the distribution of the mean value of the five indicators across the sample. The overall policy acceptance level is low: only 27% are positive; 43% are negative; and 30% are neutral.

Change in acceptance is measured retrospectively by indicators X14 and X15: 39% indicated that they adjusted to the policy over the years; and 44% said that their acceptance had increased considerably. Overall there is a slight positive trend in the public acceptance.

Indicator X16 measures perception of other people's acceptance of the policy. Whereas 27% of respondents were personally positive about the policy, 47% thought that other people accepted the policy. Jakobsson (2000) interpreted the expectation of others' intentions as anticipated social pressure on individual behaviour and a higher expectation that others' views would support the individual's own view of the policy.

Table 2.3 Policy acceptance and changes (% of respondents in agreement)

	Statement			
Sign	**Acceptance**	**Strongly/partially agree**	**Neutral**	**Strongly/partially disagree**
+	X9 - I support the quota auction policy in Shanghai.	36%	20%	44%
+	X10 - I hope the auction policy can continue to be implemented in Shanghai.	34%	22%	44%
-	X11 - Shanghai government should not use the quota auction policy to mitigate congestion.	59%	21%	20%
-	X12 - I cannot accept the quota auction policy as there are numerous problems with the existing policy.	58%	27%	15%
-	X13 - If voting, I do not want the quota auction policy to continue to be implemented.	57%	22%	20%
	Change of Acceptance			
+	X14 - I have already become used to people obtaining licenses via the auction policy.	44%	21%	35%
+	X15 - My acceptance towards the policy has increased considerably over recent years.	40%	26%	34%
	Expectation of others' acceptance			
+	X16 - Other people do accept the policy.	53%	10%	38%

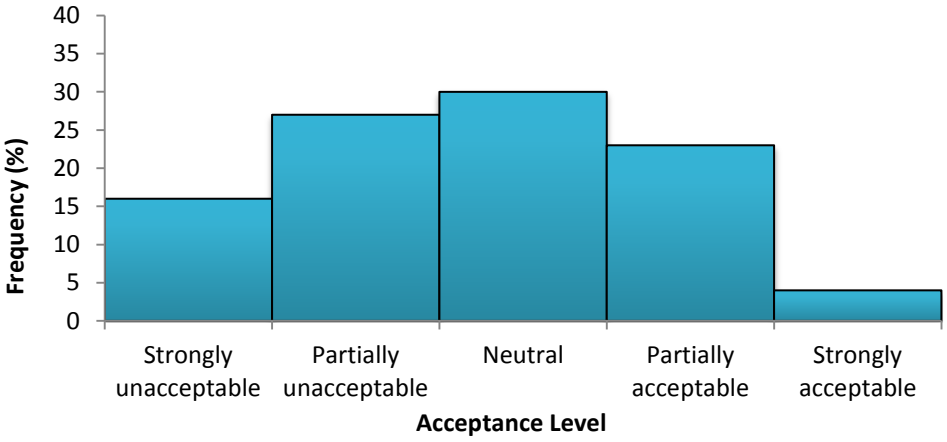

Figure 2.5 Distribution of policy acceptance level

Following the framework in Section 2.2.1, Figure 2.6 summarises public acceptance towards Shanghai's license auction policy and attitudes towards policy specifics that affect acceptance. Each factor is measured by multiple indicators, where the values reported is the mean of the indicators corresponding to the factor. While respondents consider the policy to be moderately effective in dealing with congestion, most attitudes towards effectiveness, affordability, equity, and implementation are negative, as discussed in subsequent sections.

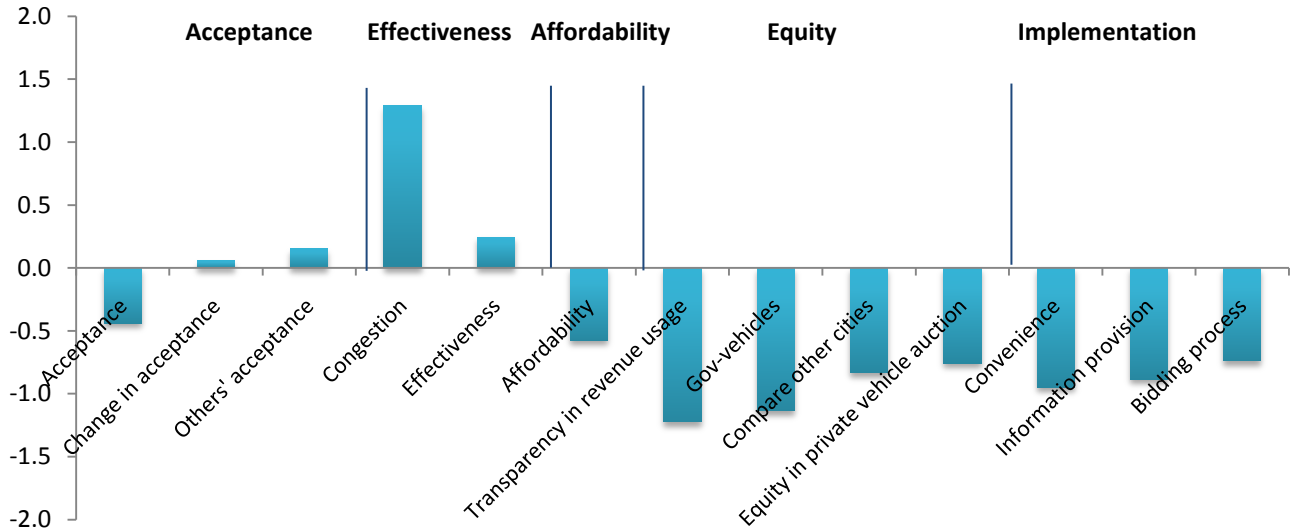

Figure 2.6 Public acceptance of license auction policy and attitudes towards policy specifics affecting acceptance

Note: +2.0 indicates the most positive perception, -2.0 the most negative and 0.0 neutral.

2.3.4 Core policy drivers: effectiveness, affordability, and equity

2.3.4.1 Effectiveness

Shanghai Metropolitan Transport White Paper (Shanghai Municipality, 2002) suggests that the license auction policy has controlled vehicle ownership growth, reduced congestion, provided time and funds for improving public transit and road infrastructure, and contributed towards transit oriented development in Shanghai. The public's perception of policy

effectiveness is positive but less admirable than the official claim, as shown in Table 2.4. 48% of respondents agree that the policy has solved Shanghai's congestion problem, and 42% believe that, without the auction policy, traffic conditions would be worse. However, perceptions of policy effectiveness are low compared with the perceptions of Shanghai's congestion levels. As noted in Section 2.3.1, 85% of respondents said that Shanghai is very congested.

Table 2.4 Policy effectiveness (% of respondents in agreement)

Statements				
Sign	**Policy effectiveness**	**Strongly/ partially agree**	**Neutral**	**Strongly/ partially disagree**
+	X17 – The Shanghai government has solved the congestion problem by implementing the license quota auction policy.	47%	29%	24%
+	X18 - Without the auction policy, there will be a rapid growth of car ownership and the traffic condition in Shanghai will worsen.	42%	27%	31%

2.3.4.2 Affordability

Shanghai license prices have fluctuated significantly. In July 2011, the average bidding price exceeded ¥50,000 - more expensive than a small car (e.g., a Cherry QQ cost ¥33,800). Many residents of Shanghai may be able to afford a small vehicle, but not a car and a license.

Indicators X19 to X22 (Table 2.5) measured the public's perception of license affordability. 73% of the respondents said that many people could not afford a license, and 56% said cars were only for rich people. On the other hand, 30% felt that the price was still personally affordable, and 21% did not care about the price as long as they could get a license. Survey respondents had a higher than average income, thus population concerns over affordability are likely higher than the results reported here.

Table 2.5 Statements on license affordability (% of respondents in agreement)

Statement				
Sign	**Affordability**	**Strongly/partially agree**	**Neutral**	**Strongly/partially disagree**
-	X19 - Many people cannot afford the high license price.	73%	16%	11%
+	X20 – The price of the Shanghai license is still within my financial affordability.	30%	21%	49%
-	X21 - The high price of the license has resulted in cars being available only for rich people.	56%	21%	23%
+	X22 - I do not really care about the price of the license as long as I can get one and drive my car.	21%	21%	58%

When asked to give an acceptable price for a license, respondents typically said ¥5,000 to ¥9,999, less than one-fifth of the bidding price at the time of the survey. When asked to give a license price that would be acceptable and effective in reducing congestion, respondents increased the price to ¥20,000 to ¥29,999, still far less than the actual bidding price.

In personal communication with the authors, Mr. Yao, a senior police officer who manages traffic in Shanghai and works with transportation planners, explained that the government wanted to keep the license price between ¥30,000 and ¥50,000. Any price over ¥50,000 would be too high and could cause public dissatisfaction, but any price lower than ¥30,000 would not be effective. Mr. Yao indicated that the government adjusted the price by changing the license quota every month: when the price was too high, the next month's quota was increased, and vice versa. This approach contrasts with stated license policy where the quota is set based on road infrastructure and the number of cars that can be accommodated, and then allows the license price to respond. Figure 2.7 summarises the price ranges discussed.

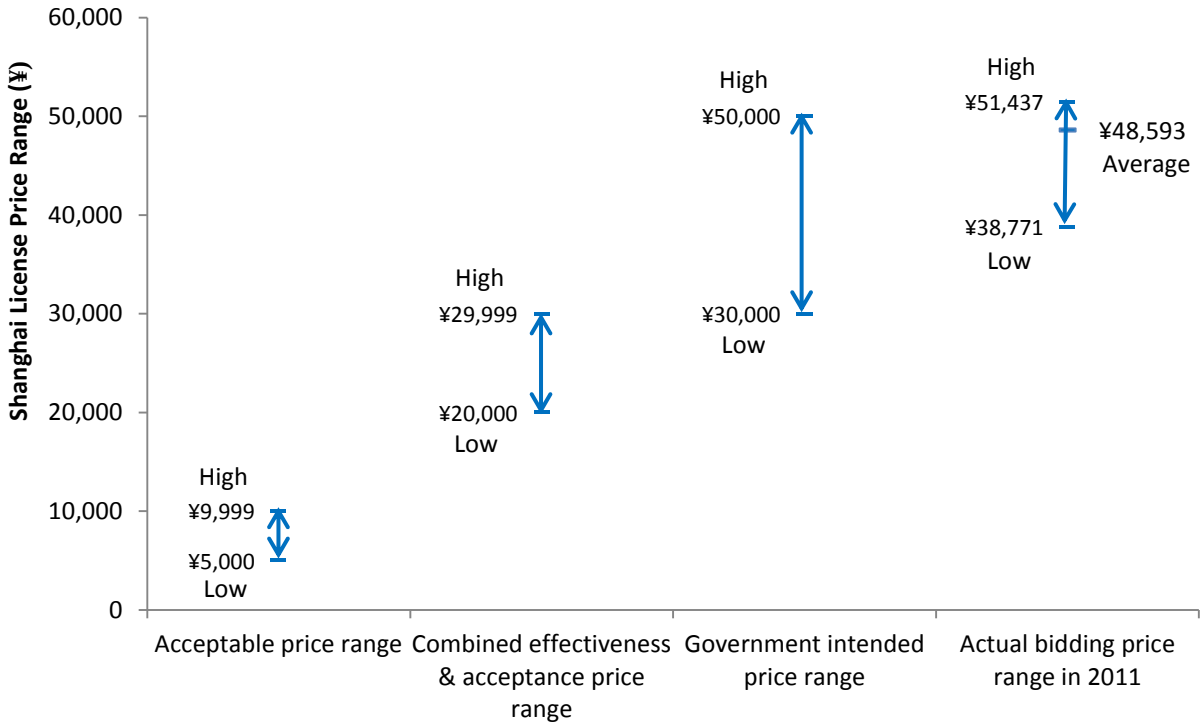

Figure 2.7 Shanghai license price range - acceptable price range, combined effectiveness and acceptance price range, government intended price range, and average 2011 ongoing price

2.3.4.3 Equity

Four sets of equity concerns are evaluated within the survey instrument: equity in private vehicle auctions, restrictions in government vehicles, fairness compared with other cities, and transparency in revenue usage. Table 2.6 provides details of the questions and responses.

Table 2.6 Statements on equity (in % of respondents in agreement)

Statement				
Sign	**Equity in private vehicle auction**	**Strongly/partially agree**	**Neutral**	**Strongly/partially disagree**
-	X23 - The auction policy is not fair as it auctions the cars together; thus the car price and car type do not matter.	71%	16%	13%
-	X24 - Shanghai's quota auction policy is not fair as it makes the road that is constructed using revenue collected from all residents only for a small portion of rich people.	67%	19%	14%
-	X21[c] - The high price of the license has made cars available only for rich people.	56%	21%	23%
	Perception on government vehicles	**Strongly/partially agree**	**Neutral**	**Strongly/partially disagree**
-	X25 - There should be more restrictions on the license quota for government financed vehicles than on private vehicles.	85%	11%	4%
-	X26 - Government should reduce the total quota released per month for government financed vehicles to reduce the ratio of government vehicles on Shanghai's road.	84%	11%	5%
-	X27 - Government should reduce and restrict the quota that each government department and agency can bid.	9%	15%	76%
+	X28 - There should be a relaxation on the quota limit for government vehicles as doing so will make government agencies more convenient and accessible.	17%	18%	65%
	Fairness compared with other cities	**Strongly/partially agree**	**Neutral**	**Strongly/partially disagree**
-	X29 - Drivers in cities outside Shanghai have more freedom as they do not need to auction for their licenses.	80%	15%	5%
-	X30 - The auction policy is not fair as it makes people in Shanghai pay more than people in other cities do to enjoy the same freedom of driving.	62%	22%	16%
-	X31 - The lottery policy in Beijing is fairer than Shanghai's auction policy, as no matter how much money you have, you can still join the lottery and have a chance to win a license quota.	59%	23%	18%
	Transparency in revenue usage	**Strongly/partially agree**	**Neutral**	**Strongly/partially disagree**
-	X32 - I do not know about the usage of the revenue collected from the auction.	86%	11%	3%
-	X33 - Shanghai should make the revenue usage transparent to the public for auditing.	85%	12%	3%
+	X34 - The revenue collected is for government use, which has no need to be transparent to the public.	17%	12%	71%

[c] The same indicator, X21, is used to measure both affordability and equity in a private vehicle auction.

Equity in Private Vehicle Auction Policy

The lack of affordability of the Shanghai license has caused concerns about the policy favouring the rich. Respondents' perceptions of equity in the private vehicle auction are consistently negative: most respondents said that the policy is unfair and makes roads and cars available only to the wealthy. Singapore categorises vehicles by capacity (S. Y. Phang et al., 1996), but Shanghai treats all vehicles the same. 71% of respondents indicate that this is unfair because it pits people who can only afford a cheap vehicle against those who can afford a luxury vehicle.

Restriction on Government Vehicles

In 2004 Shanghai announced that government vehicles would also be subjected to the auction process for the first time, but with a separate quota limit (J. Zhou, 2004). These government vehicle auctions take place every two months. A base price is established using the previous month's average bidding price at the private vehicle auction. Anecdotally, many car owners complain about the high percentage of government vehicles being driven on Shanghai's roads and particularly the private use of government vehicles. They consider the system unfair because government vehicle licenses are paid with taxpayers' money, but private car users had to pay with their own money. More than 80% of respondents indicate that there should be more restrictions on the total number of government vehicles.

Fairness Compared with Other Chinese Cities

Until 2011 Shanghai was the only city in China that restricts automobile ownership using license quota. Over half of the respondents consider the car ownership policy unfair because it makes Shanghai residents pay more than residents of other cities to enjoy the same freedom of

driving. Since 2011 three Chinese cities have also introduced their car ownership control policies: Beijing started the car license lottery policy in Jan 2011, Guizhou in Aug 2011 and Guangzhou a hybrid model combining license auction and lottery in Aug 2012. These cities following suit may influence Shanghai public's perception of this aspect of fairness. Shanghai's auction requires high license fees and Beijing's lottery requires no entry cost but long wait in the queue. Before Beijing implement the lottery policy, Shanghai residents are only comparing to cities with no car ownership control which makes the attitude relatively negative. If change the comparative frame to Beijing's lottery with low odds of winning, Shanghai car buyers especially those who are urgent to buy cars may feel better about the auction policy compare to Beijing instead.

Transparency and Trust in Revenue Usage

Shanghai's license auction policy has generated large amounts of revenue for road infrastructure and public transport. For example, Shanghai did not have a subway until 1995, but the system is now among the most rapidly expanding systems in the world (Shanghai Tour, 2011). Figure 2.8 shows the annual revenue collected from the auction calculated based on the average price of successful bids and the number of licenses released each month. As a comparison Shanghai municipal subsidy to public transportation operation in 2010 is 2.5 billion CNY, which can be more than offset by the license auction revenue in the same year (4 billion CNY). From 2002 to 2011 Shanghai's license auction generated an estimated 28 billion CNY.

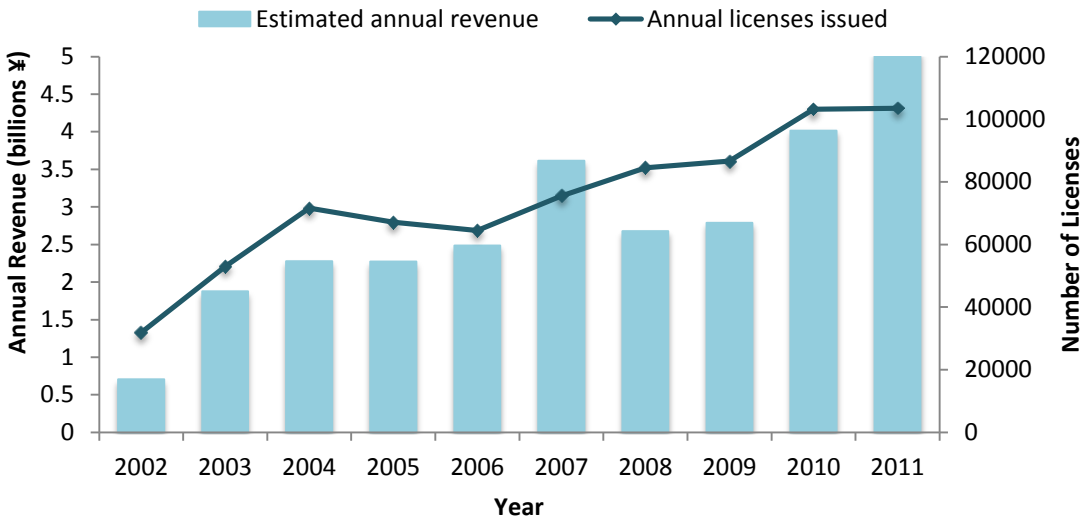

Figure 2.8 Annual revenue collected from the license auction in Shanghai from 2002 to 2011 (data: Shanghai Jinwei Automobile, 2011; calculated by the authors).

However, the actual amount of revenue and its specific uses have not been made known to the public. On May 22, 2009, lawyer Yu submitted a request to the government to release detailed information on revenue usage (L. Wang & Zhou, 2011). In response, only rough estimates and general indications of spending usage were provided. Shanghai now publishes the annual revenue usage online with rough usage information provided and detailed information was still unknown. Many question the auction policy simply as another government funding source.

The survey respondents' attitudes towards transparency in revenue usage are correspondingly consistently negative. Over 80% believe that there is a lack of transparency in revenue usage, and that the Shanghai government should make the detailed usage public for auditing. 82% believe that auction revenue should be used to improve the public transit system and reduce transit fares.

2.3.5 Implementation specifics

2.3.5.1 Process of obtaining a Shanghai license

Shanghai's license auction policy is managed and implemented by the Vehicle Management Department under the Shanghai Traffic Police Bureau. The Shanghai Auction Company manages the license auction, which takes place the third Saturday of every month (China License Plate, 2011). Bidders must register and pay a ¥ 2,000 deposit to obtain a bid auction card for the monthly auction (China License Plate, 2011). The bid auction card expires six months after registration, and unsuccessful bidders can use the card for a maximum of three times. Unsuccessful bidders must wait to join the next month's auction with no guarantee of a license that month. To bid, an applicant needs a driving license. A temporary driving permit valid for a maximum of 15 days is available. An individual can apply up to three times for the permit.

The time limits for the bid auction card and the limitations on temporary driving permits have raised concerns about the inconvenience of the whole process. More than 70% of the survey respondents indicate that the process of obtaining a Shanghai car or driving license is both time consuming and complicated, as shown in Table 2.7.

Table 2.7 Statements on the implementation process (% of respondents in agreement)

Statement				
Sign	**Process of obtaining a license**	**Strongly/partially agree**	**Neutral**	**Strongly/partially disagree**
-	X35 - Obtaining a license through auction is very time consuming in Shanghai; there is no guarantee that you will win the bid.	77%	17%	6%
-	X36 - You have to use a temporary license to drive before you win the bid in the auction; it is very inconvenient as one can only apply for a temporary license 3 times and each can be used for a maximum of 15 days.	77%	18%	5%
-	X37 - The whole process of obtaining a license to be able to drive is very complicated and time consuming in Shanghai.	70%	23%	7%
-	X38 - Car owners who cannot immediately obtain a plate must wait another month, as the license bidding takes place only once per month, which is very time consuming.	70%	20%	10%
	Bidding format	**Strongly/partially agree**	**Neutral**	**Strongly/partially disagree**
-	X39 – Using the Internet and phone bidding is not very reliable as sometimes one failed to place a bid successfully due to network paralysis or congestion in the phone lines.	69%	24%	7%
-	X40 - Bidders could not obtain the actual bidding details using the Internet or phone bidding.	62%	30%	8%
-	X41 - There are many loopholes in the bidding process, making it difficult to be fair and transparent.	57%	33%	10%
-	X42 - There might be speculative activities and black casework existing in the bidding process and system.	59%	33%	8%
	Information provision	**Strongly/partially agree**	**Neutral**	**Strongly/partially disagree**
-	X43 - Shanghai's auction policy is continually changing, and I cannot find or confirm the most current rules and specifications.	73%	21%	6%
-	X44 - I cannot update my knowledge of the changes made in the policy.	73%	21%	6%
-	X45 - Car owners often realize the change in policy only after they have been fined.	64%	27%	9%

2.3.5.2 Bidding format

The auction's bidding technology has also generated complaints. Winning bids are selected first on price and then on time. The system ranks the bidders by bid price. If the month's quota is 8,000 licenses, the system accepts the 8,000 highest bids. Initially, all bids had to be made in the Auction Hall. Phone bids were introduced in 2003. In 2008, bidding in the Auction

Hall was cancelled in an attempt to avoid the chaos that arose during the bidding process. The auction system was changed to a two-stage bidding process that allowed for price adjustments to be made after the first stage (China License Plate, 2011). Under the new system, no price limit was set and bidders could bid any price in the first stage. The number of first stage bidders and the lowest winning prices were made known. In the second stage, up to two adjustments were allowed within ¥300 above or below the lowest winning price of the first stage.

Internet and phone bidding options have made the bidding process more convenient, but created room for speculation. There are rumours of "black-case operations", and many believe that the bidding price is manipulated by car dealers and traders who hoard licenses and by traders who spread rumours of higher prices and/or bid a high price in the first round so the system can report the high price in the second round (J. Chen, 2008; Xie, 2010). Public concern has been further increased because of lack of transparency in detailed bidding information, and technical difficulties in the bidding systems. For example, many bidders have lost a bid because of system breakdowns, and the July 2009 auction was cancelled due to network paralysis.

Survey respondents indicate that the bidding technology is not reliable and lacks transparency. Nearly 60% of respondents agree that loopholes in the bidding process make it difficult to be fair, and over half believe that speculative activities exist in the bidding process.

2.3.5.3 Policy information provision

Public information about the bidding policy is limited. For example, there is no single source online or offline to check the regulations. Participants obtain information from various newspapers, policy notices, or auction guidelines posted ad hoc in public space or online. Survey respondents indicate that policy information is not properly updated and that it is difficult to

track policy specifications and changes. Over half believe that car owners only became aware of policy changes after being fined for breaking a rule.

Some people additionally question the legal basis of implementing this auction policy (Xie, 2010). When Shanghai's public auction policy was introduced, it was based on the "Regulations on Shanghai Motor Vehicle Administration" in 2000 (Yu & Hou, 2010). These regulations were replaced by the "Law of the People's Republic of China on Road Traffic Safety" in 2004. No information about any additional regulations drafted for Shanghai's auction policy is available. As far as the authors can tell from publically available sources, no legal documents currently govern the auction policy.

2.3.6 Unintended consequences

High and increasing license prices in Shanghai have seemingly pushed many locals to register their cars in other cities in order to bypass the auction. The average license outside Shanghai costs only 5% of a Shanghai license, but is less convenient to administer. Figure 2.9 compares the average car and license prices of local licenses with non-local licenses: the Shanghai license price averaged 13% of the car price whereas the non-local license price averaged only 3% of the car price.

Non-local license (NLL) holders who drive on Shanghai's roads without purchasing a local license reduce auction policy effectiveness, resulting in revenue loss, difficulties in traffic management, equity concerns among local car owners, and damage to the trustworthiness of the entire auction policy. However Shanghai must balance these goals with its role as a metropolitan center for the country. It cannot simply impose harsh restriction on non-locally licensed cars. By devising and gradually revising policies to inconvenience vehicles with NLLs, not ban them, the government has successfully compromised between the city's open-ness on the one hand, and

compliance with vehicle control policy on the other hand ((Zhao, Block-Schachter, & Chen, 2013)).

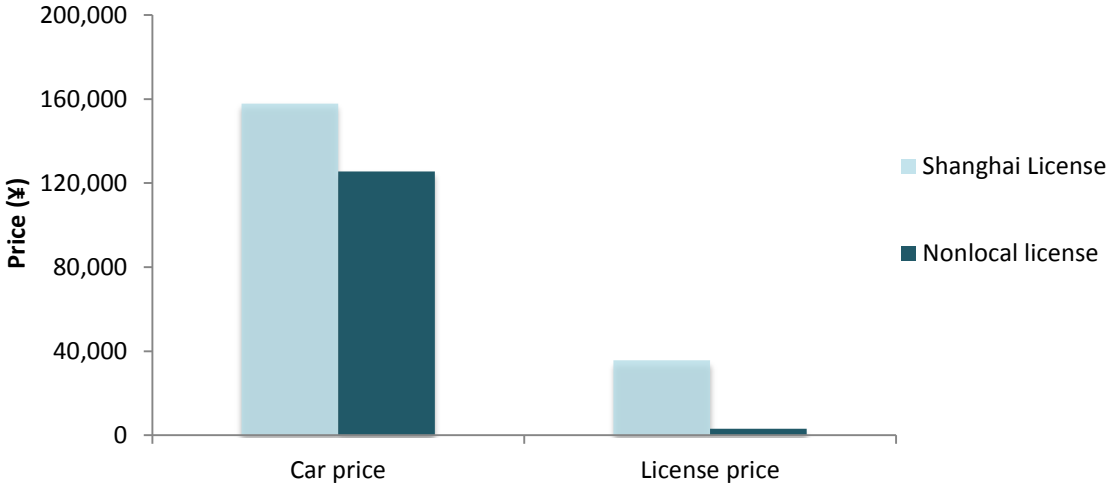

Figure 2.9 Comparison of car price and license price between Shanghai and non-local car licenses

2.3.7 Congestion mitigation policy options

Survey respondents were asked to consider three policy instruments that might replace or supplement the auction policy: parking charges, congestion charges, and fuel taxes. The questions investigated public acceptance and perceived effectiveness without specifying the details of the policies. Improving public transit was included in the pilot survey but removed in the main survey because it dominated the responses, making it impossible to distinguish between other policy options.

Figure 2.10 plots the survey respondents' attitudes towards these policies on a five-point numerical scale where 2 indicates very effective and very acceptable, and -2 indicates ineffective and not at all acceptable. Congestion charges and the license auction were the best-perceived policies in both dimensions, followed closely by parking charges. Fuel taxes were by far the worst - perceived as neither acceptable nor effective. When the respondents were asked to rate the four policies combining acceptability and effectiveness, fuel taxes remained the least

favourable policy. It is interesting that the respondents gave license auctions poor marks when they evaluated the policy on its own, but higher marks when compared with other policies. It suggests that context within which a policy is evaluated may well influence the result of the evaluation. This is consistent with Tversky and Kahneman (1981), which shows that framing of a problem can affect the outcome in part from the manipulation of the decision options offered.

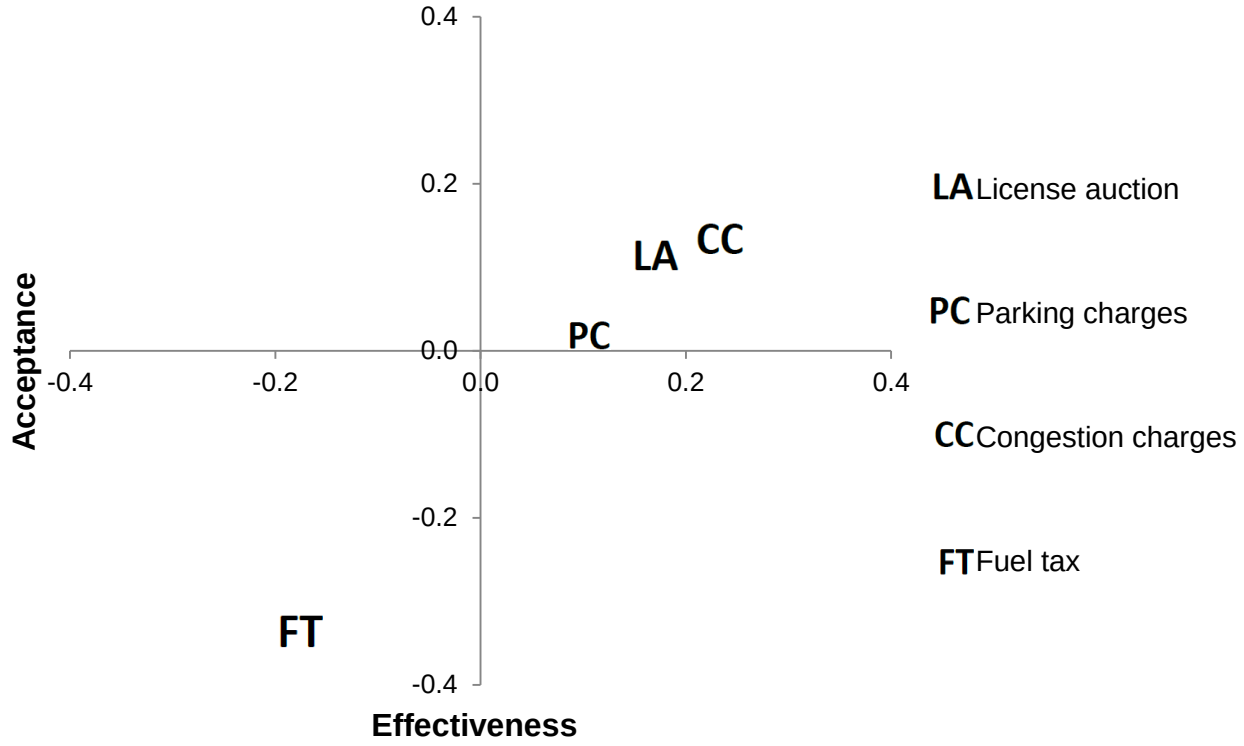

Figure 2.10 Acceptability and effectiveness of congestion mitigation policies

Figure 2.11 shows how car ownership influences respondents' attitudes towards license auctions, parking charges, congestion charges, and fuel taxes. The attitudes of car owners are circled, and the arrows show the direction of change between non-car owners' and car owners' perceptions of policy acceptability and effectiveness. Car owners were consistently more negative about parking charges, congestion charges, and especially fuel taxes than non-car owners. But they were more positive about license actions - presumably because they have

already paid for the license. Car owners saw the license auction as the best option while non-car owners saw congestion charges as the best.

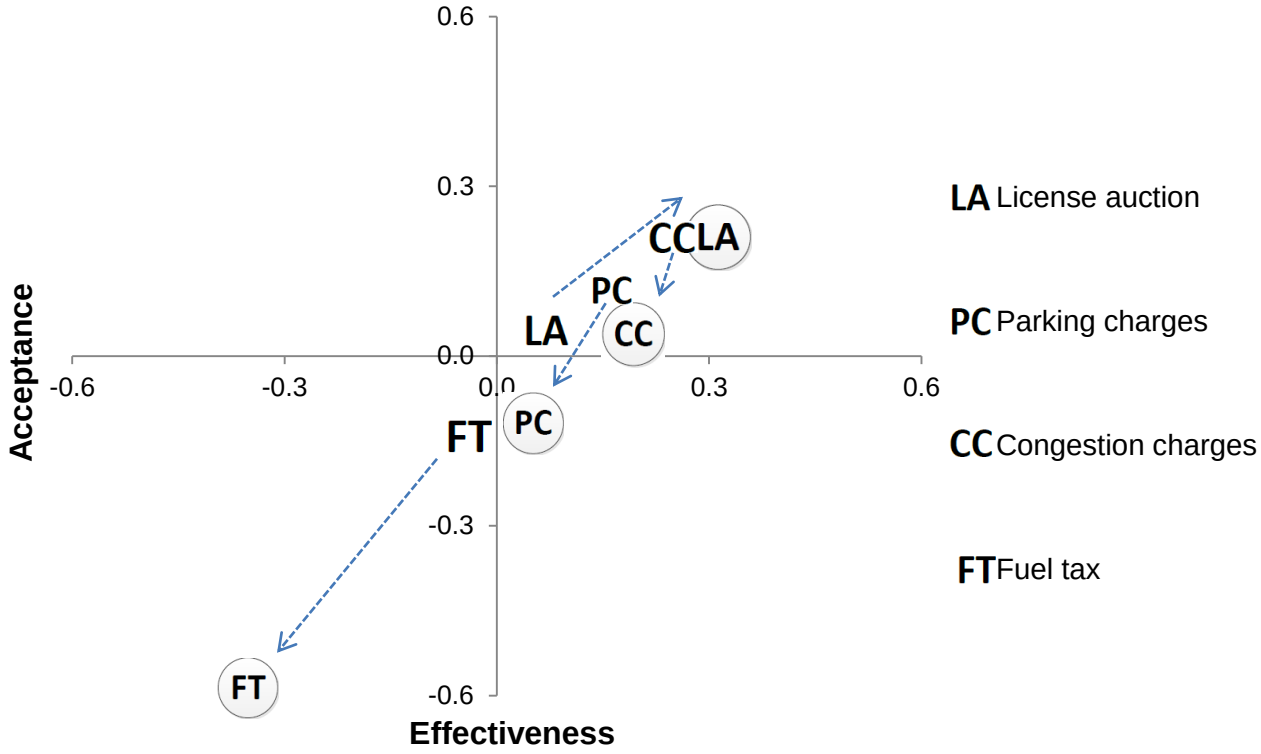

Figure 2.11 Acceptability and effectiveness of congestion mitigation instruments between car owners (circled) and non-car owners (arrows indicate the change in attitude after obtaining a car)

2.4 Discussion

This chapter assesses the acceptance of Shanghai's license auction policy by the working population in Shanghai via a survey of 524 employees at 9 companies. The results suggest that policy acceptance among respondents is moderately low but increasing, and that expectations are that others would support the policy. Respondents mostly perceive the policy as effective, but believe it is neither affordable nor equitable. Equity concerns are focused on transparency in revenue usage and the perception that government vehicles enjoy various license advantages. Respondents also are negatively disposed towards the bidding process and technology, and the amount of information available about the license auction policy.

On the basis of these results, we make five recommendations. First, transparency in revenue usage must be addressed. These findings suggest that if the public knew where their money is spent, it would increase public acceptance of the auction policy. The Shanghai government should publish detailed revenue usage information in order to demonstrate that the revenue is used to improve public transit and reduce public transit fares in Shanghai. This information would reveal both the intent and effectiveness of the current policy regime.

Second, better controls and restrictions on government vehicles would likely mitigate equity concerns about government vehicles. For example, the government could reduce the quota for government vehicles, and increase transparency regarding the total number, purpose and usage of government vehicles. Controlling the private use of government vehicles would also help alleviate public concerns.

Third, categorising vehicles by type and capacity in the auction (so more expensive vehicles would pay more than budget vehicles) would increase policy fairness and acceptability

but the specifics such as the quota ratio between various vehicle types need to be carefully thought through.

Fourth, improvements in the implementation process could increase public acceptance. For example, moderately increasing the length of the temporary driving permit period would ease the process of obtaining a license in Shanghai. So too would improving the bidding system technology, and providing necessary bidding information to the public. For example, a website for Shanghai's license auction that maintains and organises policy specification documents and updates would allow more informed bids. Such a website could also maintain current, updated information about license auction procedures and applications, traffic conditions, road construction, and improvements in public transit.

Finally, although Shanghai's license auction policy has effectively controlled growth in the number of vehicles, the demand for cars continues to increase. The car license policy alone may not be sufficient in the future. Supplementing policies aimed at car ownership with those that restrict vehicle usage in congested locations and during peak hours may be more effective. When comparing the license auction policy with other instruments such as congestion charges, parking charges and gasoline taxes, the respondents rated license auctions and congestion charges as the most effective and acceptable policies.

Building on these results and recommendations, four directions for future research stand out. 1) The study identifies a plethora of factors that may influence people's acceptance. A structural equation model could be developed to quantify the strength and direction of these factors and their impacts on policy acceptability. 2) Study respondents were all employed and had higher than average education and incomes. A study of the lower income and unemployed Shanghainese may reveal different attitudinal responses. 3) Changes in attitude are examined by

cross-sectional retrospective measures. Panel data is necessary to measure the dynamics of attitudinal change over time. 4) Beijing and Shanghai transportation policies have evolved disparately since the early 1990s. Shanghai chose to manage car ownership, while Beijing chose to control car use. Then, in 2011, Beijing adopted a monthly quota for vehicle licenses, but chose a distinctly different allocation mechanism—a license lottery. A comparison of the different paths the two biggest cities in China have taken would be of value.

Innovative policies implemented in Shanghai are often embraced by other Chinese cities - Shanghai acts as a role model (Bezlova, 2007). For example, as mentioned in the fairness comparison between Shanghai and other cities, Guangzhou implemented a hybrid model of car ownership control in 2012, borrowing from both Shanghai and Beijing. Half the vehicle quota is allocated via an auction and half through a lottery. Thus, while this chapter focuses on Shanghai, its experience, both positive and negative, can be useful to other Chinese cities seeking suitable solutions to mitigate congestion. The framework developed in this study can be applied to study public acceptance of transportation policies elsewhere.

3 Car Owners as Supporting Constituency: Preference Variations in Car Licensing Policy

Economic growth and rapid urban expansion in many developing countries has resulted in increasing trips over long distances and greater private motorization. This has led to various transportation problems such as traffic congestion, environmental pollution, and energy shortage especially in fast growing developing countries such as China. As the leading automobile producer and consumer, China has enacted various transportation related policies and regulations targeted at reducing congestion, improving air quality and energy efficiency. Many restraining policies have been studied and implemented in different Chinese cities. Congestion mitigation policies could be implemented in two ways through car usage or ownership restriction. A majority of cities have taken steps in usage restriction such as driving ban, parking charging, and fuel tax. Car ownership policies have rarely being implemented in Chinese cities, since China is aiming to boost the domestic car industry. Shanghai is the first city in China to implement a direct policy controlling car ownership growth through economic measure.

Referencing Singapore, Shanghai introduced a license quota policy in 1994 through a monthly auction to keep local car ownership at a desired level (L. Wang & Zhou, 2011). This auction policy has not only dampened the car ownership growth rate, but also generated large revenue for road infrastructure construction and public transit network expansion. However, public concerns on affordability of the license cost, fairness of the policy, and implementation process raise questions on public acceptability of such car deterrence policy. Public acceptability is one of the most important preconditions for the successful implementation of such policy, but empirical findings have shown it to be considerably low.

The political economy of most car deterring policies as congestion charging, parking charging, and fuel tax show that car owners, in general, are the group that most oppose these policies (Gomez-Ibanez, 1992). But the car license auction policy in Shanghai may prove an exception. Different from the pay as you drive theory in car use restriction, Shanghai only requires a lump sum cost for the car license with no additional driving cost. Attitude among people especially car users would be different under Shanghai's policy from other car deterring policies.

This study examines Shanghai residents' preference variation towards car license auction policy. Since people's attitude may vary quite differently within different subgroups, disaggregate analysis is important for better understanding of individual attitude. Car ownership policy is usually a less popular congestion mitigation strategy due to its low public support before its introduction, but with the increasing car ownership level, car ownership control becomes inevitable in large cities. This study will be valuable for local policy makers improving policy acceptance and also for other cities intending to introduce such policy.

Thus, questionnaire surveys were conducted online and data were analysed at the disaggregate level to: (1) Evaluate the preference variation in overall acceptance of license auction policy and attitudes towards policy specifics including perceived effectiveness, affordability, equity concerns, transparency in revenue usage, and perception on government vehicles; (2) identify the key socioeconomic determinants of public acceptability and specifics.

The chapter will start with a summary of the current literature concerning socioeconomic differences in acceptability of transportation policy and possible acceptance model used. Data and methodology used are then outlined. Disaggregate analysis together with model estimation

results are presented in Section 3.3 and finally Section 3.4 follows with a summary and discussion of the key findings from this study.

3.1 Literature

Public acceptability is one of the most important preconditions to implement any policy in transportation. Previous literature had focused mainly on congestion mitigation policies restricting usage such as road pricing. Less focus had been put on investigating public acceptability of car ownership policies and its determinants. Although not focused on car ownership policy specifically, the following literature have been reviewed to understand preference variations towards transport pricing policies and models being developed to examine determinants of acceptability. They are arranged in three categories: attitude variation of public acceptability, dynamics in public acceptance, and models on public acceptance.

3.1.1 Attitude variation in acceptability of car deterring policy

In February 2005, a referendum was held to introduce a road charging scheme in the city of Edinburgh in Scotland, UK, while public residents were involved to vote in the referendum. The public voted against the scheme by a ratio of 3:1 and it was consequently abandoned. Braunholtz et al. (2006) had investigated the public opinion towards the scheme and the underlying reasons for Edinburgh residents' rejection of the proposed strategy through questionnaire survey of 1,002 residents and a series of nine focus groups conducted in various locations across Edinburgh. The referendum results were also reflected in the survey results as close to three-quarters of the residents indicating they do not support the scheme. Support of the scheme was lowest among those who drive to work and especially car owners in general.

A similar study was also conducted by Gaunt et al. (2007) on public opposition to the proposed road pricing scheme in Edinburgh using questionnaire surveys. Car owners, again, seemed to take a higher percentage of voter turnouts since they had higher motivation to vote in the referendum. Car ownership showed significance in acceptability as voter turnout was found to increase in accordance with the number of cars available within household. This study found that the principal determinant of voting behavior was car use, and car owners were generally opposing the scheme while non-car owners supported it. Car owners did not appear to recognize, or appreciate, the potential benefits that congestion charging may have brought about. While reduced congestion and improved alternatives to the car were abstract possibilities, the prospect of being charged are more tangible, costly, and unacceptable to car owners. Different from the road pricing scheme where car users are more affected, people who are planning to buy cars are more affected under car ownership policy.

Also on road pricing, Jaensirisak et al. (2005) had reviewed various literature on acceptability of road pricing schemes and identified several limitations to the current research. One of the weaknesses he identified in existing literature is the lack of study to understand the differences in acceptability between users and non-users. Through a stated preference survey conducted in two UK cities, Jaensirisak et al.'s study suggested that while road pricing was found overall to be unacceptable, some personal characteristics made it even more or less so. Results indicated charging to be more acceptable to non-car users and those who perceived the current congestion and pollution to be very serious. Older participants were also found to be less acceptable, but income level did not show significance on acceptability in this study.

Among all literature, Gehlert et al's study (2011) had showed a clear demonstration of using a segmentation approach to investigate socioeconomic variations on public attitude

towards road pricing. These variables also caused differences in people's car use adaptation towards urban road pricing together with their preferred revenue usage. Based on data from the AKTA (Danish abbreviation for Alternative Driving and Congestion Charging) road pricing field experiment consisting of 517 randomly selected car users in Copenhagen, public acceptability of four different transport pricing systems was measured before and after the experiment. Although no significant differences were found for public acceptability, the most important variables determining different reactions towards urban road pricing were income, age, gender, education, car behavior (measured as weekly car use), house location and transport infrastructure. This study suggested that knowing the variation of response might help to design more effective policies tailored to the social background of different user groups to increase effectiveness and ensure public acceptability. Similar to urban road pricing, income level, house location and transit infrastructures may also affect people's attitude towards the license auction policy in Shanghai.

3.1.2 Dynamics in public acceptance

In addition to acceptance level, previous literature also suggested the importance of dynamics in acceptance as people's attitude do change over time.

Odeck and Brathen (1997) had reviewed the Oslo toll ring scheme in Norway, determined and explained public attitudes towards the scheme. Based on a time series interview survey between 1989 and 1990, a multivariate model was developed in this study to determine factors affecting users' attitudes towards tolls. Interview indicated a great majority across years showed negative opinions concerning the toll collections but the gap between those who are against and those who are for were narrowing as the years went by. Variations in attitudes by socioeconomic characteristics were also found while automobile users responded negatively

towards tolling as compared to transit users since tolls were not paid by transit commuters. Model results generated also confirmed that frequent car users were more likely to have negative attitudes. Elder people were also more likely to have negative opinions since they might have been the ones who were highly dependent on cars. Odeck and Brathen's study reflected that people's attitude would change once they have realized the benefits of tolls.

The congestion charging trial in Stockholm showed another example of attitudinal swung after implementation of the trail. Winslott-Hiselius et al. (2009)investigated the attitude changes in Stockholm's congestion charging through telephone interviews before and during the trial. The overall attitude shifts towards more positive stage in the trial and was further confirmed by a final positive attitude in the referendum in favor of a permanent solution with congestion charges. This study also suggested that personal effects influenced opinions about the charges especially those travelling by public transport were more positive than habitual car drivers. It suggested a possible change from structural effectiveness perspective before the trial to the personal effectiveness perspective during the trial which showed to be more positive. Public were convinced by own personal experience of the effects after the implementation. This also implied that people's view about a policy increases once the level of uncertainties decreases once a policy has been introduced.

Also studying the Stockholm congestion charges, Borjesson et al. (2012) summarized a series of factors leading to this positive change in attitude. One of the factors is the familiarity with the policy consequences which means reducing the level of uncertainty in the policy. Benefits in the congestion charges turn out to be larger than the public anticipated. Secondly, the change in cost and behavior may prove to be not as bad as expected as many people found the policy not affecting them as much. This is also suggested in Schuitema and Steg's study (2005),

where they tested the causality between revenue usage with acceptability that acceptability of transport pricing measures is higher if people think their life will not be affected too much, and if people think the congestion problem will actually reduce. Thirdly, cognitive dissonance was also mentioned as once something has been implemented, people are tended to accept the unavoidable.

Other studies also mentioned several side effects of introducing transport pricing measures that causing changes in acceptability such as "psychological reactance", rebound effect, and crowding-out effect. Psychological reactance (Brehm, 1972) refers to people who feel restricted in freedom of choice by external force may respond by refusing compliance or even display opposite behavior. Another effect mentioned was rebound effect (Binswanger, 2001) which an improvement makes car more energy efficient. And because of this added efficiency, people may tend to use it more often than regular cars which as a result water down the effectiveness of the original policy intention. Thirdly, there was another crowding-out effect of intrinsic motivation (Frey, 1993) where encourage people to manifest certain behaviors that they attribute to financial rewards or punishments. But certain unwanted effects may be evoked as a result of crowding-out effect. Different side effects may occur depends on individual characteristics and the type of pricing measure used.

3.1.3 Models of public acceptance

Structural equation modeling (SEM) is a modeling technique that can handle a large number of endogenous and exogenous variables, as well as latent variables specified as linear combinations of the observed variables. It is used to capture the causal influences of the exogenous variables on the endogenous variables and the causal influences of endogenous variables upon one another (Golob, 2003). Golob (2003) had reviewed the application of SEM

in different areas and most of the use is in travel behavior analysis. But application of SEM had also gained popularity in other transportation related fields.

Various models have been used to identify proximal determinants of public acceptability and SEM is widely adopted to examine factors determining acceptability. Jakobsson et al. (2000) provided a good example. Jakobsson et al had investigated the determinants of public acceptability of road pricing among 524 car owners living in a metropolitan area of Sweden. Structural equation model was implemented in the LISREL 8 software to specify the strength and direction of causal paths between variables. This study had demonstrated the use of structural equation modeling technique in evaluating determinants of public acceptability of road pricing. Model results showed that acceptability was negatively affected by perceived infringement on freedom, equity concerns, and income levels. The lower income the participants have, the less affordable they are and the more they intend to reduce their car use. Thus, they were less willing to accept road pricing since they were forced to drive less. They also perceived the policy infringing their freedom and unfair. Although not focusing on car ownership policy specifically, income level is also common key determinants of acceptability of public policies using economic measures.

Golob (2001) had also applied SEM to further investigate public acceptability of congestion pricing systems in San Diego including attitude towards equity and effectiveness of such system. This study was based on a panel survey conducted at six-month intervals from 1997 to 1999 in San Diego areas including 1,500 participants. The I-15 Congestion Pricing Project allowed single occupant vehicles to pay to use of two reversible HOT lanes in San Diego Metropolitan area. Carpoolers could continue to use the lanes without charge. Four opinions regarding the FasTrak program were investigated: (1) approval of this FasTrak program by

letting solo drivers to pay to use the HOT lanes; (2) perceived fairness of this FasTrak program to carpoolers; (3) perceived effectiveness of FasTrak program in reducing congestion; and (4) perceived safety advantage of travelling in using the carpool lanes. This study used joint models to interrelate demand for FasTrak and carpooling to the previous attitudes regarding the FasTrak program. Results of the study showed that FasTrak use positively affects approval of the program. Also, carpool use negatively affected attitude towards fairness of the program to carpoolers, and perceived effectiveness of the program. Both FasTrak and carpool demand perceive a greater safety advantage in using the HOT lanes than regular lanes. Perceived fairness was suggested to be the most significant explanatory variables and evaluations of all transportation projects should include assessment of equity concern to various groups.

Although none of the studies had applied the technique in assessing acceptability of car ownership policy, previous works had suggested that individual differences in public acceptability vary significantly, and people's attitude may change over years depends on the policy measure and their individual interest. Among all socioeconomic variables, one's own state as his car ownership level, and travel behavior shows significant impact on people's policy acceptance. Car users are generally least supportive for car deterring policies and one's policy support depends on if they are affected by the policy. The car ownership policy in Shanghai may be different from other car deterring policies as once people acquire a car; they are no longer affected by the car ownership policy and become policy "winners". Previous literature also demonstrated the capabilities of SEM as a powerful statistical analysis tool for different transportation analysis in handling complex relationships. Thus, structural equation models are also chosen in this study to evaluate the determinants of public acceptability of license auction policy in Shanghai.

3.2 Methodology

This study analyzes data collected among Shanghai residents using questionnaire survey. The survey was conducted from May to June in 2011 among 1,100 employees in nine local companies in Shanghai. Both online and paper based questionnaires were distributed. Our survey focuses the employed population in Shanghai including both local and migrant workers. The employed represents the middle-class population who are well-off enough to consider having a car, but not too rich enough to disregard the cost of a license. They are likely the group most affected by the car license auction policy. But we acknowledge that such focus limits the study from being generalized to represent the acceptance of the whole population.

During the implementation, we used two-stage sampling method: purposeful sampling for the selection of companies and random sampling for the selection of employees in the chosen companies. A variety of participants were included by selecting companies varying in business type, location, size, and ownership (government and private). (see (Xiaojie Chen & Zhao, 2013) for a full description of our sample recruitment method and list of the companies participated in the study). Overall we distributed 1,100 questionnaires to the employees in the nine selected companies and the total responses collected were 827 with a response rate of 75%. Overall sample of the questionnaire survey used for the study consisted of 524 participants after data filtering and controlling for invalid responses. The characteristics of the overall samples skewed to relatively young (69% younger than 34 years old), male (67%), with higher education (79% have a college or university degree), and higher household income when comparing to city statistics. (see (Xiaojie Chen & Zhao, 2013) for a detailed description of the questionnaire survey and data).

Public acceptability towards policy have been analyzed at the aggregate level in Chen and Zhao (2013). Since the same measurement indicator statements were used in this chapter, only a brief description of these measures is given. Both public acceptability and attitude towards policy specifics are measured using psychometric indicators. Each indicator statement had five response levels: strongly agree, partially agree, neutral, partially disagree, and strongly disagree, coded 2, 1, 0, -1 and -2, respectively. Explanatory and confirmatory factor analyses are performed to check the correlation of indicator statements. Corresponding changes are made and only indicators showing high correlation with each other are used in this study. Table 3.1 below shows the final indicators used to measure each attitudinal factor (adopted from Chen and Zhao (2013)). Cronbach's alpha values for latent variables are all greater than 0.7 indicating high reliability of the indicators.

Table 3.1 Indicator statements measuring policy acceptance, and attitude towards policy specifics (adopted from Chen and Zhao (2013))

Indicator statements measuring policy acceptance (Cronbach's alpha = 0.75)		**Mean**	**SD**
X1	I support the quota auction policy in Shanghai.	-0.13	1.36
X2	I hope the auction policy can continue to be implemented in Shanghai.	-0.18	1.29
X3	I cannot accept the quota auction policy as there are numerous problems with the existing policy.	-0.64	1.08
X4	If voting, I do not want the quota auction policy to continue to be implemented.	-0.64	1.22
Indicator statements measuring changes in acceptance			
X5	I have already become used to people obtaining licenses via the auction policy.	0.09	1.25
X6	My acceptance towards the policy has increased considerably over recent years.	0.04	1.21
Indicator statements measuring the expectation of others` acceptance			
X7	Do you think others accept the license auction policy in Shanghai?	0.15	0.94

Table 3.1 continued

Indicator statements measuring perceived effectiveness			
X8	Without the auction policy, there will be a rapid growth of car ownership and the traffic condition in Shanghai will worsen.	0.35	1.23
X9	The Shanghai government has solved the congestion problem by implementing the license quota auction policy.	0.13	1.25
Indicator statements measuring affordability			
X10	The price of the Shanghai license is still within my financial affordability.	-0.34	1.25
X11	I do not really care about the price of the license as long as I can get one and drive my car.	-0.54	1.22
Indicator statements measuring equity in auction (Cronbach's alpha = 0.76)			
X12	Many people cannot afford the high license price.	-0.89	1.02
X13	The high price of the license has resulted in cars being available only for rich people.	-0.52	1.16
X14	The auction policy is not fair as it auctions the cars together; thus the car price and car type do not matter.	-0.92	1.04
X15	Shanghai's quota auction policy is not fair as it makes the road that is constructed using revenue collected from all residents only for a small portion of rich people.	-0.84	1.07
Indicator statements measuring equity compared to other cities			
X16	The auction policy is not fair as it makes people in Shanghai pay more than people in other cities do to enjoy the same freedom of driving.	-0.74	1.13
X17	The lottery policy in Beijing is fairer than Shanghai's auction policy, as no matter how much money you have, you can still join the lottery and have a chance to win a license quota.	-0.65	1.23
Indicator statements measuring transparency of revenue usage (Cronbach's alpha = 0.80)			
X18	I do not know about the usage of the revenue collected from the auction.	-1.33	0.80
X19	Shanghai should make the revenue usage transparent to the public for auditing.	-1.33	0.82
X20	The revenue collected is for government use, which has no need to be transparent to the public.	-1.00	1.24
Indicator statements measuring perception on government vehicles (Cronbach's alpha = 0.90)			
X21	There should be more restrictions on the license quota for government financed vehicles than on private vehicles.	-1.34	0.87
X22	Government should reduce the total quota released per month for government financed vehicles to reduce the ratio of government vehicles on Shanghai's road.	-1.28	0.88
X23	Government should reduce and restrict the quota that each government department and agency can bid.	-1.12	1.02

This study uses two main methods. First, analysis of variance (ANOVA) tests are performed to analyze attitude variations in policy acceptance and attitude towards policy specifics according to people's car ownership and license type, car mode share, and other

socioeconomic characteristics. Second, structural equation models are developed to quantify the magnitude of impact on acceptance.

We are following the same framework developed in Chapter 2 in studying public acceptance and identifying its proximal determinants. The core factors identified as affecting acceptances are: perceived policy effectiveness, affordability, and equity concerns. Attitude variations will be examined towards acceptability and also these core policy specifics to better understand local residents' attitude.

Structural equation models (Kline, 2010) are used to specify the causal relationship between proximal determinants identified with public acceptance. The conceptual model contains several dependent variables such as policy acceptance, changes in acceptance, perceived effectiveness, affordability, and equity concerns. Explanatory variables include socioeconomic characteristics, car behavior (percentage of car trips of all trips), location and transit accessibility. SEMs are implemented in the Mplus software (Muthén & Muthén, n.d.) which supplies maximum likelihood estimates based on covariance between the observed variables.

3.3 Results

To better understand public attitude towards license auction policy in Shanghai, we segment the population into three dimensions to identify such variations, car ownership and license type, location and transit access, and other socioeconomic characteristics. In addition, this study further uses structural equation models to quantify the magnitude of impact of socioeconomics on acceptance.

3.3.1 Car-owners as supporting constituency for car deterrence policy

As inferred from Table 3.2 and Table 3.3, people's current car ownership and license type shows the most significant variations across all attitudes. Car ownership level and license

type is categorized into three groups: people with no car, local car owners, and non-local car owners. Local car owners are car purchasers who bid for their license in the auction. Non-local license owners include migrant workers, non-local companies doing business in Shanghai, and also a large number of Shanghai residents who choose non-local vehicle license for the much lower price. As the price for a Shanghai license increases, more and more Shanghai residents obtain their car license outside Shanghai to get around with auction policy (heng Jin, 2006).

Previous aggregate analysis results indicated a negative overall policy acceptance among Shanghai people in Chapter 2. However, once segmenting the population according to their car ownership and license types, local car owners actually show a slightly positive acceptance. In addition to this currently acceptance level, they also show much larger increase in acceptance over time. This implies that once Shanghai people acquire a car license through the auction, their own state and attitude become more positive. The bidding cost for a Shanghai car license is a sunk cost which is irrecoverable and after spending a large amount of money on a Shanghai license, local car owners become self-involved in the policy and do not want others to get around it. This is not limited to their acceptability, as local car owners show a higher expectation of other people accepting the policy as well. This Differs from usage restriction policies like congestion charging where car users mostly opposing the scheme. In Shanghai, local car-owners become supporters of this car deterrence policy. As the number of local car owners increases, overall acceptance of the auction policy may also increase.

Figure 3.1 illustrates Shanghai people's acceptance, changes and attitude towards different policy specifics according to their car ownership and license type. The attitude measure increases going from outside into the center of the chart from negative 2 to positive 2 (how psychometric indicators are coded). In other words, attitude gets higher as if it gets closer to the

center of the chart. As Figure 3.1 illustrates, local car owners have relatively more positive attitudes regarding all policy specifics compared to others. They perceive the auction policy to be more effective and are also more affordable although their affordability is still negative. In terms of equity, car owners emphasize different equity aspects compared to people without cars. Once they have bid for a car license, local car owners show less concern about the auction's equity compared to other cities. Instead, they show relatively higher concern for the revenue usage collected from the auction and fairness for the large number of government vehicles. Non-car owners show opposite concerns, caring more about the fairness of the policy itself. However, local car owners, who have already made the investment in the license, no longer view the auction as a problem.

Non-local license holders are a special group of car owners who are least receptive towards the auction policy. Their attitude towards the policy is even lower than those without cars. Many Shanghai residents choose non-local license for the cheaper price but non-local vehicles are restricted under a peak hour driving ban on elevated roads and electronic cameras are also installed on elevated roads to catch violators. These restrictions and enforcements have made driving non-local vehicles inconvenient. This is also reflected by the relatively strong negative opinions non-local car owners have towards the policy. The non-local vehicle phenomenon and public attitude is examined in chapter 4.

Even when other variables are controlled using structural equation modeling, car ownership and license type still shows not only significant impact but also the largest magnitude on both current level and changes in policy acceptance. As Table 3.4 infers, local car owners show significant positive acceptance and also changes which matches with the ANOVA results. Having a Shanghai license also shows significant positive impact on people's view of policy

effectiveness. Different from the ANOVA result, car owners (both Shanghai and non-local) show significant positive impact on almost all equity aspects compared to non-car owners. The explained variance for policy acceptance including only car ownership and license type is already very high (R2 = 0.172) compared to that of the full model (R2 = 0.246). This implies that car ownership differences themselves are enough to explain most of the attitude variation and it is the most significant determinant of policy acceptance.

Shanghai's car license policy was implemented in 1994 when only a small amount of private vehicles were available in Shanghai. As a result of economic growth, more people now own cars in Shanghai, increasing the size of the policy supporting constituency. Not only have they already adopted the current situation, their views towards the policy are actually getting better as years go by. The license auction policy was initially implemented as a temporary strategy to dampen car ownership growth rate to allow road infrastructure to catch up with the demand (Shanghai Municipality, 2002). As the number of local car owners who favor the policy increases, the auction policy becomes irreversible.

In addition to local car owners, non-local car owners' attitudes also show significance but in an opposite direction compared to non-car owners. Similar to the ANOVA results, having non-local licenses not only has a negative impact on current policy acceptance, but also on acceptance change. Non-local car owners do not think of the policy as effective and they view themselves as even less affordable compared with non-car owners. The high penetration of non-local vehicles in Shanghai poses challenges to local traffic management and affects the trustworthiness of government policy (detailed discussion in Chapter 4).

3.3.2 Other variables

In addition to car ownership, many other variables also show interesting findings. Firstly, Shanghai people's car mode share shows significant variation in their attitude towards acceptance. As Table 3.2 infers, frequent car users (> 70%) show a relatively higher acceptance level and significant increase in acceptance compared to car users with medium usage (30% – 70%). They perceive the auction policy to be highly effective and can more readily afford a Shanghai car license (see Table 3.3). Similar to local car owners, people with higher car usage have fewer concerns about the fairness of the auction but more about the revenue usage and government vehicles.

However, car mode share does not reveal any significance in the structural equation models in Table 3.4. This may imply that frequent car users are highly correlated with other variables as high income or local car owners who also have higher affordability. Previous literature indicated that the auction policy on one hand dampens car ownership growth rate, but on the other hand increases per vehicle miles driven (Hao et al., 2011) . This may imply that once invest in a Shanghai car license, local car owners are more likely to increase usage in order to make the most out of it.

Secondly, household income shows an interesting trend in Table 3.2. Households in the middle income level are least receptive towards the auction policy and this attitude is getting worse as seen by a decrease in acceptance level. They see the license as less affordable than low income people because most low income people cannot afford a car and do not really care about the policy anyway (see Table 3.3). The middle income people see the policy to be less equitable and most unfair compared with other cities. Together with high income people, the middle income group also shows relatively a higher concern for the transparency of revenue usage.

As expected, middle income people are financially capable of buying a car but not rich enough to ignore the license plate price. They are the exact group targeted by the policy and it is nothing but natural to observe they detest the policy the most. High income people, according to our expectation, are most in favour of the auction policy, with higher acceptance and the largest increase in acceptance. They show the highest expectation of others' acceptance as well. This is also reflected in the structural equation models (Table 3.4) as higher income people show positive impact on policy acceptance and changes compared to the middle income people.

Gender seems to be an important variable affecting public acceptability in this study. Male participants are generally less receptive towards the auction policy and their acceptance level decreases over time as reflected in both the ANOVA and SEM results. Participants living close to workplace do show significant higher acceptance and perceive the policy to be more effective. Finally, although not showing significance on acceptance and effectiveness, participants' residence status does show significance on fairness concerns. Local residents think the auction policy to be unfair across all equity aspects.

Table 3.2 Attitude variations of policy acceptance, congestion level and perceived effectiveness by car ownership and behaviour, socioeconomic characteristics, location and commuting distance

Explanatory Variables		Sample (%)	License Auction Acceptance			Congestion Level	Policy Effective-ness
			Policy Acceptance	Change in Acceptance	Expectation of other's Acceptance		
Car ownership and license type	Non car-owner	58%	**-0.44**	**0.02**	**0.13**	**1.40**	**0.18**
	Local car owners	27%	**0.08**	**0.53**	**0.47**	**1.17**	**0.76**
	Non-local car owners	15%	**-1.10**	**-0.69**	**-0.40**	**1.11**	**-0.49**
	p-value		0.00	0.00	0.00	0.00	0.00
Car mode share	Low (<30%)	68%	-0.44	**-0.04**	0.21	1.33	**0.20**
	Medium (30-70%)	11%	-0.44	**-0.03**	0.07	1.18	**0.26**
	High (>70%)	21%	-0.17	**0.43**	0.33	1.13	**0.59**
	p-value		0.10	0.01	0.31	0.13	0.02
House Location	Zone 1	31%	-0.32	0.32	0.21	1.28	**0.40**
	Zone 2	28%	-0.30	0.19	0.19	1.28	**0.43**
	Zone 3	28%	-0.38	0.04	0.20	1.18	**0.43**
	Zone 4	13%	-0.53	-0.18	0.00	1.51	**-0.09**
	p-value		0.59	0.07	0.64	0.16	0.03
Commuting distance	Short (<5km)	28%	-0.28	**0.31**	0.20	1.39	**0.51**
	Med (5 - 15 km)	32%	-0.39	**-0.01**	0.20	1.21	**0.17**
	Long (>15 km)	39%	-0.50	**-0.07**	0.09	1.27	**0.12**
	p-value		0.11	0.01	0.49	0.14	0.00
Household income	Low (<4k)	14%	**-0.32**	**0.06**	**-0.12**	1.40	**0.17**
	Med (4k - 15k)	58%	**-0.48**	**-0.08**	**0.12**	1.28	**0.17**
	High (>15k)	29%	**-0.23**	**0.36**	**0.33**	1.28	**0.50**
	p-value		0.04	0.00	0.01	0.57	0.01
Residence	Born in Shanghai	34%	-0.39	0.17	0.16	**1.42**	0.28
	Migrant to Shanghai	66%	-0.39	0.02	0.15	**1.22**	0.23
	p-value		0.98	0.18	0.86	0.01	0.63
Age	<30	44%	0.13	0.26	0.13	**1.46**	0.26
	30 - 49	50%	0.21	0.27	0.21	**1.16**	0.27
	> = 50	6%	0.16	0.63	0.16	**0.96**	0.63
	p-value		0.65	0.37	0.72	0.00	0.31
Gender	Male	67%	**-0.44**	**-0.02**	0.12	1.27	0.21
	Female	33%	**-0.26**	**0.28**	0.29	1.35	0.37
	p-value		0.04	0.01	0.08	0.26	0.14
Having Children	Yes	37%	-0.31	0.19	0.27	**1.09**	0.28
	No	63%	-0.42	0.01	0.12	**1.41**	0.26
	p-value		0.20	0.09	0.10	0.00	0.87
Education	Highschool - College/University	7% 80%	-0.38 -0.39	0.01 0.06	**-0.28** **0.19**	1.24 1.30	0.40 0.22
	Master+	14%	-0.30	0.28	**0.25**	1.29	0.49
	p-value		0.76	0.33	0.03	0.92	0.14

Table 3.3 Attitude variations of license affordability and policy equity concerns by car ownership and behavior, socioeconomic characteristics, location and commuting distance

Explanatory Variables		Sample (%)	Affordability	Equity			
				Equity in auction	Compare to other city	Transparency on revenue usage	Perception on government vehicle
Car ownership and license type	Non car-owner	58%	**-0.48**	**-0.94**	**-0.84**	**-1.15**	-1.22
	Local car owners	27%	**-0.14**	**-0.53**	**-0.31**	**-1.32**	-1.31
	Non-local car owners	15%	**-0.91**	**-0.72**	**-0.85**	**-1.38**	-1.30
	p-value		0.00	0.00	0.00	0.03	0.47
Car mode share	Low (<30%)	68%	**-0.55**	-0.90	-0.75	**-1.21**	**-1.21**
	Medium (30-70%)	11%	**-0.42**	-0.81	-0.87	**-1.50**	**-1.44**
	High (>70%)	21%	**-0.16**	-0.68	-0.60	**-1.44**	**-1.44**
	p-value		0.02	0.10	0.34	0.01	0.05
House Location	Zone 1	31%	**-0.19**	-0.93	-0.75	-1.37	**-1.46**
	Zone 2	28%	**-0.34**	-0.81	-0.77	-1.23	**-1.39**
	Zone 3	28%	**-0.51**	-0.69	-0.66	-1.21	**-1.34**
	Zone 4	13%	**-0.82**	-1.01	-0.85	-1.26	**-1.10**
	p-value		0.01	0.08	0.75	0.47	0.05
Commuting distance	Short (<5km)	28%	**-0.18**	**-0.87**	-0.70	**-1.09**	-1.16
	Med (5 - 15 km)	32%	**-0.52**	**-0.66**	-0.64	**-1.23**	-1.26
	Long (>15 km)	39%	**-0.56**	**-0.85**	-0.72	**-1.31**	-1.29
	p-value		0.00	0.04	0.74	0.05	0.37
Household income	Low (<4k)	14%	**-0.58**	**-0.71**	**-0.31**	**-0.94**	-1.14
	Med (4k - 15k)	58%	**-0.61**	**-0.91**	**-0.85**	**-1.27**	-1.29
	High (>=15k)	29%	**-0.04**	**-0.62**	**-0.57**	**-1.24**	-1.19
	p-value		0.00	0.00	0.00	0.01	0.30
Residence	Born in Shanghai	34%	-0.46	-0.86	-0.82	-1.32	**-1.38**
	Migrant to Shanghai	66%	-0.46	-0.78	-0.64	-1.21	**-1.21**
	p-value		0.99	0.30	0.07	0.16	0.03
Age	<30	44%	-0.56	-0.91	-0.77	**-1.10**	-1.22
	30 - 49	50%	-0.39	-0.80	-0.68	**-1.37**	-1.37
	> = 50	6%	-0.44	-0.67	-0.75	**-1.28**	-1.14
	p-value		0.29	0.19	0.69	0.00	0.11
Gender	Male	67%	-0.49	-0.83	-0.67	-1.27	-1.26
	Female	33%	-0.36	-0.74	-0.74	-1.14	-1.26
	p-value		0.22	0.26	0.51	0.10	1.00
Having Children	Yes	37%	-0.39	-0.72	-0.64	**-1.41**	**-1.42**
	No	63%	-0.48	-0.85	-0.74	**-1.12**	**-1.16**
	p-value		0.41	0.09	0.33	0.00	0.00
Education	High school -	7%	**-0.34**	-0.85	-0.56	**-0.79**	**-0.94**
	College/University	80%	**-0.50**	-0.78	-0.70	**-1.24**	**-1.26**
	Master+	14%	**-0.13**	-0.91	-0.72	**-1.35**	**-1.40**
	p-value		0.03	0.44	0.73	0.00	0.04

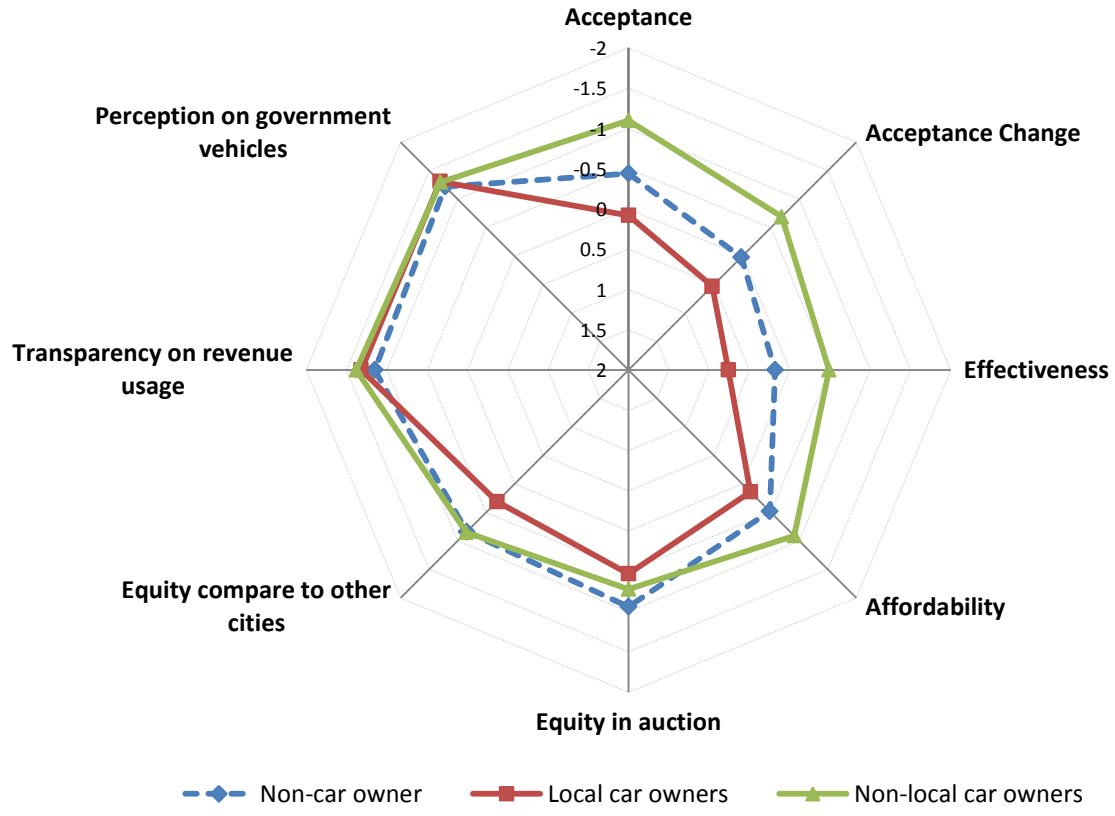

Figure 3.1 Attitude variations of car owners and non-car owners in different dimensions[a]

[a]Attitude values are measured from strongly agree to strongly disagree which is coded from +2 to -2

Table 3.4 Model estimations of socioeconomic variables on policy acceptance, changes and core policy specifics including perceived effectiveness, affordability, and equity[b]

Dependent Variables	ACCEPT	ACCEPT CHANGE	EFFECT	AFFORD	EQUITY			
					Equity in auction	Other city	Revenue usage	Government vehicle
Explanatory Variables	**Est.**	**Est.**	**Est.**	**Est.**	**Est.**	**Est.**	**Est.**	**Est.**
Car Ownership and license								
Local car owner	**0.169****	**0.116***	**0.239****	0.068	**0.477****	**0.515****	0.084	0.063
Non-local car owner	**-0.338****	**-0.327****	**-0.273****	**-0.185****	**0.233***	**0.152****	0.007	**0.114****
Car mode share								
Low (< 30%)	-0.059	-0.119	-0.071	**-0.181****	**0.243***	**0.338****	0.124	0.008
High (> 70%)	0.056	0.084	0.038	0.010	0.019	0.092	0.034	-0.048
Age								
Young (< 30)	0.012	0.032	0.061	-0.022	-0.021	-0.035	0.062	-0.006
Old (>=50)	0.016	0.006	0.083	-0.007	0.088	-0.055	-0.049	0.000
Gender								
Male	**-0.139****	**-0.143****	**-0.097****	-0.057	-0.077	0.031	-0.050	-0.007
Education								
Low (high school-)	-0.035	-0.028	0.005	-0.015	-0.082	0.018	**0.147****	0.042
High (master+)	0.067	0.065	**0.090***	**0.088****	**-0.094***	-0.036	-0.044	-0.014
Household Income								
Low (< ¥ 4k)	0.056	0.054	-0.002	0.028	**0.149****	**0.234****	**0.085***	0.011
High (>¥ 15k)	**0.136****	**0.159****	**0.162****	**0.243****	**0.174****	**0.111***	0.026	**0.074****
Children								
With Children	0.010	0.032	-0.049	-0.020	-0.020	-0.057	**-0.098***	**-0.084***
Residence								
Local born	0.036	0.036	0.00	0.012	**-0.108****	**-0.122****	**-0.098****	**-0.087****
Commuting distance								
Short (< 5km)	**0.127****	**0.153****	**0.162****	**0.144****	-0.096	-0.039	0.062	-0.005
Long (> 15km)	-0.014	-0.003	-0.007	0.021	**-0.118***	-0.030	-0.047	**-0.070****

Table 3.4 Continued

House Location								
Zone 2	0.044	-0.003	0.068	-0.019	0.032	-0.067	0.063	-0.025
Zone 3	0.007	-0.060	0.057	-0.074	**0.160****	0.005	**0.114***	0.055
Zone 4	-0.033	-0.058	-0.082	**-0.141****	-0.112	-0.087	0.085	0.056
CFI/TLI	0.965/0.951	1.000/1.022	0.997/0.993	0.976/0.947	0.927/0.895	0.890/0.761	0.972/0.956	0.974/0.958
RESEA/SRMR	0.033/0.020	0.000/0.006	0.011/0.010	0.030/0.014	0.041/0.020	0.052/0.015	0.033/0.016	0.039/0.029
R square	0.246	0.247	0.274	0.195	0.252	0.214	0.105	0.043

[b]Bases are non-car owners, medium car trip (30 – 70%), adult (30 – 49), Female, middle education (college/university), middle income (4k – 15k), without children, medium household (3 ppl), migrant, medium commuting distance (5km – 14.9km), Zone 1 (within Inner Ring Road).
*coefficient significant at 90% confidence ($0.05 < p < 0.10$)
**coefficient significant at 95% confidence ($p < 0.05$)

3.4 Discussion

Shanghai adopted a car license auction policy that succeeded in dampening car ownership growth rate and generating government revenue to spend on transportation infrastructure. Public acceptability of such a car deterrence policy is significant in both policy implementation and local policy fine-tunings. Prior study reveals a negative overall acceptance level and this study further segments the population into different dimensions to reveal any preference variation. Structural equation models are also used to quantify the magnitude of impact socioeconomics have on attitude.

Shanghai people's attitudes vary among different dimensions and car ownership and license type difference shows the most significant variation. Different from the overall negative acceptance in the aggregate level, local car owners actually show slightly positive acceptance in the disaggregate analysis. Similar to other car deterrence policies, car ownership shows the largest impact on policy acceptance among all socioeconomic variables, but the direction of causality on acceptance is quite different under Shanghai's policy. Once Shanghai people obtain a car license through the auction, they actually become more positive towards the policy and all other specifics, including its effectiveness in mitigating congestion, and overall fairness of the policy.

Not only are they more in favor of the policy, their acceptance and support also show the largest increase over time. This, seemingly contradictory to other car deterrence policy studies, is not surprising because local car owners, by paying the high license fee, have invested in this policy and become an interest group supporting it. As Borjesson et al. (2012) suggested, policy acceptance is positively related to the level of involvement in the policy and familiarity with the policy. After paying high license fees, the level of uncertainty in the policy reduces. Local car

owners then become “winners” of the policy and enjoy the benefits of driving with Shanghai car license. They want this policy to continue so that other people will have to pay as they did in order to be fairer to them and keep the transportation system less congested. This creates a unique positive dynamic for the policy: as income continues to increase and, more people own a car increase and the more the policy will be supported.

Shanghai’s policy is a good example of policy development process showing the spectrum of the time span of transportation policy intervention. Transportation policies could vary based on their frequency of intervention from a daily, to monthly, yearly, and even last for lifelong. Usage restriction policies such as congestion charges in London and area licensing policy in Singapore are examples of daily intervention which charges citizens every day or each time when they are using the road system. Another intervention to a lesser degree is fuel tax which charges drivers on a weekly or monthly basis on they fill up the gas tank. Follow this spectrum, insurance policy is a good example showing a yearly intervention. After purchasing an annual insurance, car owners gain the right to drive and no longer don’t need to worry about the charge until next year.

Shanghai’s license auction policy is at the end of the spectrum. It is an extreme case that demonstrates one-time government intervention that gives car owners lifelong entitlement of a license. Once car buyers obtain the license through the auction, they no longer need to worry about it and the policy has no further impact. Shanghai’s auction was adopted from Singapore which was the first city implementing car ownership policy. Singapore’s policy is between a yearly intervention and Shanghai’s policy that it gives car owners entitlement to own a car license for 10 years through the auction. After the entitlement is expired, the drivers would need

to go through the same process again and pay a similar amount of money again to renew their license for another 10 years.

If considering the behaviour impact of these interventions, the more frequently intervened would have the largest impact. Every day when car owners pay congestion charge, it reminds and charges them every time for using the road resources. Different from daily intervention, Shanghai's license auction policy has relatively the least impact on behaviour. This is not saying that Shanghai's policy is not effective at all. The policy is effective in controlling overall car ownership level and growth. However, when comparing to other frequencies of intervention, Shanghai's lifelong license entitlement has very rare effect after the intervention when car owners obtain the license. Shanghai's policy shows a type of "psychological adaption" which means people quickly adapt to the environment or any changes that occurred. As car owners pay the capital investment and without any further changes in the system, they would quickly adapt to it and don't feel the need of reducing car use. This may encourage car owners to drive more in order to make the best of it as the data showed.

On the other hand, Shanghai's policy tends to have the highest public acceptance compared to other frequencies of interventions. However, this does not mean the citizens like Shanghai's policy or support it. Instead, this high acceptability refers to and occurs at the state after people paid the license charges and joined the Shanghai license "owner's club". Once license holders are in the "owner's club", they start to enjoy the club's benefit of driving in Shanghai with no other restrictions and want to keep their benefits and status. As a comparison, public support in Singapore's policy would not be as high as that in Shanghai. With a requirement of license renewal for every 10 years, car owners do not get the same promise of using the license. Nevertheless, despite the lower support, Singapore's policy is more effective

than that in Shanghai. Car owners still need to worry about renewing the license and paying extra amount of money every 10 years for renewal. Shanghai's policy demonstrates the importance of duration of entitlement as even similar policies are implemented in Singapore, the difference in the duration makes the two policies differ in both their effectiveness and public support.

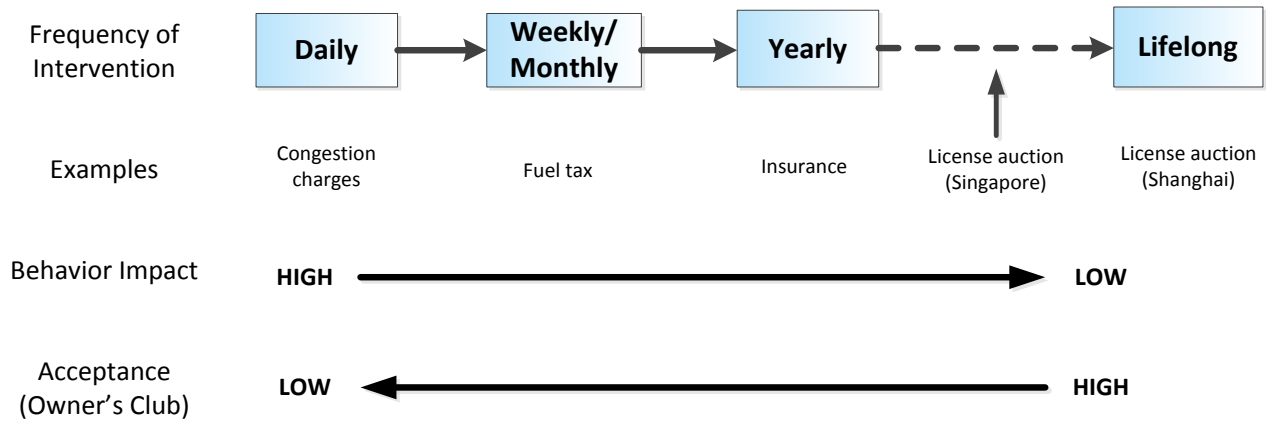

Figure 3.2 Types of government interventions with their behavior impacts on people and public acceptance

Shanghai's policy was first announced to be a temporary strategy for dampening car ownership growth until Shanghai start congestion charges (Shanghai Municipality, 2002). Although there were always rumors about cancellation of the policy, the car license auction policy has continued for over 17 years. By this time a middle class family could afford a car, a solid constituency supporting the policy has already formed. Car owners who have vested interest and is most influential, make the policy almost irreversible in Shanghai. Also, assuming an average of 5000 car licenses issued every month, there have been at least 600,000 people getting licenses through auction since 2002. It also becomes difficult to compensate those large percentages of Shanghai car owners if the auction policy is cancelled in the future.

The auction policy also demonstrates the importance of the stage of policy intervention. When this policy was first introduced in the 1990s, private automobiles were rare and most were owned by a small group of rich people and government officials. The car limitation policy and the additional cost required to obtain a car license in Shanghai is almost fair to the majority of all Shanghai citizens since every individual needs to go through the same auction process and not many individuals yet have cars. It is introduced time wisely which does not resulted in the equity concern among related groups as what happened in Beijing. Beijing also implemented a car license lottery policy to control car ownership starting in 2011 very recently and suddenly. But by the time of policy implementation, Beijing already has the highest car ownership level among all Chinese cities. By implementing at a later motorization stage, Beijing's policy raised concern as the policy not being fair to new car purchasers and only provided the road resources to prior car owners (Xiaohong Chen & Zhang, 2012). Shanghai's policy clearly is developmental wisely across cities and proves that the time point of policy intervention is very important even if similar policies are adopted.

Restraining car ownership is a less popular congestion mitigation strategy implemented worldwide due to its low public support before its introduction. However, with increasing population and car ownership level in many cities, car ownership control is inevitable. Results from this study imply support for the policy is increasing as the number of local car owners increases and their views continue to adapt to the policy. This is valuable especially to cities seeking urgent car ownership control in dampening car growth but hesitating in implementation due to public reactance.

Findings from this study are also significant in improving the policy acceptance. In terms of equity concerns, car owners place different emphasis than people with no car. Once they have

obtained a license, local car-owners show more concern for the revenue usage and the large amount of government vehicles taking up Shanghai's road space. Although Shanghai's government announced plans to spend the auction revenue on transportation related projects such as subsidies for public transit (Zhang, 2011), detailed usage information was not published. Improving transparency of revenue usage and limiting the amount of government vehicles could further increase car owners' acceptance.

On the other hand, both the ANOVA test and model estimation show non-local car owners are least receptive towards the policy and their views are even lower than people who do not have cars. Their acceptance also shows the largest decrease over time. Based on the survey result, 36.7% of the car owners have non-local licenses indicating significant penetration in Shanghai's road. Non-local license owners' high reactance towards the policy may be one type of "psychological reactance" as a side effect of transport pricing measures (Brehm, 1972). As mentioned in previous literature, Shanghai people who are restricted in freedom of choice by the license auction policy may respond by refusing to comply with the policy. They may instead choose non-local license to get around with it and for a cheaper price which water down the policy effectiveness. Further control on non-local vehicles in Shanghai is necessary to improve public acceptance and ensure auction policy effectiveness.

In addition to car ownership, car mode share shows significant variation in attitude as frequent car users are supportive of the policy. However, car mode share does not show significance in the SEM model when other variables are controlled. One possible explanation is high usage may be correlated with local car-owners. In order to make the best out of a car license after investing in one, local car owners tend to use their car more frequently. This type of rebound effect, will water down the effectiveness of the car ownership policy in congestion

mitigation. Further policy packages implementing usage together with ownership control similar to Singapore will be more effective in controlling congestion.

Shanghai's policy uses economic measures to control congestion and it is no surprise to see people's household income level showing significant impact on policy acceptance. According to our expectations, the middle income group shows the most opposition and a decrease in acceptance level. They are exactly the group this car ownership policy is targeting on. Male participants also are less receptive towards the policy compared with females. Residents living close to workplace also are more supportive of the policy. Local residents, compared to migrants, do not think the policy as fair in all aspects.

This study only includes socioeconomic characteristics as proximal determinants of public acceptance which has relatively small explanatory power ($R2 = 0.265$). Further research could include (1) attitudinal variables as proximal determinants of acceptance such as perceived effectiveness, affordability, and equity. (2) In addition to the socioeconomic variables in the model, transit access is an important variable that may have impact on acceptance. However, our measure of transit accessibility is limited to only include distance to nearest stop. People's distance estimation could be wrong, and even it is correct, using distance to stop is not enough to measure transit accessibility. Future studies including transit accessibility will further improve the explanatory power for public acceptance. (3) Non-local license owners, showing significant lower acceptance, are unintended consequences of Shanghai's policy transfer from Singapore. Further study evaluating Shanghai's challenges with and actions took to control non-local vehicles, and public attitude towards the auction policy is significant (see chapter 4).

4 Shanghai's Non-Local Vehicles as A Dilemma in Transportation Policy Transfer from Singapore

After decades of rapid economic growth, Chinese cities now face serious urban transportation challenges such as traffic congestion, air pollution, and energy shortage. Efficient and equitable transport policies are essential to sustainable development in China. Chinese cities have studied and adopted many policy strategies internationally. Driving bans in Beijing adopted from Mexico City (R. Wang, 2010) and the car license auction policy in Shanghai adopted from Singapore are examples of policy transfer. But the differences in China's local context, both institutional and structural, have created many problems in policy transfer from other nations. This study presents an example of policy transfer focusing on the license auction policy in Shanghai since it was the first city of China to implement a policy controlling car ownership.

On May 1st,1990, Singapore implemented a car quota scheme which required all purchasers of new cars to bid for car licenses through monthly auction (Koh & Lee, 1994). This was the first time for this kind of system to be implemented in the world (S.-Y. Phang, 1993). Shanghai adopted this car quota policy after visits of municipal officials to Singapore in the early 1990s (R. Wang, 2010). This policy was officially implemented in 1994 in Shanghai which was just four years after the first introduction in Singapore where careful evaluations of the effectiveness and local suitability could hardly have been done. The auction policy had similar effects in both Shanghai and Singapore on controlling vehicle fleet growth and generating government revenue. It also generates similar problems as the high license price causes affordable concerns, social equity concern of favouring the rich, and speculation activities such as car dealers and traders hoarding licenses (Xiaojie Chen & Zhao, 2013; S.-Y. Phang, 1993)

There was one unanticipated phenomenon that only occurred in Shanghai: the large number of non-local vehicles on Shanghai's road.

The current price for a Shanghai license has gone over ¥50,000 (approximately $ 8,000 USD) (Shanghai Jinwei Automobile, 2011) which is more expensive than a small vehicle. Many Shanghai residents instead turn to non-local licenses in nearby cities for much cheaper prices and to avoid the auction policy. Large amount of non-local vehicles driving on Shanghai's roads has watered down the effectiveness of license auction policy and resulted in large revenue loss from Shanghai. Based on our survey result, 36.5% of total car owners have non-local license and these vehicles are registered in different cities issuing the licenses which created even more problems in traffic management. Nearby cities has collaborated with Shanghai to increase the level of difficulty for Shanghai residents registering a non-local license (Yu & Hou, 2010), and Shanghai has posted peak hour restrictions (7:30 am - 9:00 am and 4:30 pm - 6:30 pm) on non-local vehicles driving on elevated roads. However, few studies have evaluated the effectiveness of these restrictions in controlling non-local vehicles and local residents' attitude towards non-local vehicles in Shanghai.

Singapore, as a city-state, is a closed system with no non-local vehicle problem. Shanghai, as one of the Chinese cities and metropolises, is an open city with continuous inter-city business and trading. The effectiveness of the city in controlling non-local vehicles is the key leading to successful implementation of the car ownership policy. Shanghai, as a city of China in the Yangtze River Delta, is surrounded by more than 10 cities with total population of more than 50 million people. With an open boundary to these neighbours, Shanghai is facing the dilemma of enhancing policy effectiveness for congestion mitigation versus openness of the city for economic growth. The hukou relaxation in state government had resulted large inflow of migrant

workers to big cities as Shanghai. The current floating population in Shanghai is over 11.2 million (National Statistical Bureau, 2011) which is 44% of the total population. Migrant workers are no longer a minority in Shanghai which makes non-local vehicle problems even more challenging.

Shanghai's non-local vehicle phenomenon is an unanticipated consequence of policy transfer. Evaluation of the policy restrictions on non-local vehicles, and better understanding of public attitude towards non-local vehicles are significant for local policy makers to improve the policy. As a result of policy transfer, this case study in Shanghai is also a good policy lesson to other Chinese or Western cities seeking opportunities for car ownership policy transfer.

Thus, the corresponding objectives in this study are to (1) compare license auction policy in Shanghai to its origin place in Singapore; (2) investigate the scale of and their consequences on non-local vehicles including challenges on local traffic management, revenue control, policy effectiveness and equity concerns; (3) discuss Shanghai's dilemma of congestion mitigation versus the city's openness and examine government's response through policy refinement and regional collaboration; and finally (4) use local survey data to evaluate public's attitudes towards the dilemma.

4.1 Literature Review

Chinese cities investigated transport policies of other nations as they sought to solve China's traffic congestion problems. Car license auction policy is one example of direct policy transfer from Singapore. The following nine papers have provided insights to problems regarding transport policy transfers, and non-local vehicle phenomenon in Shanghai as an unintended consequence from policy transfer.

4.1.1 Policy transfer

City to city policy transfer is a very active process in the field of transportation. However, not enough is yet understood about its benefits or the optimum conditions under which it is most effective. Such understandings would help to promote and accelerate the uptake of effective and well- matched policies.

Although not focused on transport policy, Marsden and Stead (2011) provided a thoughtful literature review on why and how transportation planning policies were transferred between cities by drawing lessons from policy transfers in the field of public policy such as political science. Marsden and Stead noted that policy lessons sometimes spread only based on the trust in the transferability of the policy between similar contexts. There was common thinking that policy solutions already existed in other countries and simply needed to be implemented more widely. They had pointed out the gap in the evaluation of policies transferred since few studies had traced policies through to implementation. This study also highlighted the importance of case studies in studying policy transfers and suggested that negative policy lessons were equally valuable to the policy development process. Our study aims to fill this gap in the research of policy transfer by studying the non-local vehicle phenomenon in Shanghai as a case study.

To better examine transferred policies, Dolowitz and March (2000)developed a framework to examine the process of policy transfer. They suggested examining the "Why transfer" issue through the theory of bounded rationality which defines two important aspects. First, there are cognitive limits to the individual in terms of the choice sets that can be evaluated. Secondly, the environment that individuals are in affects the outcomes, which limit the range of

options for the search. The choices people make are 'intended rational' within the limits of knowledge, context, uncertainty, timescales, and other constraints (Simon, 1956).

Marsden et al. (2012) confirmed this bounded rationality in policy search by evaluating the research conducted in the field of urban transport and planning policy across eleven cities in Northern Europe and North America. Their study seeks to explore the rationale for the search for new policies and the processes that city planners adopt in the field of transport planning and ways in which the search for policy lessons is bounded. Thirty policies were examined using document review and interviews with key actors. This paper suggested that the process of policy seeking and learning is defined by individuals operating within a particular policy space and show strongly bounded rational choice. They are significantly influenced by preconceptions of the nature of the preferred solutions and the likelihood of cities in other contexts offering meaning learning opportunities. Due to the large volume of information available and the quality often uncertain, key policy actors rely heavily on trusted peer networks to filter information and to learn from. The mobility of policies seems also to be linked to the mobility of the key transfer agents. This study suggests that despite the volumes of information available, the agents of transfer are critically important in how and why policies move. The key actor's influence on seeking policy lessons can also be seen in Shanghai's case as the license auction policy is quickly adopted after several visits of the Shanghai government agencies to Singapore.

Two recent papers below, by Attard and Enoch (2011) and Bray et. al (2011), showed example of using case studies in different countries to evaluate implementation of policy transferred from other nations using a model framework developed by Dolowitz and Marsh (2000). The framework considered the necessity of policy transfer, people involved in the policy

transfer, and policy details transferred. It also included the origin city where policy lessons were learnt, degree of transfer, and constraints that transfer had occurred.

Attard and Enoch (2011) analyzed the implementation of road pricing in Valletta, Malta, and the role played by policy transfer in its introduction. In the first two years of policy development, the local committee of Malta studied the experiences with road pricing from London, Durham, Edinburgh and Stockholm through visiting and monitoring with respect to various aspects of road pricing policy approaches. They had noted that the timing of particular events and local situations were important for policy transfer to be successful using London as an example. Malta's case study suggested geographic proximity of locations was not the most important aspect, but instead, the economic, social, political and ideological context of the policy borrower and lender were more important.

Bray et al. (2011) examined the urban transport policy evolutions in the five largest cities of Australia: Sydney, Melbourne, Brisbane, Perth and Adelaide. This study was supplemented by observations from survey of public servants in the policy and strategy divisions of state and territory transport agencies. In line with Marsden and Stead (2011), Bray et al. also found that performance of previous strategies were not critically examined. There was also little evidence that the approaches transferred to states of Australia were superior to alternative approaches and were able to achieve the objectives set beforehand. This study noted the mismatch between views of policy professionals and politicians, where politicians seek action plans that could achieve specified outcomes, but professionals viewed strategies being important to present government aspirations for future urban transport.

Wang's (2010) paper focused more on China's context. He investigated congestion pricing, new plate quotas, driving bans, and park-and ride policies, and considered how these

four policies might function in Chinese cities. For example, Wang compared Shanghai's car quota policy with the experience of such policy in Singapore. He noted that Shanghai's car quota policy failed to address the uncertain relationship between vehicle ownership and vehicle use. Secondly, Wang also mentioned that the effectiveness of license auction policy in reducing vehicle fleet growth depends on the extent to which a city could prevent residents from registering their vehicles with other non-local places. Unlike the city-state of Singapore, Chinese cities needed to place extra regulatory measures to control non-local vehicles and regional cooperation on the auction policy can be difficult. Wang concluded that the local context could significantly influence policy performance and must be carefully considered before any policy is implemented. Wang concluded that the auction policy was less effective in Chinese cities and could not eliminate the uncertainty of vehicle fleet growth due to the trade-off between local scheme and the mobility of vehicles. Wang's study was not specifically focused on Shanghai's non-local vehicles and only provided qualitative descriptions of the problems.

4.1.2 Non-local vehicles in Shanghai

Previous literature on Shanghai's license auction policy only stated the general problems regarding non-local vehicles. None of the studies collected first hand data and investigated local residents' attitude towards non-local vehicles.

Hu (2004) stated several problems that Shanghai's car license auction policy was facing, including the large number of non-local vehicles, and Liu (2008) provided a thoughtful historical overview of Shanghai's license auction policy. Also, Lv (2009) had analyzed the policy effectiveness from an economic perspective. Although these three papers ended with different conclusions, they all had noted the large amount of non-local vehicles driving on Shanghai's road and paying taxes to non-local cities had caused large revenue loss outside

Shanghai. Non-local vehicles, registered to the city of purchase, also led to difficulties with traffic management particularly during traffic accidents. Hu (2004) also mentioned that the proportion of non-local vehicles was largest among car owners with smaller or economy vehicles less than ¥100,000. Based on our survey results, 78% of the non-local license holders in our sample have small or economy vehicles. Local license holders, however, tend to choose more expensive and luxury vehicles.

Liu's (2008) study noted that license auction policy eased traffic congestion to some extent, and generated large revenues to spend on transportation infrastructure. In line with Hu (2004), Liu also suggested the policy reducing automobile sales caused negative effects on the economy. The high price of licenses in Shanghai led to speculative activities and car owners obtaining non-local licenses. Non-local vehicle license had formed an industry chain in Shanghai which attracted many car dealers and traders providing agent services. Liu concluded that Shanghai's policy encouraged more vehicle usage to counteract the high license price, partially offsetting the policy's effect. He also suggested that Shanghai should restrict vehicle usage rather than continue to restrict ownership.

Different from Hu's (2004) and Liu's (2008) opinions, Lv (2009) was optimistic about the effectiveness of the policy. Using traditional supply and demand theory, Lv noted that without government policy intervention, individuals would go for user optimum conditions to maximize use of the roads, which was not optimum for society. Shanghai's auction policy had suppressed the demand on vehicles that was effective in allocating scarce resource. He suggested that government would need to control the license price at a balanced market level and not so high as to force more car owners into getting non-local licenses, but also not too low as to be ineffective.

Previous studies specified that the government policy search process is limited and bounded. There is also often lack of careful policy evaluation after the implementation. The importance of case studies is also emphasized in previous literature on policy transfer. Literature focusing on Shanghai's policy also lacked quantitative data support and understanding of people's attitude was very limited. Thus, our study will fill the gap in transport policy research by evaluating Shanghai's policy as case study and collect first hand data to analyze public's attitude towards non-local vehicles.

4.2 Methodology

Two main methods used in this chapter are document review and questionnaire survey. Government policy documents, literature, and newspaper articles are reviewed to examine license auction policy details in both Shanghai and Singapore, problems generated by large number of non-local vehicles in Shanghai and the government's response to the problems. Questionnaire survey is conducted among local residents to examine public response to the dilemma in both their attitude and behavior.

4.2.1 Data

This study will use data collected from a questionnaire survey conducted among Shanghai residents on public acceptance towards Shanghai's auction policy. Our survey focuses the employed population in Shanghai including both local and migrant workers. The employed represents the middle-class population who are well-off enough to consider having a car, but not too rich to disregard the cost of a license. They are likely the group most affected by the car license auction policy. But we acknowledge that such focus limits the study from being generalized to represent the acceptance of the whole population, and particularly the unemployed and very low-income population.

We used two-stage sampling method: purposeful sampling for the selection of companies in Shanghai and random sampling for the selection of employees in the chosen companies. In the first stage, we selected nine companies varying in business type, location, size, and ownership (government and private).They included four engineering companies, two design companies, one research institute, one trading company, and one chemical plant factory. They were distributed from the central district (within the inner ring road) to the outskirts (outside the outer ring road), and ranged from 20 employees to 500 employees. Five of them are government owned and four are privately owned. The second stage uses random sampling to select employees in each company. In small companies with less than 200 employees, all employees were invited to participate. In large companies, 200 employees were randomly selected to participate. Overall we distributed 1,100 questionnaires to the employees in the nine selected companies in Shanghai.

The number of total responses collected was 827 with a response rate of 75% and overall sample of the questionnaire survey used for the study consisted of 524 participants after data filtering and cleaning of in-valid responses. The general characteristics of the sample skewed to relatively young, male, with higher education and household income due to the limitation in the sampling method. However, a variety of participants were included by selecting companies varying in business type, location, size, and ownership (government and private) to obtain a more representative sample. Please see Chen and Zhao (Xiaojie Chen & Zhao, 2013) for detailed description of the survey questionnaire design and sample characteristics.

In addition to the socioeconomic characteristics, the survey also measured participants' attitude towards the restriction on non-local vehicles from 2 aspects: effectiveness of the current restriction, and necessity for further restriction. Each attitudinal factor is measured using psychometric indicators which are further measured at five response levels: strongly agree,

partially agree, neutral, partially disagree, and strongly disagree, coded 2, 1, 0, -1 and -2, respectively.

4.2.2 Model

This study uses Structural Equation Modeling (SEM) to better understand Shanghai people's view towards the current restriction on non-local vehicles and Shanghai's dilemma in posing further restriction. Structural equation models (Kline, 2010) are used to specify the causal relationship between proximal determinants identified with public attitude. The conceptual model contains two dependent variables and several explanatory variables. The key dependent variables are people's attitude towards current restriction on non-local vehicles, and necessity for future restriction. Explanatory variables include the observed variables that are directly measured as socioeconomic characteristics, car ownership and license types, location, and transit accessibility.

SEMs are implemented in the Mplus software (Muthén & Muthén, n.d.) which supplies maximum likelihood estimates based on covariance between the observed variables.

4.3 Results

4.3.1 State-city (Singapore) vs. city in a region (Shanghai)

In May 1990, Singapore introduced the Vehicle Quota System (VQS) which determined the number of new vehicles allowed for registration while the market determined the price of owning a vehicle through auction. It was the first time in the world for such policy to be implemented (Koh & Lee, 1994). The Shanghai government referenced the policy from Singapore in 1994 to dampen the car ownership growth rate in order for road infrastructure and public transit system to catch up (R. Wang, 2010). In both policies public auction is used for

vehicle allocation and license auction also generates a large amount of government revenue. While Shanghai's policy originates from Singapore and still shares many similarities, it has also evolved and been fine-tuned after years of implementation that demonstrates enough differences from Singapore's.

Although both controlling vehicle ownership by setting up license quota, policies in Shanghai and Singapore differ in their methods and level of transparency in determining the car quota allowed. Singapore has a dedicated formula in calculating car quota taking into account the prevailing traffic conditions and the number of vehicles taken off the roads permanently (Land Transport Authority, 2012a). All the quota information and updates in Singapore are published publically. Although Shanghai also announced it would calculate the quota based on road capacity (Shanghai Municipality, 2002), no detailed information is released on how car quota is determined.

One of the important differences between policies in Singapore and Shanghai is the amount of time owners are allowed to keep the license. Vehicle owners in Singapore bid for a Certificate of Entitlement (COE) through the auction that allows the holders to register a car for a period of 10 years, after which they must scrap their car or renew their COE. In order to keep the license, holders will need to pay a prevailing quota premium (average quota premium in last 3 months) to renew the license for further 10 years (Land Transport Authority, 2012b). License holders can also choose to renew for 5 years by paying only half the amount of the prevailing quota premium, but a 5 year license cannot be renewed after. Different from Singapore, Shanghai's license obtained through the bidding is life-time and will not expire. Even after scrapping the car, Shanghai license holders are allowed to keep and register license to new vehicles within six months (China License Plate, 2011).

Although both policies use public auction to allocate car license, they also differ in the bidding format. Singapore categorized the auction according to five license types from Category A to E (Land Transport Authority, 2012a). Category license A and B are for cars. License A is for small cars (<= 1600 cc) and taxis, and B is for large vehicles (> 1600 cc). Category C is for commercial vehicles and buses, while D is for motorcycles. In addition, Singapore also has Category E that can be registered to any vehicles. The quota allocated to each category is in proportion to that category's share of the total vehicle population. By having this sub-categorization, Singapore not only can control the total quota but also the proportion of vehicle types. Shanghai, on the other hand, only categorizes licenses to cars and motorcycles in the auction with no further categorization within cars.

Both policies result in a distortion in the motor vehicle market. Car buyers in both places move toward buying larger and more luxurious vehicles through the auction as the relative price of license plates became higher for smaller and less expensive vehicles (R. Wang, 2010). Since lower income people can afford only small vehicles, the auction policy is considered to be inequitable as favoring the rich. Larger vehicles also pose higher environmental impact. Although Singapore's sub-categorization tends to achieve fairer tax burden across income groups since quota premium for smaller vehicles is indeed lower than large vehicles, it's still not affordable to many lower income people (Land Transport Authority, 2012a).

In terms of the bidding process, Singapore holds two auctions per month and each auction takes up three working days (Land Transport Authority, 2012c). Singapore uses an Open Bidding System allowing bidders to submit the bid by keying in their reserve price, monitoring price and revising reserve price for the bid. The bidding price is updated in real-time and the reserve price is the maximum bid amount that a bidder is prepared to pay for the license. The

bidding system will automatically revise the bid upwards until the reserve price of the bidder is reached. If the bidders' reserve price falls below the Current COE Price, the bidder is out of the running unless he revises his reserve price upwards. There is no limit to the number of revisions allowed. The Current COE Price will stop to rise when the number of bidders left equals the quota set up for that month.

Different from Singapore, Shanghai holds only one auction per month and the auction takes one day. Shanghai uses a two-stage bidding process. The first stage takes the initial bidding price from each bidder. The lowest winning price from all bidders in the first stage will be given and price adjustments are allowed in second stage. No price limit is set and bidders could bid any price in the first stage. In the second stage, up to two adjustments are allowed within ¥300 above or below the lowest winning price of the first stage (China License Plate, 2011).

Singapore and Shanghai's auctions also differ in the way bidders pay for the license. The latest Current COE Prices for each vehicle categories in Singapore will be set as the Quota Premiums and all successful bidders will pay the same Quota Premium for that category (Land Transport Authority, 2012a). Unlike Singapore where all bidders pay the same price, Shanghai uses a pay as you bid system where all successful bidders pay the price they bid on. License quota transfers are banned in Shanghai but Singapore's Category C (commercial vehicle), and Category E license (an open license that can be registered to any vehicles) are transferable (Lee, 2009).

Affordability of the license is a concern in both places but the license price in Singapore is much higher than that in Shanghai. The current price for a Shanghai license is over $9,000 (Shanghai Jinwei Automobile, 2011) while the average quota premium for private cars in Singapore in April 2012 is over $60,000 for Type A cars (Land Transport Authority, 2012c)

which is seven times higher than that in Shanghai. The price for larger cars (Type B) or an Open license in Singapore is even higher ($90,000). Vehicles in Singapore are also more expensive. Singapore does not have domestic car industry and all the vehicles are imported. Controlling car ownership is harder in Chinese cities since the Chinese government is trying hard to boost domestic car industry.

Table 4.1 summarizes the comparison between policies in Singapore and Shanghai. Despite all these differences in the specifics as the policy evolves, the non-local vehicle is a unique phenomenon that only exists under Shanghai's policy. As a city-state, Singapore has no non-local vehicles although the license price is much higher than that in Shanghai, whereas Shanghai is a city of China with open boundaries to its neighboring cities. Many Shanghai residents get a license outside Shanghai to avoid the high license price. This results in revenue loss, waters down the theoretical effectiveness of the auction policy, exacerbates equity concerns, lowers trustworthiness of the government, and causes challenges in traffic management which is discussed in the section below.

Table 4.1 Vehicle quota policy in Singapore and Shanghai

	Singapore	**Shanghai**
Timeline	Introduced in 1990 First time in the world	Introduced in 1994 First and only city in China
Policy goal	Control car ownership level Generate revenue	Control car ownership level Generate revenue
Quota calculation	Released to the public	Not transparent
License useful period	First auction: valid for 10 years Renew (5 or 10 years) by paying prevailing quota premium	Life time
License category	Category A (car <=1600 cc) Category B (car > 1600 cc) Category C (commercial vehicle, bus) Category D (motorcycle) Category E (Open license)	Car Motorcycle (no longer available)
Transferability	Open category (Category E) and Category C are transferable	Non-transferable
Price	Over $60,000	Over $9,000
Equity concern	Favoring the rich	Favoring the rich
Bidding process	2 auctions per month Takes up 3 days Open Bidding System	Once per month Takes up 1 day Two-stage bidding
Auction outcome	All bidders pay the same price	Pay as you bid
Domestic car industry	No	Yes
Non-local vehicles	No	Yes

4.3.2 Shanghai's challenges with non-local vehicles

As mentioned previously, many Shanghai residents get non-local licenses in nearby cities to avoid the high license price through the auction. Since license registration and annual vehicle check would need to be done in the city issuing the license, cities close to Shanghai in Jiangsu and Zhejiang Provinces are popular choices for Shanghai residents seeking non-local licenses.

The hukou relaxation in China allowed migrant workers to live and work in different cities with valid temporary residence permit that can be applied with current local residential address (Z. Li & Wu, 2006). Non-local residents could apply to register vehicle license with temporary residence permit valid for at least 1 year (TrafficInfo, 2004). Thus, Shanghai residents

can simply apply a temporary residence permit in non-local city in order to register a vehicle license there. This is also true for residents settling in other cities.

As Shanghai license price increases, more and more Shanghai residents choose non-local licenses for the much cheaper prices. Identifying the number of non-local vehicles in Shanghai is at first difficult as no formal statistics are available. Shanghai had once tried to conduct a census of the amount of non-local vehicles through issuing environmental emission permit (Green Mark) in 2006 (heng Jin, 2006), but it failed in implementation. Shanghai requires all vehicles entering the central city to obtain a green mark by paying road construction tolls including non-local vehicles. Many non-local vehicle owners left their license registration information when they pay the tolls but it was difficult to trace these vehicles and the effort failed. Our survey result indicates 36.5% of the Shanghai car owners hold non-local licenses, which is a large proportion indicating significant penetration of non-local vehicles in Shanghai.

In order to control the total vehicle quota, city needs to be a closed system. To implement any transportation congestion management instruments, a city needs to be clear and precise on the demand they are aiming to control. But the base for Shanghai's transportation management is inaccurate with one third of the vehicles not counted in the system. This large number of vehicles missed in the system also waters down the theoretical effectiveness of the policy. The effectiveness of the policy is exaggerated if considering this large amount of "outsiders". Owners of non-local vehicles are also paying maintenance fees to these cities, resulting in large revenue loss outside Shanghai. Shanghai's annual road maintenance fee is ¥ 3,000 and car operation tax fee is ¥ 100 (USD $ 15) which adds up to an estimated annual revenue loss of ¥ 0.3 billion (USD $ 45 million) from Shanghai to other cites (Wu, 2004). This amount of revenue loss is already

huge without including the revenue generated from the bidding in the auction and car insurance fees.

Looking past revenue loss, the high penetration of non-local vehicles also exacerbates equity concerns and loss of trust in government among Shanghai people. Non-local license holders who enjoy the same freedom of driving in Shanghai without paying the high license price, causes fairness concerns among Shanghai license holders. Large amounts of Shanghai residents getting around the auction policy to register non-local licenses also make government policy less trustworthy. As this group of people increases, more Shanghai residents are likely to follow suit, making the auction policy less useful.

In addition to that, Shanghai residents getting non-local license also cause challenges in traffic management. Since most of these Shanghai residents do not live in non-local cities and the addresses provided on their temporary residence permit are made up, accountability and responsibility during traffic accidents becomes difficult. Also, Shanghai residents with non-local vehicles violating regulations such as speeding cannot be fined as there is nowhere for the tickets to be sent (Yang, 2008).

4.3.3 Government response

In response to the challenges generated by the large amount of non-local vehicles, Shanghai government must both collaborate with nearby cities and fine-tune its own policy to control non-local vehicles.

During the meeting of vehicle management department among 15 cities from the Yangtze River Delta districts in Shanghai in 2004, cities came into agreement setting up a traffic management information communication system and ensuring local vehicles are registered by

local license (TrafficInfo, 2004). The main objective of the meeting is not to collaborate with Shanghai but to enhance communication between cities for better traffic management. Still, many local restrictions helped limit Shanghai residents registering licenses in these cities. The general restrictions in nearby cities in Jiangsu and Zhejiang Provinces are designed to raise the difficulty in temporary residence permit registration for Shanghai residents.

Shanghai has also taken actions in controlling non-local vehicle registration by allowing vehicles purchased in Shanghai car dealerships to be only registered with a Shanghai license. This is also valid for non-local residences in Shanghai formally starting from 2009 in order to protect the local car market (S. Zhou, 2009). In terms of usage, Shanghai has banned non-local vehicles driving on elevated roads during rush hour (heng Jin, 2006). These elevated roads are expressways to speed up the traffic on surface roads. Restrictions on using elevated roads are inconvenient for non-local drivers but they can still drive on surface roads underneath. Figure 4.1 below highlights the restricted elevated roads (in red) banning non-local vehicles in the city. Non-restricted elevated roads are highlighted in blue. Only the Outer Ring Road is excluded and most of the restrictions are in the central city (Middle Ring and Inner Ring Road). Non-local vehicles violating this peak hour restriction face ¥200 fines and mark 3 credits on their drivers' license. Enforcement is done by installing electronic cameras on elevated road to catch violating vehicles in 2011 (Sun & Yu, D., 2011). Other than this, Shanghai had kept this compromise on peak hour restrictions for several years without further restrictions.

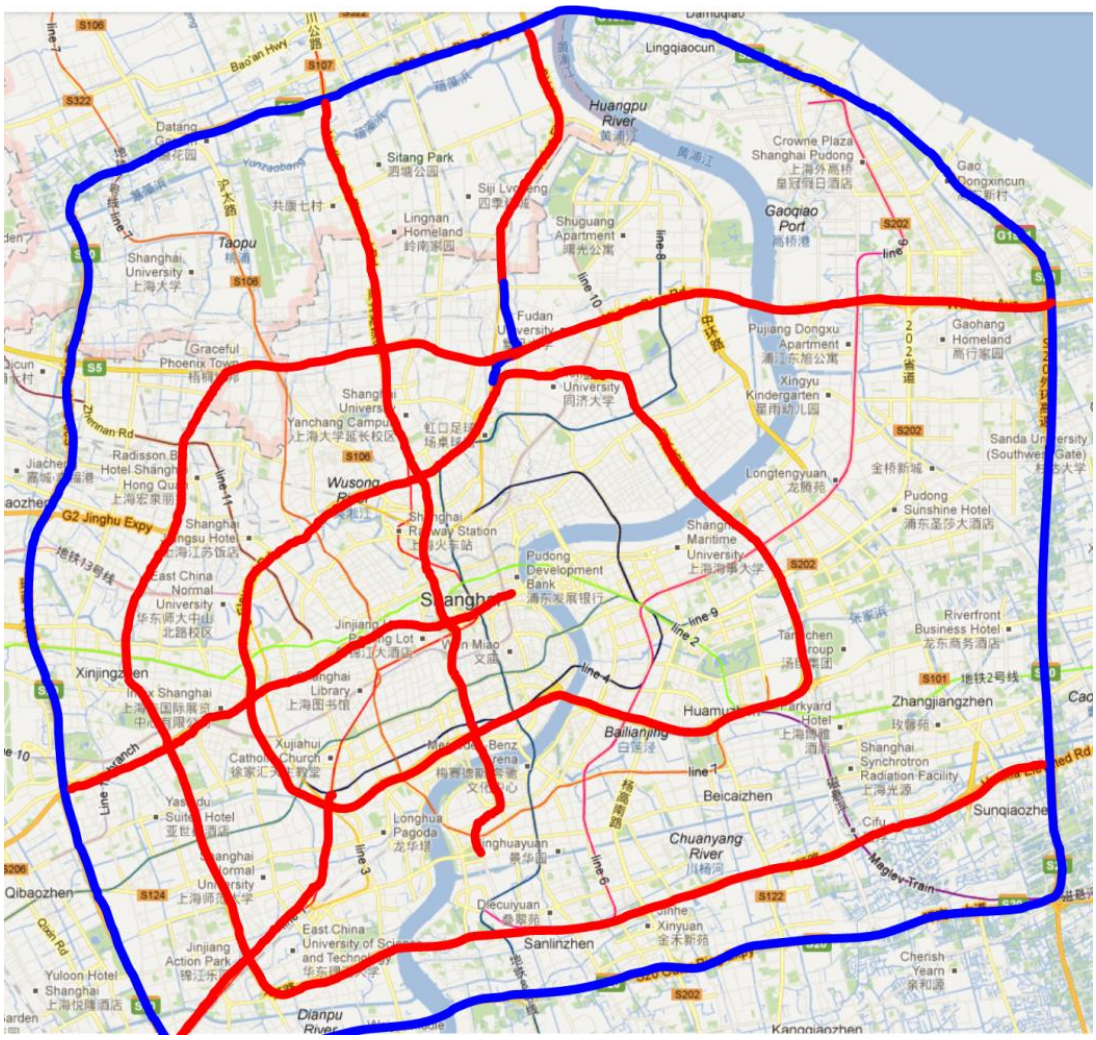

Figure 4.1 Peak hour restricted elevated roads for non-local vehicles (Shanghai Municipal Public Security Bureau, 2011)

A city's capacity in controlling non-local vehicles is the key to successful implementation of car ownership policy. As one of the leading cities in China, Shanghai has the capacity and power to pose harsher restrictions, yet Shanghai has hesitated to step forward. By posing further restrictions, Shanghai would have to sacrifice its openness as a city that is one of the most important features for maintaining city competitiveness (Clark, 2010). An open city could create a labor pool in supporting public infrastructure and services, attracting different skill sets to boost the city economy in different sectors, fostering economic internationalization and specialization, and attracting innovators, investors, visitors, and residents. Also, openness of a

city needs to be two-way, having low barriers of entry and exit (Clark, 2010). Shanghai's debate around openness is not only a local issue, but also a conflict with other cities. Closing Shanghai's boundary to outsiders may also affect nearby cities. Thus, the art of balancing congestion mitigation versus openness as a city has made non-local vehicle management more difficult. Further restriction may also raise public concern given the high penetration of non-local vehicles already in Shanghai. However, previous government restrictions do not offer a full solution to the non-local problems but instead result in a type of business chain in Shanghai.

4.3.4 Market response

As the demand for non-local license increases among Shanghai residents, many car dealerships started to provide services in registering temporary residence, getting non-local license and doing annual vehicle check for their Shanghai customers for a certain amount of service charge (heng Jin, 2006). The services provided by car dealers make getting non-local vehicles more convenient, further encouraging more Shanghai residents getting non-local licenses.

As a result of nearby cities increasing restrictions on non-local vehicle registration, service charges for car dealership also increased. Service charges in getting car license by dealership initially cost only ¥ 1,000 but quickly increased to ¥ 4,000 after these restrictions (TrafficInfo, 2004). Suzhou is among the most difficult cities to get license as it requires not only a temporary residence permit but also requires other documents such as proof of work, proof of housing purchase, or a business license (Wu, 2004). In response to the restriction, car dealers extend their services to cities farther away from Shanghai such as Anhui and Shandong Provinces with looser control on non-local license registration. Some even got license from Inner Mongolia which is at the north edge of China (Ye, 2012). The current service charges provided

by one of the Shanghai car dealerships for a Jiangsu license for Shanghai residents cost ¥ 9,200 which is almost a quarter of the ongoing price for a Shanghai license (Shanghai Jinwei Automobile, 2011). Even the price for cities farther away in Shandong cost ¥ 4,500.

4.3.5 Public response

4.3.5.1 Overall attitude

In addition to the market and government response, how Shanghai people view the controls on non-local vehicles and Shanghai's dilemma is also important. Table 4.2 shows the two attitudes investigated including views about effectiveness of current restriction and enforcement. Shanghai people's attitude towards the dilemma can be reflected in their attitude towards the necessity for further restriction on non-local vehicles. Indicator statements used to measure each attitudinal factor, percentage of responses, and Cronbach's alpha value for each attitudinal factor are shown in the table.

Overall, Shanghai people think the current restriction on non-local vehicles together with the enforcement is already effective. As mentioned previously, violating the peak hour restriction results in a ¥ 200 fine with 3 credits deducted from the driver's license. Driver's license will be taken away if the driver loses all 12 credits. The driver will then be forced to learn lessons on road safety regulations, and pass the knowledge test to renew his driver's license (Driving School Information, 2012). Although ¥ 200 fine seems to be small comparing to the expensive price of a Shanghai license, the credit penalty does make it inconvenient for non-local drivers. The peak hour restriction is further enforced by installing electronic cameras on elevated roads and over 60% of the participants feel the penalty and enforcement to be effective.

Facing the dilemma of congestion mitigation versus openness of the city, Shanghai government has kept a compromised peak hour restriction. Given the high penetration of non-local vehicles in Shanghai, we also ask people's attitude towards the dilemma as to if it is necessary to pose further restriction on non-local vehicles. In terms of further restrictions, there are two paths the government can follow: totally ban non-local license registration or ban non-local vehicles entering Shanghai. In general, Shanghai residents do not feel it's necessary to totally ban non-local vehicles, and more people oppose banning non-local vehicles driving in Shanghai compared to non-local license registration. Majority of the people do recognize Shanghai as a metropolis should be more open to other cities.

Table 4.2 Indicator statements measuring public attitudes towards non-local vehicles in Shanghai

	Statement			
Sign	**Effectiveness of current restriction**	**Strongly/partially agree**	**Neutral**	**Strongly/partially disagree**
+	I1 - Cars with non-local licenses driving on elevated road during rush hours would be fined ¥200, which would effectively reduce the amount of non-local vehicles on elevated road.	60%	20%	20%
+	I2 - The Traffic Control Photographic Systems installed can effectively reduce the number of non-local vehicles driving on elevated road during rush hours.	61%	23%	15%
	Further restriction on non-local vehicles (Cronbach's alpha = 0.69)	**Strongly/partially agree**	**Neutral**	**Strongly/partially disagree**
+	I3 - Shanghai should cooperate with nearby cities to totally ban Shanghai residents registering non-local vehicle licenses.	36%	20%	44%
+	I4 - Shanghai government should totally ban non-local vehicles driving on Shanghai's road.	25%	18%	57%
-	I5 - As a metropolitan, Shanghai should welcome vehicles from other cities to enter and drive freely in Shanghai.	53%	28%	19%
-	I6 - Shanghai should lose the restriction on non-local vehicles since it has a lot of trading with other Chinese cities.	54%	27%	19%

4.3.5.2 Attitude variations

In order to better understand public attitude, we further segment the population along three dimensions to identify any attitude variations: car ownership, socioeconomic characteristics,

location and transit accessibility. Among all independent variables, two show the most significant variations: 1) current car ownership and license types; and 2) participants' residence status.

Shanghai people's attitude towards effectiveness of non-local restrictions varies largely among car owners. Shanghai car owners, who bid for their car license through the auction, think government's peak hour restriction and enforcement as the most effective compared with others. In contrast to that, non-local license holders actually feel the exact opposite way. This could be because people who think of the current restriction as effective will be more likely to choose a Shanghai license to avoid the inconvenience in driving non-local vehicles. However the government's current response to non-local vehicles does not seem to be effective as viewed by the non-local license holders and Shanghai's government kept this compromise for years without further action. This peak hour restriction may not have any impact on people who do not need to travel in peak hour or have no need of using elevated roads. Also, the majority of the restricted elevated roads are within the Outer Ring Road as shown in Figure 4.1 above, and those living outside of the Outer Ring Road will be less affected by the restriction.

In addition to attitudes towards the current restriction, we also ask people's view on the dilemma Shanghai currently faces: should Shanghai government enforce the auction policy by totally banning non-local vehicles or should it loosen the restriction to promote more inter-city trade for openness of the city? Car ownership and license type again shows significant variations and two key findings can be seen. First, non-local license holders' opposition towards further restrictions is the strongest as they will be mostly affected by. Secondly, even Shanghai license holders, who are most likely in favor of further restrictions, do not want to totally ban non-local vehicles. Our initial hypothesis is a large amount of non-local vehicles in Shanghai not only

waters down the policy effectiveness, but also exacerbates equity concerns among Shanghai car owners. Yet based on the results, despite the equity concern, Shanghai car owners do understand the dilemma the Shanghai government faces and the importance of a city to remain open.

People's residence status also shows significant and interesting variations in the two attitudes. Locally born residents feel the current restriction to be more effective than migrants, but as migrants live longer in Shanghai (> 10 years), their attitude gets more positive and are even higher than local residents. Migrants' opposition towards further restriction is stronger than local residents despite the variation in attitudes among migrants living over different periods of time in Shanghai. This is true even for migrants who have lived more than 10 years in Shanghai.

As Table 4.3 shows, the percentage of non-local license holders among car owners is the largest among migrants especially those who have lived for less than 10 years. One possible explanation is migrants may already have non-local vehicles and further restrictions will obviously affect their travel in Shanghai. This also implies that even after the migrants have settled down in Shanghai for years, they still feel less connected to Shanghai than locally born residents. Given the large number of floating population in Shanghai, problems with migrants may be challenging for Shanghai government in posing further restrictions.

Secondly, migrants living in Shanghai for longer than 10 years show less opposition to further restriction compared to those residing in the city for a shorter period of time. Surprisingly, migrants who live for 5 to 10 years in Shanghai show the strongest opposition. Migrants are floating population and many of them do not have Shanghai hukou. Without a hukou in Shanghai, they cannot share the same social and medical benefits as local residents do. Their children cannot even attend school in Shanghai which makes them feel less connected. As they stay

longer, many migrants are able to obtain a Shanghai hukou, buy cars and houses, and finally feel settled down.

Table 4.3 Attitude variations towards non-local vehicles according to socioeconomic, household structure, location and transit accessibility characteristics

Variables		Sample (%)	Effectiveness of current restriction	Further restriction
car ownership and license type	**Have no car**	58%	0.27	-0.41
	Local car owners	27%	0.63	-0.04
	Non-local car owners	15%	-0.02	-1.03
	p-value		0.00	0.00
Residence status	**Migrants live < 5 years**	31%	0.11	-0.51
	Migrants live 5 – 10 years	14%	0.24	-0.59
	Migrants live > 10 years	21%	0.61	-0.35
	Locally born in Shanghai	34%	0.46	-0.24
	p-value		0.00	0.01

Table 4.4 Car ownership distribution with different residence status

Car ownership and license type		# of car owners/total population	NL license holders /car owners
Residence	**Live < 5 years**	8%	57%
	Live 5 - 10 years	5%	41%
	Live 10 years +	14%	28%
	Born in Shanghai	16%	28%

Even when other variables are controlled, car ownership and residence status still show a significant impact. Using structural equation models, Figure 4.2 illustrates the impact of people's characteristics on the two attitudes (only variables significant at 95% confidence level are shown). Attitude towards effectiveness of the current restriction is shown correlated with support for further restriction (causal path shown in double headed arrow). Various variables are included in the model: socioeconomics, car ownership and license types, and locational variables. Car ownership and license type shows significance in both attitudes. Compared to non-car owners, having cars with Shanghai licenses has a positive impact on effectiveness of the current restriction and these people also are more willing to accept further restrictions. Having cars with non-local licenses, on the other hand, has a negative impact on belief in the current restrictions

and non-local license owners do not want further restrictions. Being migrant workers also show significant negative impact on effectiveness of the current restriction.

In addition, participants who are male are less amenable to further restrictions. Interestingly, other variables which we expected to have impacts on people's attitude, like education level and household income, do not show significant differences. This implies that despite ones' socioeconomic characteristics, people's residence status and car ownership and license types show more impact on their attitude towards non-local vehicles.

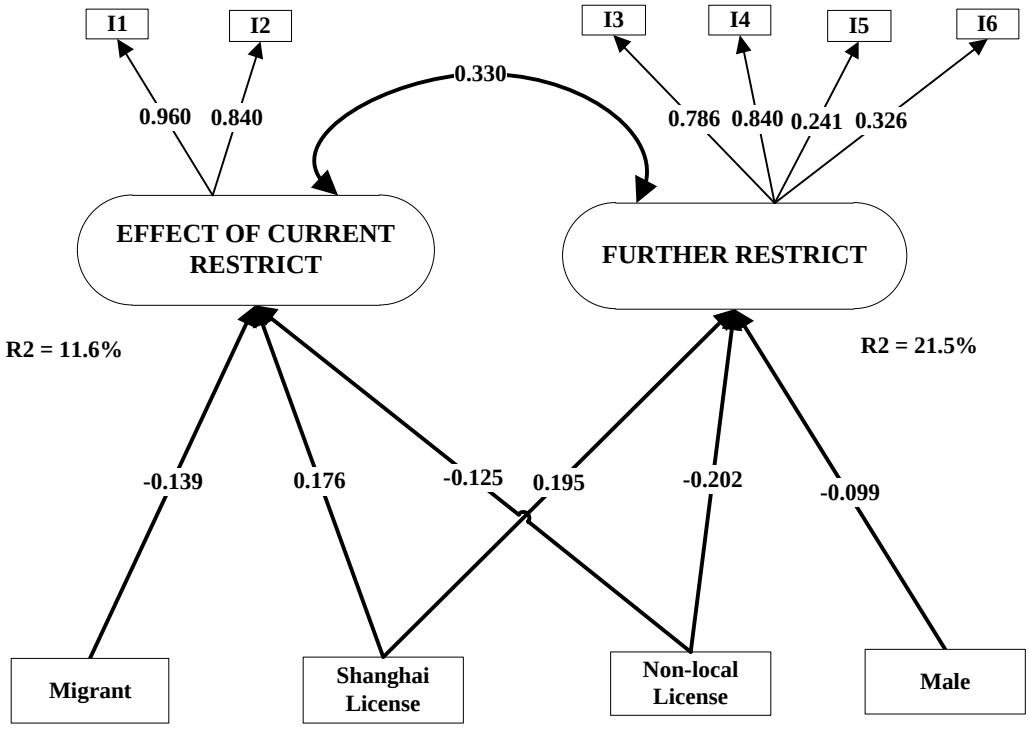

Figure 4.2 Structural equation models on attitude towards restriction on non-local vehicles (variables show are significant at 95% confidence level)

Not only car ownership and people's residence status shows largest significance on attitude, their attitude also varies significantly within the group. Figure 4.3 graphs the mean attitude among local and migrant residents with different car ownership and license types. Three findings could be summarized:

1) Both attitudes do not vary significantly for Shanghai license holders no matter if you are local or migrant residents.

2) Residence status shows significant variation in attitudes among non-car owners. Local residents with no car think the current restriction as more effective, and they show relative support for further restriction on non-local vehicles.

3) With non-local licenses, residence status also shows significance. Migrant workers having non-local licenses, local residents do not think the current restriction is effective and they also show strong opposition towards further restriction. Migrants, however, are more willing to accept further restriction.

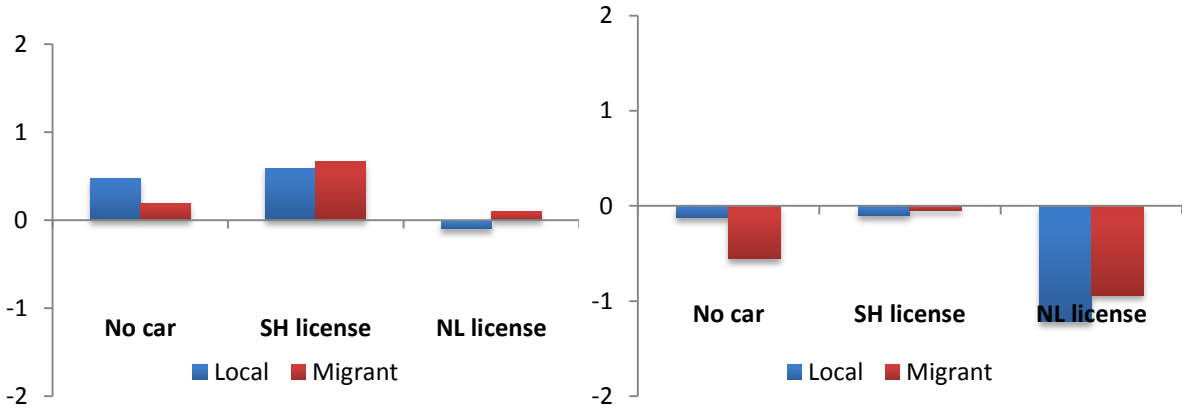

Figure 4.3 Attitude variations towards effectiveness of current restriction (left) and support for further restriction (right) among local and migrant residents based on car ownership and license types

4.4 Discussion

Shanghai adopted the auction policy in early 1994 just four years after its introduction in Singapore. Through years of implementation, the policy in Shanghai has become fine-tuned and differentiated from Singapore's auction in order to suit local context. While both policies have similar goals of controlling car ownership and generating government revenue, they differ in

many aspects of the implementation process. Both use public auction in allocating vehicle license, but Singapore's policy is more transparent in its quota calculation. Although both policies cause equity concerns favoring the rich, Singapore's auction achieved a relatively fairer tax burden across income groups by sub-categorizing the license. Singapore's policy is also stricter comparing to Shanghai, as it only allows license holders to keep their license for 10 years initially and renewable only after paying the premium again. Vehicles and licenses are also much more expensive in Singapore compared to Shanghai. Yet even with much higher cost for a license, Singapore has no problem with non-local vehicles, as happens under Shanghai's policy.

Singapore, as a city-state, has no non-local vehicles and nor does it have a local car industry. Shanghai, as a metropolis in China, has open boundaries with its neighbors and continuous inter-city trading. Comparing the auction policies in Shanghai with its origin nation, the phenomenon of non-local vehicles in Shanghai is an unanticipated consequence of policy transfer from Singapore. Penetration of non-local vehicles is not only high based on our survey result (36.5%) but also unknown. This amount of cars driving in Shanghai is not captured by city statistics which is the first step required in order to manage it. This largely waters down the theoretical effectiveness of the auction policy in Shanghai and results in large revenue loss outside Shanghai every year. Despite the traffic management problems generated by large amounts of non-local vehicles, it also exacerbates equity concerns among car owners and decreases the trustworthiness of government policy. A city's capacity in controlling non-local vehicles is the key to successful implementation of car restraining policy. In order to fully control non-local vehicles, Shanghai needs to trade-off in openness as a city, thus reducing inter-city mobility and trading.

In response to the challenges with non-local vehicles, the Shanghai government has taken action in both region collaboration and internal policy refinement to manage non-local vehicles. Nearby cities have raised restrictions on temporary residence registration for Shanghai residents. This raised barrier s is also reflected in the increasing service charges for car dealership services of getting non-local licenses. Shanghai also controls non-local vehicles in both license registration and usage. Shanghai government requires Shanghai vehicles to be only registered by Shanghai license to protect local car market. Shanghai also poses peak hour restriction to ban non-local vehicles on elevated roads during rush hour.

Shanghai's peak hour restriction has been implemented for years, but the effectiveness is hard to measure as can be seen from the large penetration of non-local vehicles in Shanghai. Shanghai's government could further limit non-local vehicles but this poses significant enforcement challenges: how to identify non-local vehicles, and much more difficult, how to differentiate non-local drivers with legitimate business in Shanghai from those Shanghai residents escaping the auction policy. Although Shanghai has the technology and institutional capacity to strictly enforce the policy, it cannot simply shut its door. As a metropolitan area, Shanghai has continuous business with other cities and it is the biggest trading center in China. This dilemma of the congestion mitigation versus openness as a city of a state has made the non-local vehicle management very difficult. Although many rumors had come out over the years speculating on the government's decision to further control non-local vehicles, Shanghai has continued to keep its current compromise without stepping further. More restrictions may endanger the openness of the city and Shanghai's competitiveness among other cities.

Public's attitude towards the current restriction on non-local vehicles and Shanghai's dilemma for further restriction are measured. The majority of participants think the current peak

hour restrictions, fines, and enforcement are effective except non-local license owners. In terms of the dilemma, people do not want further restriction that would totally ban non-local vehicles. Majority of them do understand the current dilemma of congestion mitigation and openness of the city Shanghai is facing. People's attitude varies among different groups, but people's car ownership and license types together with their residence status show more significant impacts on their attitudes than their socioeconomic characteristics such as education and income. Although local license owners' attitude is relatively neutral, they still do not want the government to totally ban non-local vehicles. Migrants' opposition towards further restrictions is also stronger than locally born residents and they want the city to be more open.

Shanghai resident's attitude varies significantly not only according to their residence and car ownership, but also within the groups. Local residents, who are theoretically more likely to favor further restriction, show significant and negative attitude. While migrant residents, who should be opposing further restrictions, are more willing to accept strict restrictions once they've obtained a Shanghai license. Non-local vehicles in Shanghai offer a good example of the unanticipated consequences of policy transfer. The balancing art of how to manage non-local vehicles is one key factor to the policy success. Parking charges may be a supplemental policy to consider if Shanghai government wants to raise the barriers on nonlocal vehicles. Local residents living in Shanghai would need to find dedicated parking lot for their vehicles. Parking is a good way to identify the nonlocal license holders who live in Shanghai and differentiate from the travellers and those who live in Shanghai for a short period of time for business purpose. In addition, since cost is one key concern that leads many Shanghai residents choosing nonlocal license, having different parking charges for local and nonlocal vehicles would be an option to increase cost of owning nonlocal vehicles which would instead deter some potential nonlocal

license buyers. Moreover, our understanding people's license choice was mainly based on the financial ability. However, license choice may be a complex process that other factors may have significant impact such as people's respect of government regulation, their social image concern for local and nonlocal licenses, Furture research may include using parking as a way to control nonlocal vehicles and develop a logit model to exmine the factors contributing to Shanghai residents' license choice decisions.

5 Superficial Fairness in Beijing's Car License Lottery Policy

Rapid growth in vehicle ownership in large Chinese cities has caused concerns over traffic congestion, air pollution and increasing fuel demand. The growing difficulty of moving people and goods around the city and the impacts of traffic on quality of life has created many problems in Chinese cities, particularly in Beijing. Beijing residents spend more time commuting to work compared to residents living in other Chinese cities. For a commuting commute, the average commuting time to work is around 52 minutes in Beijing (n.d., 2012). A global survey conducted in 2010 surveyed 8,192 motorists in 20 cities on six continents and compiled the results into an index that ranks the emotional and economic toll of commuting in each city to develop a commuter pain index (IBM, 2010). Among these cities, Beijing tied with Mexico City was ranked as the world's worst commute.

5.1 Beijing's Congestion Mitigation Strategies

In response to the state government's goal of developing a domestic auto industry and boosting local auto sales, Beijing did not impose any control on congestion before 2008. In 2001, Beijing was elected as the host city for the 2008 Olympic Games. As an immediate solution to guarantee the performance of the Beijing Olympic Games and to the relieve the growing traffic congestion of the city, Beijing implemented an odd-even license plate driving restriction during the 2008 Olympics (half of vehicles were restricted every other day based on their plate digits) (J. Liu & Zuo, 2011). Before the driving restriction, there were in average about 40 roads in the central city of Beijing suffering from traffic jam every day while the average running speed of motor vehicles was less than 20 km/h (Mao, 2008). Successful implementation of the above-mentioned strategy, Beijing had seen a decrease of daily traffic flow by 45% in average during the Olympics with an average running speed of motor vehicles in the central city reaching 43

km/h together with significant increase in public transit ridership as the restricted car owners switched to public transit (J. Liu & Zuo, 2011).

Because of this immediate effect and together with good feedback from residents, Beijing continued the license plate driving ban after the Olympics, but under a slightly different method called "one day off the road". Such policy was continued till now as cars are restricted to drive one day per week based on their license tail plate number. All the tail plate numbers of no-driving vehicles in regional rush hours on weekday are divided into 5 groups (2 license plate numbers per day) on a 13-week rotating basis (Beijing Traffic Management Bureau, 2013; Beijing Transportation Research Center, 2012). Vehicle use has been effectively reduced as statistics demonstrated the vehicle flows in the main streets were reduced by 4.1% and on the ring roads by 2.8% with significant reduction of duration of congestion on weekdays from 7h to 2.5h. Passenger flow volume of public transport also increased by 20% as a result of the limitation (Hao et al., 2011).

Both driving restrictions demonstrate immediate effects on easing the traffic. However, such usage restriction is different from congestion charging which constrain vehicle usage through trips made. Conversely, Beijing's driving restriction control usage through vehicle license digit and as a result increases incentives for people to own multiple vehicles so they can drive everyday by alternate use of the cars (Hao et al., 2011). Statistics showed that approximately 30% of car sales in Beijing were to satisfy the need of the second car and the major intention of buying the second car is to avoid the usage restriction. Thus, the rebound effect of vehicle ownership increase partly offsets the policy benefits on reduction of total vehicle use. Realizing the limitation of restricting usage through license digit and the continue

increase in vehicle ownership, Beijing referenced a car ownership policy from Shanghai to slow down the rapid car fleet growth at the beginning of 2011.

5.1.1 Car license lottery policy

Starting from January in 2011, Beijing government allocates new car license quota through lottery drawing. The government fixes the monthly quota to be 20,000. License lottery has no entry cost but applicants need to satisfy certain requirements in order to qualify for the lottery. The lottery policy states that Beijing residents need to fulfill one of the following requirements in order to qualify for the lottery: (1) Local residents have Beijing hukou; (2) police forces and servicemen; (3) foreigners living in Beijing for more than one year; (4) Beijing residents holding working residence permit; or (5) Beijing residents holding temporary residence permit and having paid social insurance and personal income tax continuously for 5 years. Successful lottery winners need to register the license to a vehicle within six months before the quota expires. Unsuccessful applicants will stay in the lottery pool and automatically been transferred into next month's draw.

5.1.1.1 Effectiveness

The lottery policy cuts down the sharp increase of car ownership. This policy seems to be very effective in controlling growth as seen from an immediate break put on the annual motor vehicle growth in Beijing compared to that in Shanghai in 2011 (Figure 5.1). Total motor vehicle ownership differences between Beijing and Shanghai were very small in 2004 (both slightly over 2 million). However, without ownership restriction before 2011, total motor vehicles in Beijing doubled in 2010 (4.81 million) as compared to the much slow increase in Shanghai (3.10 million). Annual growth rate in Beijing was five times as high in 2010 before the lottery policy was introduced (Figure 5.2). Nevertheless, the license lottery policy is not necessarily effective

in mitigating congestion as Beijing's road is already saturated with the 4.81 million motor vehicles before the policy was implemented. Late control on the additional cars added to the traffic would not be helpful in easing the current congestion. Also, the sudden announcement of the policy leads to many residents rush to buy cars the night before the policy started although they initially had no plan of buying cars (Hou and Li, 2011). Despite this episode, the lottery policy does seem to be a very effective strategy in damping car fleet growth in Beijing which is the objective of car ownership policy.

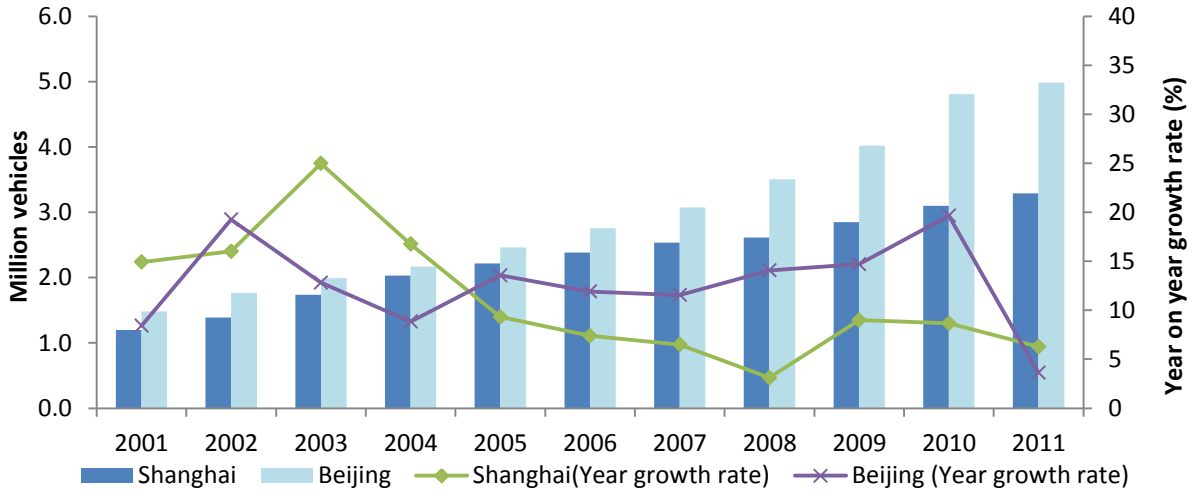

Figure 5.1 Total motor vehicle ownership and annual growth rate in Shanghai (Shanghai Statistic Bureau, 2011) and Beijing (Beijing Statistic Bureau, 2010) from 2001 to 2011 (adopted from (Xiaojie Chen & Zhao, 2013))

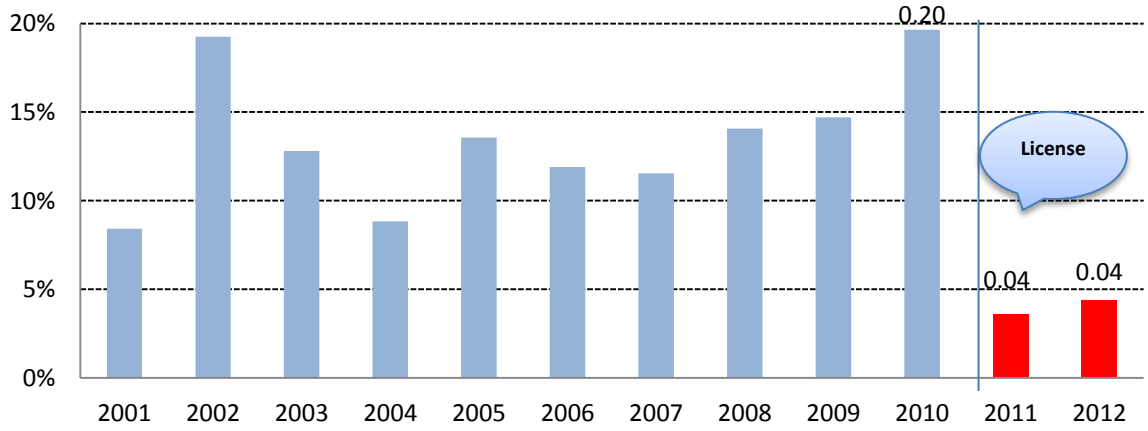

Figure 5.2 Annual motor vehicle growth rates in Beijing

5.1.1.2 Efficiency

Requires no cost of entry, Beijing's license lottery suffers from its low efficiency in resource allocation. Lottery applicants only need to apply once to join the lottery with required supporting documents to prove their lottery qualification. Once applicants are in the lottery pool, they no longer need to worry about further processing because license lottery takes place every month and unsuccessful applicants would be add into next month's draw automatically. This queuing process creates a large pool of people waiting for licenses. This creates a snowball effect as unsuccessful applicants remain in the pool but new applicants keep join in. The applicant snowball gathers as it goes on and with no instrument to absorb the demand. The odds of winning in the lottery decrease while getting a license in Beijing becomes very difficult. The current odd of winning is 1:80.6 (Tang, 2013) with the number of applicants close to 1.5 million (at the end of April, 2013) which is much lower compared to the ratio in the first lottery draw when the policy just started (1:11 at the end of January, 2011). This problem gets even worse as many applicants rush into the lottery to "take a seat" recognizing the difficulty of getting a license through the lottery. Because the lottery policy allows 6 months for license quota winners to register a license with no penalty for unused quota, many residents step into the lottery even they have no plan of buying cars now. Some households even encouraged all family members to join the lottery in order to take up more spaces. Obviously, many lottery winners do not buy cars and there is an imbalance between the number of quota allocated and the number of cars actually sold. After the first quarter in 2011 when the lottery started, there were estimated 2/3 of the total quota being unused (Fan, 2011). License lottery in Beijing is inefficient as it detached car from people's actual travel needs as many urgent car buyers do not get licenses but license winners do not buy cars.

Using a lottery mechanism in allocating license also takes no consideration of people's willingness to pay, unlike Shanghai's car license auction where the willingness to pay is reflected in the bidding price. Not only willingness to pay, the bidding price also reflects people's capacity to pay. However, Beijing's lottery policy ignores both people's willingness and capacity to pay. Urgent car buyers in Beijing have no alternatives but stay in the queue and wait (Y. Li, 2011). Although the government realizes the problem of no entry cost provides no way to reflect people's travel needs, it tries to increase the cost of entry through time and effort instead of money. The lottery policy has been fine-tuned that the lifelong queuing in the pool has been adjusted to three months. Starting from April in 2012, lottery applicants in the pool need to confirm their desire of staying in the queue every three month by renewing their application online (B. Li & Li, 2012). Without this confirmation, applicants would be taken out of the queue and need to reapply in the future. Although this sets up some barrier to reflect applicants' seriousness in getting license, but the problem remains in.

5.1.1.3 Equity

Beijing's license lottery is effective in slowing down car fleet growth, but its allocation mechanism is not efficient. However, the reason that Beijing uses a lottery format instead of Shanghai's auction is for equitable resource allocation. Shanghai allocates car license quota through public auction and the higher bid gets the license. Car license price in Shanghai has gone over CYN 90,000 (approximately 1,400 USD) in February 2013 (Shanghai Jinwei Automobile, 2013) which is more expensive than some small cars. The auction mechanism is criticized for being unfair for low income people and making cars only available to the rich. Recognizing the equity issue in Shanghai's car license auction, Beijing's license lottery tries to take an equitable approach in allocating new licenses. When the resources cannot be allocated efficiently among

different groups, lottery is a way of distributing the resources based on chances unlike the pricing based auction policy in Shanghai. A randomized, transparent and fair lottery process with no privilege could lead to a fair policy allocating resources. The lottery policy is designed to address the equity issue as many of the policy specifics such as no entry cost demonstrates its intention to be fair and have an equitable allocation of resources. Conversely, the equity issue is not very well addressed in the lottery policy as design of the lottery mechanism could not cover various equity dimensions: treatment of prior versus new car buyers, discrimination towards migrants, ability to generate and redistribute revenue, locational impacts, large amount of government vehicles, and loopholes in the policy and implementation process. This study focuses on equity issues in the lottery policy as it makes effort in addressing equity but the treatment is incomplete.

5.1.2 Transport equity

In any transportation policy, public acceptability is key in successful implementation. Factors affecting policy acceptability include effectiveness, efficiency, and equity (which is most overlooked by researchers). Historically, transport equity has been neglected as an object of investigation by researchers and planners. In 1999, the importance of equity in transport policy been more recognized as an executive member of the National Academies 'Transportation Research Board called for "more analysis and discussion of the distribution of costs and benefits of transportation policies" to disadvantaged populations, predicting that equity would become one of the major themes in transportation policy studies in the subsequent decade (Tavares, 2010).

Evaluation of transport impacts tends to be seen as technical and economic focusing on the effectiveness and efficiency of transport policy which yield very negative consequences from social, equity and environmental points of view. Especially in developing countries such as

China where income and social disparities are very large, the pure economic approach has favoured the interests of the high income who use private cars but has adverse impact on the mobility needs of the non-motorized (who walk, cycle or use public transport). Transport policies may have inequitable effects on the ability of low-income individuals and minorities to access places, and also have serious indirect effects such as encouraging residential segregation; restricting access to economic opportunities, housing, and education. With rapid increase in motorized travel in the future, the concept of equity has to be placed at the centre of any analysis of urban transport policies (Vasconcellos, 2011).

Traditional concept of equity focuses on economic aspects as everybody should pay for what they get and public services should be offered to whom having an ability to pay. While a more recent and broader concept of equity not focusing on individual's ability to pay but rather on their needs and has an underlying premise the belief that everybody should receive what they need regardless of their personal, physical, mental or social circumstances (Vasconcellos, 2011). A more recent thinking provided by Litman defines transport equity as the fairness with which impacts (benefits and costs) are distributed (Litman, 2010).

Equity evaluation could be performed from different approaches. An earlier framework suggested by Viegas divides equity into 4 aspects: horizontal, vertical, territory, and longitudinal equity (Viegas, 2001). A more recent guideline provided by Litman refines the categorization and adjust into three dimensions: horizontal equity, vertical equity with regard to income and social class, and vertical equity with regard to mobility needs and ability (which includes territory equity) (Litman, 2010). Similar to Viegas, horizontal equity is concerned with the distribution of impacts between people considered equal in ability and need. This suggests equal individuals and groups be treated the same and public policies should avoid favouring one over

others. A policy that fulfills horizontal equity is it treats everybody equally unless specified and individuals bear the costs they impose.

Vertical equity (also referred to social inclusion), is concerned with the distribution of impacts between individuals and groups that differ in abilities and needs. If it is regard to income and social class, transport policies are equitable if they favour economically and socially disadvantaged groups and compensating for overall inequities. Another vertical equity is concerned with the distribution of impacts between individuals and groups that differ in transportation ability and need, the degree to which the transportation system meets the needs of travelers with special constraints. Territory or spatial equity mentioned in Viegas (2001), could be categorized into vertical equity with regard to mobility need but with a slightly different definition. Territory equity in Viegas's paper associated with the right to mobility and provision of identical conditions for citizens living in all parts of a given country. Whereas Litman's vertical equity with regard to mobility needs suggested favouring individuals or groups living in areas that are less mobile. One equity dimension that is not mentioned by Litman is the longitudinal equity which is associated with the comparison of conditions between present and past, for each citizen individually, and for social groups (Viegas, 2001).

Categorization of equity could be complex as these different types of equity often overlap and conflict with each other (Litman, 2010). For instance, is favouring people living in less mobile areas or treating everyone living in all parts the same more spatially equitable? In addition, horizontal equity requires road users bear the costs of their transport services, but vertical equity often requires subsidies for disadvantaged people. Thus, trade-offs between different equity objectives are involved when making and evaluating transport policies. One policy could fulfill one equity dimension but contrary to another. Transportation equity analysis,

as pointed by Litman, could be difficult not only there are several types of equity, but also various ways to categorize people for equity analysis, numerous impacts to consider, and various ways of measuring these impacts. This makes transportation decision making difficult as a particular decision may seem equitable when evaluated one way but inequitable when evaluated another.

More and more literature started applying equity analysis when evaluating transport policies and services. Various aspects of equity have been examined; equity analysis has been applied to different transport policies, with different contexts, and measured using different methods. Among them, vertical equity with regard to income or social class (Litman, 2010)is most frequently evaluated in previous literature. Disparity between different income groups seems to be the largest concern when researchers discussing about the fairness of any transport policy (Bills, Sall, & Walker, 2012; Delbosc & Currie, 2011; Eliasson & Mattsson, 2006; Karlström & Franklin, 2009). In addition, majority of the literature looked at road pricing strategies as congestion charging (Eliasson & Mattsson, 2006; Juan, Luo, Fu, & Jia, 2008; Karlström & Franklin, 2009; Maruyama & Sumalee, 2007; Rajé, 2003), some examined provision of public transit system including metro system, bus services, and high speed rail (Bills et al., 2012; Delbosc & Currie, 2011; Monzón, Ortega, & López, 2013; Shi, Wu, & Jin, 2011; Tavares, 2010). Quantitative methods running equity models are frequently used and none applied equity analysis on car ownership policy in developing countries.

When evaluating road pricing strategies, spatial equity was also considered frequently to examine the policy impact on social inclusion/exclusion together with vertical equity with regard to income (Maruyama & Sumalee, 2007; Rajé, 2003). For instance, focusing on road pricing, Maruyama and Sumalee applied equity analysis on comparing performances of two pricing

regimes: cordon- and area- road pricing (Maruyama & Sumalee, 2007). Using a case of Utsunomiya city in Japan, the researchers found the area-based schemes to perform between than the cordon-based schemes in terms of social welfare improvement as the area-based scheme affects a higher volume of demands in the network within the same boundary and generated a higher level of spatial equity impacts as compared to the cordon-based scheme. Also on road pricing, Raje analyzed spatial equity as discussing the ways in which transport can impact on social exclusion process if road user charging is introduced in Bristol (Rajé, 2003). Results of the study found that congestion charging policy could instead promote social inclusion (vertical equity) as revenue collected from the charging could be used to improve good modal alternatives (public transport system) to the private car.

On road pricing in Stockholm, Eliasson and Mattsson further demonstrated the importance of spatial equity impacts (Eliasson & Mattsson, 2006). This study found that the two most important factors for the net impact of congestion pricing are the initial travel patterns and how revenue is used. Distributional impacts between different groups were also been recognized as men, high-income groups and residents in the central parts of the city affected the most by the charges. The authors suggested that careful monitoring of distributional impacts from the revenue use is at least as important as monitoring the direct distributional impacts from the charges themselves. If revenues are used for improving public transport, this will benefit women and low-income groups the most. If revenues are used for tax cuts, the net benefits will be about equal for men and women on the average, while it naturally will benefit high-income groups. The author also implies that the distributional impacts of congestion pricing have to be assessed on a city and scheme specific basis taking into account where different population groups live

and work and what mode of transport they use for their travelling and how the revenues are allocated back to them.

In assessing equity on public transport, Monzon et al. applied equity analysis on (Monzón et al., 2013) high speed rail (HSR) projects built focusing on the spatial equity as the main accessibility benefits brought by the HSR were primarily concentrated in urban areas with a HSR station, whereas other locations obtain only limited benefits. This analysis assessed both the magnitude and distribution of the accessibility improvements deriving from a HSR project. Spatial equity implications are derived from changes in the distribution of accessibility values among these urban agglomerations. The authors called for an assessment of the effects not only on the cities in the HSR corridors with a HSR station, but also on other cities outside the corridor, regardless of whether or not they have a HSR station. HSR stations may cause a "tunnel effect" as the existence of "islands" with enhanced levels of accessibility, and shadowed areas in isolated locations. Using Spanish cities as case studies, this study revealed the importance of geographical position as potential drivers to gain accessibility benefits. A spatially balanced distribution of HSR stations would cause a global rise in territorial equity.

Different methods could be applied in evaluating transport equity and mostly were very quantitative and objective with equity models built up. For instance, Juan et al. used Lorenz curves and Gini coefficients to quantified the equity of urban road resources allocation by travel modes before and after the implementation of urban road congestion pricing (Juan et al., 2008). In this case, Juan et al. found the equity effects to be positive as congestion pricing will make the road resources allocation more equitable by bringing the change of population proportion and average travel time in different travel modes. Many other literatures used Gini coefficient as the major indicator measuring equity. Karlstrom and Framklin used Gini coefficient in welfare

analysis of congestion pricing in Stockholm (Karlström & Franklin, 2009), Maruyama and Sumalee used static trip-chain equilibrium base model and modified Gini coefficient to measure equity impact of cordon and area pricing schemes (Maruyama & Sumalee, 2007), Delbosc and Currie developed a new approach to use Lorenz curves to measure the relative supply of transit to the population in Melbourne and presented Gini coefficients as a single measure of overall equity (Delbosc & Currie, 2011). It was found that 70% of the population shares only 19% of the transit supply.

Using a different approach, Bills et al. applied activity-based travel demand models for equity analysis across income classes in San Francisco Bay Area in California (Bills et al., 2012). Delmelle and Casas used gravity based measure on the spatial accessibility of development of the Bus Rapid Transit (BRT) systems and explored the spatial accessibility in Cali, Colombia in terms of both access to the BRT system itself and access to three distinct activities around the city (Delmelle & Casas, 2012). Also on BRT system, Shi et al. presented a comparison of the transportation structure in Beijing with that in other big cities around the world using cluster analysis and applied a road spatial recourse analyzing model which described how to distribute road spatial resources fairly to private cars, taxies, and buses (Shi et al., 2011). This study takes both the objective and subjective approach in analyzing Beijing's BRT system. Both quantitative model and qualitative survey examining local residents' satisfactory degree about the BRT line are used. Eliasson and Mattsson used a full-scale, state-of-the-art transport model together with a sample enumeration-based model developed specifically to take socioeconomic differences in valuations and travel behavior into account when evaluating equity impact (Eliasson & Mattsson, 2006).

Few qualitative methods were used. Raje used focus group discussion to gather views about transport in Bristol together with interviews of local residents (Rajé, 2003). Tavares also used qualitative analysis to investigate the current transport policies progressiveness, institutional structure and system ownership, mode predominance, and fare structure based on documentation and archival records in cities of the BRIC nations: Brazil (Sao Paulo), Russia (Moscow), India (Mumbai) and China (Shanghai) (Tavares, 2010).

As above mentioned, most prior literature used extensive models and very quantitative ways of analyzing transport equity based on researchers' objective views. Different from effectiveness and efficiency that could be easily understand through objective measures as percentage of change, fairness is an emotional judgement which contains subjective matter. Technical evaluation using Gini coefficient and various modelling technique could be very limited. The categorization for technical evaluation might be crude and indicators of equity could not be sufficiently captured. The same group of people could be both better off and on the other hand worse off if examining from different equity dimensions. Majority of prior literature is supply driven with only researchers' technical evaluation, while our work contains public perception in it. In addition, car license lottery is a new policy that is first adopted in the world that worth discuss. Moreover, few literatures focus on transport equity in developing country as China. Differences in context as governance structure, motorization rate, the policy implementation process all may lead to different equity concerns. Lastly, car license lottery policy is designed to address equity issues. Thus, this study fills the gap in prior literature through performing an equity analysis on new car license lottery policy implemented in Beijing, one of the biggest Chinese cities.

5.1.3 Research questions

This study focuses on equity aspects in Beijing's car license lottery policy. Prior literature has provided a strong base and theoretical framework for different equity dimensions that could be looked at, but none of the literature was focused on car ownership policy.

Thus, this study aims to (1) first develop an equity framework that is targeting specifically at car ownership policy based on prior literature and China's context. (2) Policy documents will be reviewed to compare the policy specifics with the theoretical framework to evaluate which equity dimensions have been properly addressed and which are missing in the lottery policy. Various equity dimensions will be examined as how does the policy deal within car owners, compared to non-car owners, how is the implementation process, etc. (3) Lastly, public opinions towards various equity dimensions are also reflected in this study. Since results of equity analysis could be different depends on how the user group is categorized, disaggregate analysis looking at how different population segments view equity in the policy will also be included to see if any particular group of people is worse or better off the policy. The population will be segmented along their socioeconomics, car ownership and license types, geographic locations and participation status in the lottery. Public perception is collected through questionnaire survey among local residents in Beijing.

5.1.4 Questionnaire survey

From June 2012 to January 2013, two questionnaire surveys were conducted in Beijing among local residents. One survey company "51poll" was hired to conduct the survey. The first survey was conducted in June, 2012 and 8365 samples were randomly selected from the survey company's database (which contains 120,000 Beijing samples). An invitation letter containing the survey link was sent to the selected samples and 4233 members checked the invitation email

with 1557 members clicked the survey link. Among those, in total of 1085 responses were collected at the end with a response rate of 70%. The sample distribution was controlled along age, gender, education, hukou status, and household income in order to match with the distribution stated in Beijing city statistics. Only those qualified participants were allowed to proceed. After removing incomplete responses, we have collected 1000 complete responses in the first survey. Cash credit rewards was given to the participants. It's ¥6 for a complete questionnaire response, and ¥1 for incomplete but attempted response.

However, we didn't control household car ownership in the first survey and our questionnaire attracted a much higher percentage of car owners than that in the city statistics. One rationale for this high percentage was because our questionnaire was focused on car ownership policy and car owners were more interested in the topic. In order to have a well representative sample of Beijing's residents, we conducted a second survey in January, 2013 to collect more responses from non-car owners in Beijing. A similar approach was used and 600 complete responses were collected among non-car owners in Beijing. In total, 1600 complete responses were collected from these two surveys. For data integrity, 1600 responses were further filtered based on sets of invalid patterns designed to remove the invalid responses. In total of 1505 valid responses were used in this study after filtering.

Even we have collected more non-car owners in the booster survey, our sample still have a higher percentage of car owners compared to city statistics. Also, our sample distribution has changed after data filtering. Thus, weighting is applied to avoid over-sampling or under-sampling of any particular group. Iterative proportional fitting (IPF) was chosen to weight the data along six dimensions: age, gender, education, household location, hukou status, and household car ownership. Household income was not included in IPF because only an average

income value could be found in city statistics which is difficult to weight since IPF requires ratio adjustment for different categories. In total of 1505 valid responses were used after filtering and Appendix A summarizes the weighted sample distribution. Participants' age, gender, hukou registration, education, car ownership and house location are weighted using IPF to match with city's statistics.

5.2 Framework

Traditional equity framework has been developed and applied in many prior literatures, but this chapter tries to summarize and update an equity framework targeting specifically at car license lottery policy in China's context. Figure 5.3 below illustrates the framework structure, different categorization of people, and various equity dimensions applied in the lottery policy. Based on prior literature and Beijing's policy context, we summarize the equity dimensions used in this paper into three areas illustrated in Figure 5.3: (1) Classic equity as found in the literature; (2) Unique equity dimensions that only exist in China's context; and (3) seemingly unintended equity dimensions that result loopholes in the policy.

Classic Equity Dimensions

As Litman pointed out, there are several types of equity, various ways to categorize people, and numerous impacts to consider (Litman, 2010). First of all, classic equity includes the generic equity dimensions discussed in prior literatures as the equity between car owners and non-car owners, and with regard to location. The broad transport equity framework categorizes people according to their mobile ability or travel modes (car drivers versus other road users). Within car owners, we look at how does the lottery policy deal with the income disparity which in this case, the *rich versus poor*. Since Beijing implemented the policy at late motorization stage, there were already large amount of car owners before the lottery policy started. Thus, equity

between current/future car buyers who need to go through the lottery policy and prior car owners is also an important dimension to consider. This chapter compares car owners before and after the policy starts to examine if it has treated both groups equally.

Between car owners and non-car owners, how does the policy redistribute the impacts from car users to other road users are one of the most important indicators of fairness in the policy. As Eliasson and Mattsson found, different use of the pricing revenue generate very different equity impacts on various social groups (Eliasson & Mattsson, 2006). Our equity framework also includes this equity impacts between car owners and non-car owners which is the ability of the policy to redistribute resources and impacts between these two groups which in this case, the *revenue transfer*.

In addition to the social dimensions of horizontal and vertical equity, we pay particular attention to inequities in the spatial dimension of accessibility (Table 5.1). Past research has found that location is tightly connected to mobility ability. Many researchers analyzing spatial equity impacts from different pricing strategies and development of public transport systems found it to be largely affecting not only individuals' travel pattern, but also economy of the city as whole (for example, location of the HSR stations have large impact on city's prosperity (Monzón et al., 2013), etc.). This chapter also examines spatial equity in lottery policy to see how the policy treats people living in different regions with different accessibility.

Table 5.1 Social and spatial dimension

	Horizontal Equity	**Vertical Equity**
Social Dimension	Individuals with similar income and other socio-economic status should be treated alike.	Individuals with low income, elderly, young, disabled should be favoured.
Spatial Dimension	Individuals at similar locations should be treated alike.	Individuals at disadvantaged locations (least well served locations) should be favoured.

Unique Equity Dimensions in China

In addition to the generic equity dimensions that could apply to various transport policy, there are also some dimensions that is unique to Chinese cities. The *hukou* system is a unique household registration system in China which official identifies a person as a resident of an area. With China's large rural population of poor farm workers, *hukou* limits mass migration from the land to the cities to ensure some structural stability and success in limiting population growth in the cities. This also prevents large migration between cities as migrants without local *hukou* do not enjoy many economic benefits in the city. The way Beijing's car license lottery policy treating migrants also reflects the openness of the city to the outsiders. Previous classic equity dimensions apply to the local residents in Beijing, this study also examines vertical equity with regard to different social class in Beijing's lottery policy.

Furthermore, the license lottery policy is targeting at controlling private vehicles, but Chinese cities also contain high percentage of government-financed vehicles. These government vehicles also largely contribute to traffic congestion and how the policy treats government vehicles is another issue to be considered when we evaluate overall policy equity.

Policy Loopholes

In addition to the classic and unique equity dimensions, lottery policy also has loopholes that provide channel for other people to get around with the policy. Corruption with the government officials and lack of transparency in the lottery process all lead to further equity concerns.

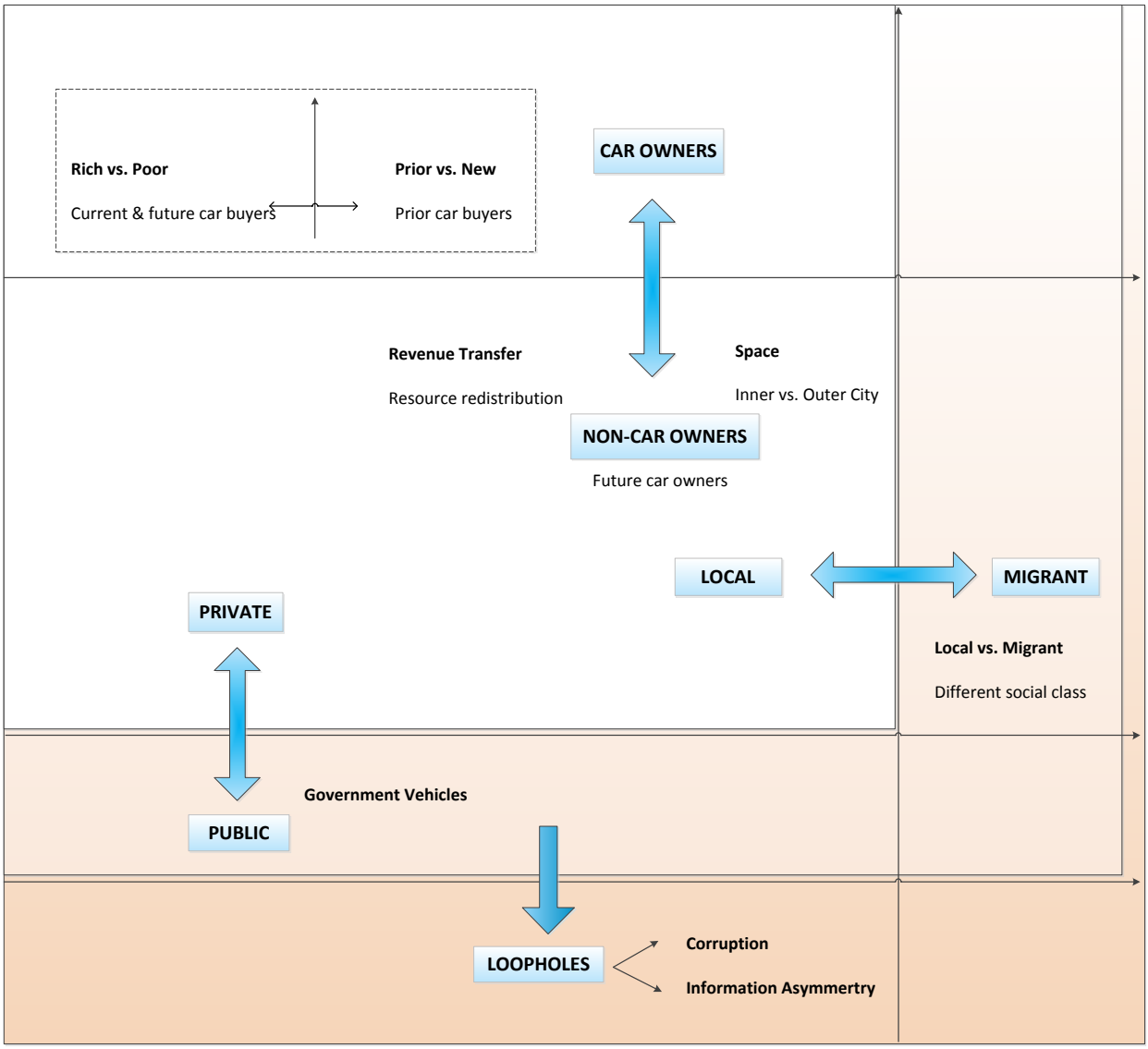

Figure 5.3 Equity framework of Beijing's car license lottery policy

5.3 Results

An important consideration in assessing policy instruments is the issue of fairness. This has to do with the distribution of the costs and benefits among different groups in the population. In order to better assess fairness in the lottery policy, various equity dimensions are considered and public opinions are collected. Public perception is consulted and attitude among different segmentation of people are examined as socio-economics, car ownership and license types,

geographic location, and participation status in the lottery. Based on the framework developed, equity dimensions are categorized into three areas below: classic equity from theory, unique equity to China's context, and policy loopholes.

5.3.1 Classic equity

5.3.1.1 Rich vs. poor

When equity is mentioned in transport policy, we usually refer to the economics as if individuals are treated the same despite his/her affordability. In congestion charging, low income group is worse-off as they are less affordable of the charges. Similarly in Shanghai's license auction policy, pricing is also a key concern as income restraint affordability in bidding. However, this is not a concern in Beijing's policy as everyone joining the lottery is treated the same and has the same chance of winning. Not only that, low income group is actually better off since they usually have lower value of time compare to high income group. Despite high income group's financial ability, the lottery is totally chance based instead of price based and the odds of getting a license is the same. In terms of vertical equity with regard to income group according to Litman's guideline (2010), Beijing's policy is progressive as it favours the disadvantaged low income group.

Li also mentioned this fairness in Beijing's lottery as compared to Shanghai's auction (Y. Li, 2011). Without the auction policy in Shanghai, local residents have relatively equal rights of driving as rich people could afford a luxury car while poor people could still buy an economic vehicle if they need to drive. With the auction policy and as the bidding price increases, car license in Shanghai becomes more expensive than many small and low brand vehicles (current bidding price has gone over ¥ 90,000 in March 2013 (Shanghai Jinwei Automobile, 2013)). This results in the small and low brand vehicles being pushing out of the market and the vehicle type

options left over for low income people gets narrowed down. Within car ownership policies, Beijing's free lottery seems to be more equitable in terms of vertical equity with regard to income compared to Shanghai's auction, as it favours economically disadvantaged group and compensating for overall inequities that everyone needs to wait and being treated the same in the lottery.

Survey results matches with our expectation that over 60% of the participants agree the lottery policy is fair in terms of rich versus poor as everyone is treated the same and have the same chance of winning (Table 5.2). When segmenting the population along different dimensions, car owners show relatively much stronger agreement than people with no car (Table 5.3). Attitude is particularly stronger among car owners with Beijing licenses compared to nonlocal license holders. Beijing has banned vehicles with nonlocal license to drive on and within the 5th Ring Road during rush hour which may be one of the reasons that nonlocal license holders showing a relatively lower attitude of the policy being fair. Those who have participated in the lottery and obtained license successfully also feel the policy to be fairer than others. Lower educated group feel the policy is relatively fairer which makes sense since they may have lower income as well and the policy favours the lower income group. Residents in higher income households feel the policy is relatively fairer and even more positive than low income people. High income group may already have cars and are less affected by the policy.

Table 5.2 Equity concern of the lottery policy in terms of rich versus poor

Sign	Policy statements	Strongly/partially Agree	Neutral	Strongly/partially Disagree
	Rich vs. poor			
+	License lottery is fair as everyone could join and has the same chance of winning despite his/her financial ability	65%	24%	25%

Table 5.3 Attitude variations in terms of rich versus poor

Segmentation of Population	Rich vs. Poor	Segmentation of Population	Rich vs. Poor
Car Ownership and Lottery Participation	**Weighted Average**	**Socioeconomics**	**Weighted Average**
Car ownership		**Age**	
Non-car owner	0.48	Young (<30)	0.49
Car owner	0.86	Adult (30 – 50)	0.61
car ownership and license type		Senior (50+)	0.75
non-car owner	0.48	**Education**	
prior BJ license owner	0.90	Highschool-	0.69
lottery BJ license owner	0.86	college/university	0.43
other BJ license owner (car renting, second hand market)	0.82	master+	0.39
NL license owners	0.44	**Income**	
Lottery participation		Low (<5k)	0.63
Participated, obtained license	0.86	Med (5k - 15k)	0.55
Participated, still waiting	0.56	High (15k+)	0.72
Planning to participate	0.58	**Hukou**	
Not planning to	0.53	Local	0.66
Not qualified	0.58	Migrant	0.50
		Location	
		within 2nd ring road	0.78
		between 2nd - 4th ring road	0.75
		4th - 6th ring road	0.53
		outside 6th ring road	0.59

5.3.1.2 Prior vs. new owners

Within the car owners' club in the framework, Beijing also includes large amount of car owners who obtained license before the lottery policy started. As mentioned previously, license lottery policy would not be effective in mitigating congestion as there has already been large amount of car owners existing in the current road system before the policy is introduced. Fairness concern is also raised between prior car owners and current car buyers as prior car owners do not need to go through lottery process. Beijing's policy restrict second car purchase as car owners with cars already registered under their names are not allowed to join the lottery, this high percentage of prior car owners also contributed largely to the congestion in Beijing. However, they are exempted from the lottery policy and not getting any "penalties". Beijing's

lottery does not match with the longitudinal equity (Jose, 2001) as it is not fair comparing individuals between past and present. Prior car owners actually may be better off compared with new car owners since they have few competitors for road resources as the number of additional cars added to the system has been controlled. This is unfair for the new car owners who did previously no harm to the system but get restricted when they are planning to buy cars.

Conversely, Shanghai's license auction, being implemented at an early stage where private motorization was rare, is fair longitudinally as everyone wishing to buy cars need to go through the auction process. There is only the difference for price, but not for chances of avoiding the process.

Local residents also recognized the concern as over half of the participants think it is unfair that prior car owners are omitted from the policy. But surprisingly, prior car owners themselves also think it is relatively less equitable compare to non-local license holders and Beijing license owners who got around with the lottery (Table 5.5).

Table 5.4 Equity concern of the lottery policy in terms of prior vs. new owners

Sign	Policy statements	Strongly/partially Agree	Neutral	Strongly/partially Disagree
	Prior vs. new car owners			
-	The lottery policy is not fair to new car purchasers since prior car owners before the policy don't need to go through this process.	54%	30%	16%

Table 5.5 Attitude variations in terms of prior vs. new owners

Segmentation of Population	Prior vs. New Owners	Segmentation of Population	Prior vs. New Owners
Car Ownership and Lottery Participation	**Weighted Average**	**Socioeconomics**	**Weighted Average**
Car ownership		**Age**	
Non-car owner	-0.51	Young (<30)	-0.43
Car owner	-0.52	Adult (30 – 50)	-0.57
car ownership and license type		Senior (50+)	-0.49
non-car owner	-0.51	**Education**	
prior BJ license owner	-0.55	Highschool-	-0.51
lottery BJ license owner	-0.55	college/university	-0.51
other BJ license owner (car renting, second hand market)	-0.15	master+	-0.59
NL license owners	-0.29	**Income**	
Lottery participation		Low (<5k)	-0.44
Participated, obtained license	-0.78	Med (5k - 15k)	-0.54
Participated, still waiting	-0.70	High (15k+)	-0.55
Planning to participate	-0.48	**Hukou**	
Not planning to	-0.33	Local	-0.52
Not qualified	-0.24	Migrant	-0.51
		Location	
		within 2nd ring road	-0.43
		between 2nd - 4th ring road	-0.46
		4th - 6th ring road	-0.58
		outside 6th ring road	-0.37

5.3.1.3 Revenue transfer

Above-mentioned equity dimensions are within car owner group, while another equity dimension that has been frequently debated is the equity between car owners and non-car owners and the possibility of redistribute resources between these two groups. Revenue collected through pricing strategies as congestion charging is good way of redistributing resources between various road users. Beijing's lottery policy with no entry cost tries to be fair to all income groups, on the other hand, does not generate any revenue. On the contrary, Shanghai uses public auction to allocate car license quota and the auction generates revenue which is more economically efficient to the society. In addition, the way how revenue has been used also has important equity impacts on the society (Eliasson & Mattsson, 2006) and Shanghai utilizes the auction revenue to redistribute resources from car owners to other road users.

Both the auction and lottery policies penalize car drivers as they need to pay a price in order to get a license, but the difference is the price Shanghai car drivers pay is money which is redistributable. Conversely, the price that Beijing car owners pay as time through waiting in the lottery is not redistributable.

Moreover, the way Shanghai spends the revenue is more progressive as Shanghai spends all revenue on improving public transport systems and subsidizing public transport users. Calculated based on the number of quota allocated and average bidding price for each month, license auction in Shanghai has generated CYN 6.71 billion in 2012 alone. Including the revenue banked from previous year, there was in total of CYN 7.12 billion to be used and majority were spent on public transportation (PT) such as buying more buses (28%), subsidy for PT transfer (23%) and senior pass (14%), PT construction and maintenance (18%), MRT construction (13%), and miscellaneous uses (Shanghai Finance Bureau, 2012). Usage of revenue collects from Shanghai's auction satisfies vertical equity with respect to driving ability as the revenue is spent on non-drivers. As a class in Litman's definition (Litman, 1996), non-drivers tend to be economically, physically and socially disadvantaged. Shanghai's license auction has the potential of benefiting non-drivers overall by increasing the use of alternative travel modes, resulting in improved service due to economies of scale. Vertical equity justifies using auction revenue to support alternative transportation programs or fund public services that benefit disadvantaged populations.

Beijing, on the other hand, has already highly subsidizing local public transit system as transit fare in Beijing is much cheaper than that in Shanghai. But the subsidy comes from the general funds, not from the lottery policy specifically. Shanghai's auction is fairer as it transfer cost directly from car drivers to benefit non-car drivers, whereas Beijing uses the cost from all

the population to non-car drivers. Beijing's lottery policy is only fair within the car owner group but not fair between car and other modes. Equity between different road users (car owners, transit users, cyclists, etc.) is the traditional key dimension of transportation equity. Car drivers cause congestion and environmental problems while other road users are forced to take these externalities. Transport equity also involves how the policy redistributes resources to balance out these externalities on other road users. Equity cannot be just within car owners and Beijing's lottery policy missed the opportunity of redistributing resources between car owners and other road users. It is actually a perverse incentive to worsen conditions for everyone, as more cars actually make everything worse with no revenue to improve the alternatives.

5.1.3.4 Spatial equity

Prior literatures have focused on the social dimensions of equity as horizontal or vertical equity. Social dimensions include income, education, household structure and employment status. Households with different socio-economic statuses may receive quite different impacts from transport policy. However, there are also spatial dimensions to consider in addition to the social dimensions. Prior literature also recognized the spatial impacts of car use restriction policies such as congestion charging since geographic location is a direct factor connecting to mobility needs. But is spatial equity also a concern in car ownership policy? Both implemented a car restrain policy deter car ownership, Shanghai and Beijing show very different attitude towards the treatment of space.

Shanghai requires all car buyers bid for their car license quota in a monthly public auction, but it also gives preferential treatment to residents living in the outer city. Unlike congestion charging, car ownership policy seems to not directly relate to space, but people's socio-economic variations have their projection on space which makes it harder to distinguish

social and spatial dimensions. For instance, the most economically disadvantaged classes are often concentrated in certain zones or districts that are least well served by transport. Vertical equity for the disadvantaged group therefore requires paying special attention to transport services in geographical zones that are currently the least well served. To address this spatial dimension of vertical equity, Shanghai issues a license "Plate C" to residents in the outer region while public transit is less well covered. Plate C is exempted from the auction but Plate C vehicles cannot drive into the central city.

Many households in Shanghai move towards the outer city to avoid high housing expense in the central city. However, these low income households also suffer from the inconvenience of living in the outer city as many areas do not have proper public transit coverage. With high mobility needs but no other alternatives, these households have high needs for private motorization. Recognizing this, Shanghai limits the constraint to residents living in central city where congestion is most severe through license auction policy, but waives residents living in the suburb. The way Shanghai treating location satisfies spatial dimension for both horizontal and vertical equity as it treats people living in similar locations alike (all need to go through public auction) while favours individuals living at the disadvantaged locations.

On the contrary, Beijing is indifferent about space. Horizontal equity is satisfied because residents in similar locations are treated alike, but vertical equity is not; people disadvantaged by their location have no better chance at obtaining a vehicle. This is also reflected as Beijing residents living close to and outside 6^{th} ring road think the policy is less fair compared to those living in the central city (Table 5.3, Table 5.7). Beijing has a very naive form of treating everyone the same despite their location and travel options available. The lottery policy shows no difference in treating residents in and outside the city. Shanghai acknowledges that

geographic location is important, and satisfies both the spatial dimension for horizontal and vertical equity. However, Beijing tries to keep everyone in the policy to be equal despite your income and location. This raises an important question on what is spatial equity and should we treat people differently? More specifically, where and how should we treat people differently?

There are many ways to differentiate people in the policy, by income, access to public transit, *huhou*, and age, etc. For instance, Shanghai could separate residents by their income level and waives low income people in the auction policy. However, Shanghai chooses geographic location as an important factor to differentiate people in the policy since location is more connected to vehicle and mobility needs. Moreover, it also has a clear differentiator on separating people. Shanghai has three ring roads: Inner Ring Road, Middle Ring Road, and Outer Ring Road where the Outer Ring Road divides the central city and the suburban area. Shanghai uses the Outer Ring Road as a differentiator and waives residents living outside the outer ring road by issuing a Plate C to car buyers. Using the ring road as the dividing line is clearer and also easier to manage. On the contrary, it would be much more difficult to choose a proper differentiating line in Beijing as it has six ring roads and very complicated to manage.

5.3.2 Unique equity dimension in China

Classic equity includes the dimensions that have been discussed in other transport policies and in other countries previously. Nevertheless, some equity dimensions only exist in China's context such as the way in treating residents with different *hukou* status, and the problems with large amount of government vehicles.

5.3.2.1 Local vs. migrant

Beijing's policy seems to be equitable if only consider the previous equity dimension. However, this fairness is only applicable to qualified applicants who are able to join the lottery. Residents holding Beijing hukou have no difficulty in enjoying the equity in the policy. However, Beijing's requirement for migrants is rather strict. Many are not qualified and have no chance of participating in the lottery. One of the requirements for getting a working residence permit in Beijing is to have a college or university degree. This in terms excludes the low educated migrants. Even with temporary residence permit in Beijing, migrants still need to pay necessary fees and tax continuously for five years which exclude the low income group and the unemployed. The lottery policy seems to satisfy vertical equity with regard to income as it treats everyone equally in the lottery, it already filtered out the low income and low educated migrants from entering the lottery. Li also emphasized the importance of qualification standard for the lottery as the premise for policy fairness (Y. Li, 2011). If the qualification requirement is unfair before the applicants join the lottery, the policy would not be fair despite the lottery process and results. Beijing's current lottery qualification standard is considered discriminated towards the migrants as it restricts the right to drive and opportunities migrants have if without the policy. The lottery policy seems to satisfy vertical equity but it is not fair when categorizing people according to their social class as migrants are worse off under the policy.

Public attitude is also consistent as over half of the people agree that the qualification standard is unfair and it restricts the migrants from buying cars in Beijing (Table 5.6). Close to 60% of them also feel the specific requirement for temporary residence to paying social security and tax continuously for five years is unfair and too strict.

Of the different social groups, migrants obviously show relatively higher concern of the qualification requirement than local residents with Beijing hukou since they are the disadvantaged group under the policy (Table 5.7). When segmenting car owners according to their car license types, car owners obtain Beijing license through other channels such as car renting together with nonlocal license owners feel relatively higher concern on the policy being unfair to the migrants. They may be the residents who are not qualified applicants and therefore use other methods to get license. Location also shows significant variation as suburb residents living outside 6th ring road show higher concern. Suburban residents may be correlated with migrants with low income or unemployed who may not be qualified for the lottery. Their access to opportunities may be further reduced as their right to drive has been restricted.

Table 5.6 Equity concern of the lottery policy in terms of local vs. migrant

Sign	Policy statements	Strongly/partially Agree	Neutral	Strongly/partially Disagree
	Local vs. Migrant			
-	The requirement for registration is too strict since people holding a temporary residence will need to pay social security and tax continuously for 5 years.	61%	20%	19%
-	The registration requirement is unfair to migrants since they have to hold a working residence permit or temporary residence permit but have paid social security and tax continuously for 5 years at the mean time.	59%	21%	20%
-	The lottery policy is unfair since it restricts the migrants from buying cars in Beijing.	53%	25%	22%

Table 5.7 Attitude variations in terms of local vs. migrant

Segmentation of Population	Local vs. Migrant	Segmentation of Population	Local vs. Migrant
Car Ownership and Lottery Participation	**Weighted Average**	**Socioeconomics**	**Weighted Average**
Car ownership		**Age**	
Non-car owner	-0.46	Young (<30)	-0.51
Car owner	-0.56	Adult (30 – 50)	-0.52
car ownership and license type		Senior (50+)	-0.37
non-car owner	-0.46	**Education**	
prior BJ license owner	-0.54	Highschool-	-0.53
lottery BJ license owner	-0.48	college/university	-0.39
other BJ license owner (car renting, second hand market)	-0.93	master+	-0.55
NL license owners	-0.80	**Income**	
Lottery participation		Low (<5k)	-0.55
Participated, obtained license	-0.59	Med (5k - 15k)	-0.45
Participated, still waiting	-0.39	High (15k+)	-0.54
Planning to participate	-0.59	**Hukou**	
Not planning to	-0.43	Local	-0.29
Not qualified	-0.45	Migrant	-0.84
		Location	
		within 2nd ring road	-0.33
		between 2nd - 4th ring road	-0.42
		4th - 6th ring road	-0.55
		outside 6th ring road	-0.69

5.3.2.2 Private vs. public owned vehicles

Beijing as the capital city in China is also the working center for government officials and government financed vehicles took up 15% of the motor vehicles in Beijing at the end of 2010 (Chen, 2011). Usage of government financed vehicles is also much higher than private vehicles. There are also concerns of private use of government vehicles. Government financed vehicles are large contributor to the congestion problems in Beijing. Beijing implemented the lottery policy to control private vehicles, and announced to not allocating any more government vehicle quota.

Restriction on government vehicles are strict but the unclearness in the amount of government vehicles, the large percentage of private use of government vehicles all raise public

concern. The survey results also indicated people's strong concern on government vehicles as over 90% of them feel there should be more restrictions on government instead of private vehicles. Although the government announced that they will not allocate any new government vehicle license, still over 70% think government officials could get around with it to get car licenses (Table 5.8). Not many variations are seen among different groups except people living close to the city center (within 2nd ring road) show relatively less concern on government vehicles. This also indicates Beijing residents in general show low very negative perception on large amount of government vehicles (Table 5.9).

Table 5.8 Equity concern of the lottery policy in terms of implementation

Sign	Policy statements	Strongly/partially Agree	Neutral	Strongly/partially Disagree
	Perception on government vehicles			
-	There should be more restrictions on licenses for government-financed vehicles than on private vehicles.	91%	8%	1%
-	Although Beijing government will not increase any new government vehicle licenses, they could still get around with it to get car licenses.	74%	23%	3%
+	Having government financed vehicles would be convenient for government officials and the quota should be increased.	32%	20%	48%
-	Government should restrict the vehicle licenses each government department can have.	82%	13%	5%

Table 5.9 Attitude variations towards perception of government vehicles

Segmentation of Population	Government Vehicles	Segmentation of Population	Government Vehicles
Car Ownership and Lottery Participation	**Weighted Average**	**Socioeconomics**	**Weighted Average**
Car ownership		**Age**	
Non-car owner	-1.01	Young (<30)	-0.90
Car owner	-0.89	Adult (30 – 50)	-1.03
car ownership and license type		Senior (50+)	-0.91
non-car owner	-1.01	**Education**	
prior BJ license owner	-0.91	Highschool-	-0.95
lottery BJ license owner	-0.85	college/university	-1.00
other BJ license owner (car renting, second hand market)	-0.62	master+	-1.10
NL license owners	-1.05	**Income**	
Lottery participation		Low (<5k)	-0.96
Participated, obtained license	-0.86	Med (5k - 15k)	-1.00
Participated, still waiting	-1.06	High (15k+)	-0.93
Planning to participate	-0.93	**Hukou**	
Not planning to	-1.04	Local	-0.96
Not qualified	-0.92	Migrant	-1.00
		Location	
		within 2nd ring road	-0.81
		between 2nd - 4th ring road	-1.01
		4th - 6th ring road	-0.96
		outside 6th ring road	-0.92

5.3.3 Policy loopholes

In addition to the lottery design issues that lead to above mentioned equity concerns, loopholes in the implementation process of the policy also causes problems. Corruption among government officials and lack of transparency in the process provide channel for speculative activities.

5.3.3.1 Corruption

For residents who do not qualify for the lottery or do not want to wait for the license, some car dealerships also have channels to buy a license for their customers through internal connection with the officers in the Transportation Bureau in charge of the license quota. Car dealers even have an open price of ¥ 40,000 to ¥ 60,000 to buy a car license quota where such

amount of money only goes to private account owned by the dealers rather than public use as opposed to Shanghai (PC auto, 2011). Since the lottery policy does not apply to property transfer due to debt owed, there are also ways of making the license seller and buyer as debtor and creditor even though they are strangers. Through connection with the court, license traders could make seller's vehicle as a way of paying off the debt to the buyer and transfer the vehicle with the license together to the buyer legally (n.d., 2011). There is also an open price of CYN 20,000 for each case the court takes.

Public also show a strong agreement that over 60% of the participants feel the policy as unfair since there are many loopholes and over 70% think there are alternative ways of getting license directly if having connection with the officials (Table 5.10). When segment the population, Beijing license owners who get license through other channels (car renting, from second hand market, etc) think the policy as least equitable. They are the people who see the loopholes and use it to get around the lottery. Residents who have participated in the lottery (no matter if he has won a license or not) show relatively stronger equity concern since they have more experience with the lottery policy (Table 5.11).

Beijing's license is supposed to be free of charge. However, the creative ways of getting a license in Beijing avoiding the lottery drawing also attach a value to Beijing's license which makes the fairness only at the superficial level. Shanghai's auction policy is priced based bidding from the beginning and market oriented that any speculation activities would have little distortion in the resource allocation. Different from Shanghai, shadow price of Beijing's license could vary significantly from CYN 40,000 to CYN 130,000 to the extreme cases. If consider Beijing's license having an initial value of zero, shadow price of Beijing's license is significantly higher than that in Shanghai. Beijing's policy is time based queuing where there is no cost but

applicants need to wait. Having a high shadow price for Beijing license also has large distortion on the market. It changes Beijing's policy from time based queuing to price based or even power based (one can get around with the lottery policy if he has money or connection with the officials). The shadow price for Beijing license is high enough to switch it from a free resource to a luxury good. Although the policy is designed to be fair in terms of rich versus poor as everyone is treated the same, but rich people can still get around the policy and avoid the whole process makes the fairness only superficially.

Table 5.10 Equity concern of the lottery policy in terms of policy loopholes

Sign	**Policy statements**	**Strongly/partially Agree**	**Neutral**	**Strongly/partially Disagree**
	Policy loopholes	**Strongly/partially Agree**	**Neutral**	**Strongly/partially Disagree**
-	Beijing's license plate lottery is unfair because there are too many loopholes and ways to around it.	64%	27%	9%
-	Even with the license lottery policy, some people could still get license directly having connection with the government officials.	73%	23%	4%

Table 5.11 Attitude variations in terms of policy loopholes

Segmentation of Population	Policy Loopholes	Segmentation of Population	Policy Loopholes
Car Ownership and Lottery Participation	**Weighted Average**	**Socioeconomics**	**Weighted Average**
Car ownership		**Age**	
Non-car owner	-0.87	Young (<30)	-0.87
Car owner	-0.90	Adult (30 – 50)	-0.92
car ownership and license type		Senior (50+)	-0.74
non-car owner	**-0.87**	**Education**	
prior BJ license owner	**-0.92**	Highschool-	-0.89
lottery BJ license owner	**-0.77**	college/university	-0.82
other BJ license owner (car renting, second hand market)	**-1.25**	master+	-1.01
NL license owners	**-0.81**	**Income**	
Lottery participation		Low (<5k)	-0.88
Participated, obtained license	**-1.01**	Med (5k - 15k)	-0.90
Participated, still waiting	**-1.08**	High (15k+)	-0.81
Planning to participate	**-0.83**	**Hukou**	
Not planning to	**-0.74**	Local	-0.85
Not qualified	**-0.64**	Migrant	-0.92
		Location	
		within 2nd ring road	-0.70
		between 2nd - 4th ring road	-0.87
		4th - 6th ring road	-0.92
		outside 6th ring road	-0.77

5.3.3.2 Information asymmetry

Implementation process is also a significant factor affecting the lottery equality as mentioned in Li's paper (L. Liu & Li, 2011). Feng (Liguang, Haozhi, Yulin, & Zhaorong, n.d.) also mentioned that how well the policy is implemented and how does the government ensure transparency in the overall process to avoid black case work is important in easing equity concerns among the public. License lottery drawing results are made public to Beijing's residents and everyone can check the licence winners' list online. However, various lottery formats could be used depending on different purposes and such process is not transparent to the public. Only the first few lottery drawings are live broadcasted and majority feel they don't get detailed information about the policy.

Close to 80% of the participants think the overall lottery drawing process is not that transparent and they don't get enough detailed information on the drawing process (Table 5.12). Close to 70% feel the loopholes in the drawing process and think there might be black case work underneath the process (Table 5.12). When segmenting the population based on their lottery participation status, those are still waiting for a license in the lottery shows the highest equity concern on transparency of the implementation process (Table 5.13).

Table 5.12 Equity concern of the lottery policy in terms of implementation

Sign	Policy statements	Strongly/partially Agree	Neutral	Strongly/partially Disagree
	Implementation loopholes			
-	It is not possible for the drawing process to be transparent since only the first few drawings could be watched in real time.	78%	19%	4%
-	Although lottery registrants could get the results through internet and telephone, they cannot obtain the detailed information on the drawing process.	80%	18%	2%
-	There are many loopholes in the drawing process which makes it hard to be fair and transparent.	69%	27%	5%
-	There might be speculation and black case work in the drawing process.	70%	26%	4%

Table 5.13 Attitude variations in terms of implementation loopholes

Segmentation of Population	Implementation	Segmentation of Population	Implementation
Car Ownership and Lottery Participation	**Weighted Average**	**Socioeconomics**	**Weighted Average**
Car ownership		**Age**	
Non-car owner	-0.99	Young (<30)	-0.92
Car owner	-0.95	Adult (30 – 50)	-1.04
car ownership and license type		Senior (50+)	-0.85
non-car owner	-0.99	**Education**	
prior BJ license owner	-0.95	Highschool-	-0.96
lottery BJ license owner	-0.92	college/university	-0.99
other BJ license owner (car renting, second hand market)	-1.11	master+	-1.07
NL license owners	-0.96	**Income**	
Lottery participation		Low (<5k)	-1.01
Participated, obtained license	-1.03	Med (5k - 15k)	-0.97
Participated, still waiting	-1.20	High (15k+)	-0.94
Planning to participate	-0.94	**Hukou**	
Not planning to	-0.89	Local	-0.98
Not qualified	-0.70	Migrant	-0.98
		Location	
		within 2nd ring road	-0.65
		between 2nd - 4th ring road	-0.99
		4th - 6th ring road	-0.99
		outside 6th ring road	-0.70

5.4 Discussion

Since Beijing implemented its vehicle license lottery policy in 2011, the effectiveness has been extraordinary. The rate of growth of car ownership has decreased significantly. By examining the policy through three lenses of equity – classic equity drawn from the literature, unique equity based on China's context, and policy loopholes – we find that that the equity of the license lottery is only superficial. On its face this policy is aimed directly at addressing equity issues, by giving each application for a license an equal chance at obtaining one. Table 5.14 summarizes the equity implications of each of the dimensions analyzed. Equity in the lottery policy is progressive in terms of two aspects: rich versus poor, and controlling government vehicles. The policy is successful in dealing with income disparity; every applicant in the lottery

has the same chance of winning without regard to his or her financial ability. The Beijing government has also reduced the government vehicle quota to zero.

However, migrants, who make up 36.8% of Beijing's population, are systematically excluded. Prior car owners, all 4.26 million of them (considering total passenger cars in Beijing at the end of 2010), are grandfathered in. The government's treatment of prior car owners only restricts the purchase of a second car. It does not distinguish between people with and without access to other modes of transportation based on residential or employment location. Location, tightly connected to mobility needs, is not covered in the lottery policy. The policy raises no revenue, and thus has no means to correct for equity implications between drivers and non-drivers. Lack of transparency and perceived corruption have opened room for speculators, allowing the wealthy to effectively buy their way out of the lottery. Finally, it results in serious inefficiencies in who purchases automobiles, since rational behaviour is to enter the effectively free lottery, regardless of the need or desire for a vehicle. In short, while the policy is mostly effective in controlling the growth of automobiles in Beijing, the equity obtained from the policy is superficial.

Table 5.14 Beijing government treatments on various equity dimensions

Treatment direction / Equity dimensions	Positive	Negative
Classic equity		
Rich vs. Poor	**X**	
Prior vs. New		**X**
Revenue Transfer		**X**
Space		**X**
Unique equity		
Local vs. Migrant		**X**
Private vs. Public	**X**	
Policy loopholes		
Corruption		**X**
Information Asymmetry		**X**

Policy implementation requires choices in how to treat different groups – what type of vertical equity to emphasize. The dimension a government chooses is a reflection of its tradition and preference. Beijing and Shanghai show a strong contrast. Shanghai chooses to differentiate people by location (as a crude proxy for accessibility). Shanghai's policy is based on valorizing mobility without regard to class. This is equality of opportunity, with allocation by capacity to pay. The emphasis is on efficiency. Beijing chooses to differentiate people by *hukou* (local vs. migrants). China's *hukou* system dates from 1958 and serves to make migrants outsiders in cities. Shanghai's preferential treatment favours disadvantaged suburban residents with low mobility. Beijing's treatment, on the contrary, favours local citizens instead of protecting the disadvantaged migrant population (who usually have low income and more restrictions in the city). The emphasis is on bureaucracy, rules, and "local protectionism".

While the directionality of these preferences is clear, the extent paints a more complicated picture. Although Shanghai favours suburban residents by permitting them to opt for a free license, these license holders are totally banned of entering into the city. Shanghai has also kept the option to subject such license to auction in the future. Beijing's restrictions based on *hukou* do not permit alternatives for those migrants. The restriction on non-local vehicles leaves no alternative options for migrants who do not qualify for the lottery.

The progressive or regressive nature of any given dimension of equity depends on the scale of analysis. The license lottery policy seems to be progressive if the scale of equity analysis is only within new car buyers who are eligible to enter the lottery pool. Everyone is treated the same despite financial ability. Enlarging the scale to all car buyers, the policy becomes regressive. It greatly restricts car ownership by the disadvantaged migrant population. Including prior owners, lottery entrants are disadvantaged, who tend to be less wealthy than those already

owning a car. Across the entire populace, the lottery raises no revenue, and thus cannot effect redistribution of access. The details of a policy are required to truly judge the equity implications.

One of the unique aspects of Beijing's policy is that it was oriented toward equity, as opposed to efficiency. Efficiency of resource allocation is low because it does not require payment to enter, and all losing participants are re-entered each month. Even if one does not have current need for a car, the rational choice is to enter the lottery. Because the lottery policy allows 6 months for license quota winners to register a license with no penalty for an unused quota, many residents enter the lottery without a plan to buy a car. The queuing process creates a large pool of people waiting for licenses. The odds of winning as of April 2013 are 1:81 (Ma, 2013) with the number of applicants close to 1.5 million. When the policy began in January 2011 the odds were 1:11. To counteract the worst effects of this situation, starting in April 2012 lottery applicants in the pool are required to confirm their desire to stay in the queue every three months online (B. Li & Li, 2012), but this has clearly proven ineffective.

Given the current odds, there can be little rational expectation of winning, and thus few people are likely to have plans to buy a vehicle immediately when they enter the lottery. The result is that there is an imbalance between the allocated quota and the number of cars actually sold. Since January 2011, an estimated 2/3 of the total quota has been unused (Fan, 2011). The lottery has effectively detached vehicle ownership from the need for travel. People who need cars immediately do not get license, and license winners do not buy cars.

Beijing's lottery policy sacrifices efficiency for equity, and the saliency of its equity emphasis makes the policy perceived as equitable. 69% of the participants in the survey think Beijing's lottery is more equitable compared to Shanghai's auction. However, findings from this study show only a small portion of the entire equity domain has been addressed. Close to half of

the participants (49% in the survey) feel that fairness in Beijing's lottery policy is only superficial when compared to Shanghai's auction (Table 5.15). The implication is that it is useful politically, but not sufficient in policy terms, for a government to focus on equity in policies restricting car ownership. As these polices become more prevalent within China and elsewhere we hope that policy designers continue to focus on equity, especially those dimensions that are unique to their context.

Many adjustments in the policy could be made to improve equity and efficiency at the same time. For instance, Beijing could reduce the license entitlement from lifetime to a certain fixed duration in order to reduce the equity concerns between prior car owners and new car buyers. For example, Singapore's license entitlement is ten years and renewal is required after expiry. Beijing could enfranchise migrants by reducing eligibility requirements. Beijing could also introduce spatial considerations into the policy to treat people with different mobility needs differently, although current urban form may make this difficult. There could be stricter restrictions on government vehicles including both reductions in numbers and restrictions on their use. Beijing could also impose an entry fee on the lottery in order to filter out non-serious participants. Although it is an efficiency measure, such a fee would also improve vertical equity by offering those with greater mobility needs a higher chance of winning. Lastly, supplementing car ownership policies with additional usage policies including congestion charging may also improve equity by allowing redistribution of collected revenue.

Table 5.15 Fairness comparing auction and lottery

Sign	Policy statements	Strongly/partially Agree	Neutral	Strongly/partially Disagree
-	Beijing's car license lottery policy is only fair superficially compared to Shanghai's auction policy.	49%	34%	17%
-	Beijing's lottery policy embodies the principle of equity more than Shanghai's auction since everyone has the same chance of winning despite his financial ability.	69%	24%	7%

6 Conclusion

6.1 Summary of Behavior Findings

Increased automobile ownership and use in China over the last two decades has increased energy consumption, worsened air pollution, and exacerbated congestion. However, the countrywide growth in car ownership conceals great variation among cities. For example, Shanghai and Beijing each had about 2 million motor vehicles in 2004, but by 2010, Beijing had 4.8 million motor vehicles whereas Shanghai had only 3.1 million. Among the factors contributing to this divergence is Shanghai's vehicle control policy, which uses monthly license auctions to limit the number of new cars. Shanghai government sets up a total quota each month and requires every car owner to join a bidding process to obtain a vehicle license. The policy appears to be effective: in addition to dampening growth in car ownership, it generates annual revenues up to 5 billion CNY (800 million USD). Despite these apparent successes, the degree to which the public accepts this policy is relatively low.

Two questionnaire surveys were conducted in Shanghai and Beijing. Shanghai's survey was focused on the working population and was conducted by the researchers among nine local companies in Shanghai in 2011. In total of 1100 employees were recruited while 827 responses were collected. After filtering the invalid answers, 524 valid responses were used for analysis. Beijing's survey was conducted online through the survey company "51poll" with a total of 1600 responses collected and filtered down to1505 valid responses used in the thesis.

Based on the survey data, this thesis investigates the policy acceptance of Shanghai's car license auction, develops a framework for evaluating key determinants of public acceptability, and examines local residents' attitude towards the core factors: perceived effectiveness, perceived policy effectiveness, affordability, equity concerns, and implementation process.

Respondents in the first survey perceive the policy to be effective, but are moderately negative towards the policy nonetheless. However, they expect that others accept the policy more than they do. Respondents also hold consistently negative perceptions about the affordability of the license, the effects on equity, and the implementation process. Revenue usage is not seen as transparent, which is exacerbated by a perception that government vehicles enjoy advantages in obtaining a license, issues with the bidding process and technology, and difficulties in obtaining information about the auction policy. Nevertheless, respondents believe that license auctions and congestion charges are more effective and acceptable than parking charges and fuel taxes. Although their overall acceptance is low, they do reflect a slight increase in attitude.

In addition to examining public acceptance and attitude at the aggregate level, this thesis also investigate the preference variation among local residents in their auction policy acceptance and its various determinants: perceived effectiveness, affordability, equity, transparency of revenue usage, and perception on government vehicles. Based on the second survey conducted online among Shanghai residents, four major dimensions are used to segment the population: car ownership and license type, people's urgency to buy a car, locational variables as house location and transit access, and other socioeconomic characteristics (income, residence, age, education, and gender). Analysis of variance (ANOVA) test is used to evaluate the significance of the preference variation, and structural equation models (SEM) are developed to quantify the impact of the determinants of policy acceptance among different population segments. Among all dimensions, car ownership and license type turns out to be the most important differentiator in terms of the policy acceptance and attitude. The political economy of most car deterrent policies shows that car owners, in general, are the group that most oppose these policies, but the car license auction policy in Shanghai shows a slightly different story. Different from other car

deterrence policies, local car owners (bid license through auction) are more supportive of the auction policy in Shanghai. Their acceptance level also increases significantly over time. Local car owners also perceive the policy as more effective and more affordable. This study suggests that local car owners, by paying the high license fee, have invested in this policy and become an interest group in support of it. As the percentage of local car owners grows, the auction policy gains more support and becomes almost irreversible. Within non-car owners, urgent car buyers also show highest support of the policy. As compared to the time queuing lottery policy in Beijing, Shanghai's auction becomes more attractive to urgent car buyers since they can get license as long as they are willing to pay high enough.

Public attitude is not only affected by the design of the policy, but also implementation of the policy as defined in the acceptance framework. In addition to the general implementation process, we also found a phenomenon that causes difficulty in implementing and managing the auction policy as an unintended consequence of policy transfer from Singapore. The manner in which Chinese cities often adopted policy strategies internationally has created many problems due to the differences in local context and institutional structure. Shanghai's car license auction policy transferred from Singapore is an example showing how a technical issue of non-local vehicles raised a dilemma for Shanghai government in the trade-off between congestion management and openness of Shanghai as a metropolitan center. Shanghai requires all car buyers to bid for their license through the auction and license price increases to be even more expensive than a small vehicle. As Shanghai license prices continuous to increase, many Shanghai residents get a non-local license outside Shanghai for a much cheaper price. The problem of non-local vehicles is a unique phenomenon that would happen in cities with open boundary as Shanghai and Beijing. It waters down the policy effectiveness, results in challenges in traffic management.

It also results in large revenue loss outside Shanghai, exacerbates equity concerns among Shanghai car owners, and decreases trustworthiness of government policy. Singapore as a state-city has no non-local vehicles, but Shanghai as a city of a state, is facing the dilemma of further controlling non-local vehicles to mitigate congestion versus the city's openness to promote inter-city trade. Although Shanghai has taken actions in controlling non-local vehicles through both internal policy refinement and regional collaboration, it has hesitated in posing harsher restrictions. Public views vary across different dimensions and two variables show the largest impact on attitude: car ownership and license type, and residence status. The public does understand Shanghai's dilemma and the importance of the city to remain open as the public opposes further restrictions on non-local vehicles. Even local license owners and locally residents, who are most likely in favour of further restrictions, do not want harsh restrictions banning non-local vehicles.

Shanghai referenced the auction policy from Singapore, but Shanghai's policy itself provides inspiration to many other Chinese cities. Beijing is one of them and is the second city implementing car ownership policy after Shanghai, but in a different format. Beijing introduced a lottery policy to allocate car license quota for free. The lottery policy is effective in damping car ownership growth rate similar to Shanghai's auction policy. Nevertheless, it is not efficient in allocating resources to the ones who need them the most. With no entry cost, the lottery policy reflects neither people's willingness to pay nor their capacity to pay while the bidding price in Shanghai's auction reflects both. Shanghai's auction policy raises concerns on equity of the policy favoring the rich and public's negative attitude towards equity proved that as well. Learning from Shanghai's experience, Beijing's lottery is designed to address the equity issues as it requires no cost for lottery entry, but the Beijing's effort in addressing equity is only

superficial. Equity has gained increasing importance in transport policy and Beijing's new car license lottery system provides a good opportunity for equity analysis. Based on prior literature and China's context, an equity framework is also developed for this specific lottery policy including three categories: (1) classic equity dimensions that have been mentioned in prior literature; (2) unique equity dimensions that only exist in China's context; and (3) policy loopholes that provide people opportunity to get around with it. Public perception towards these equity dimensions are examined based on a similar questionnaire survey implemented online through the survey company among Beijing residents. After data filtering, in total of 1505 valid responses were collected.

While this policy is aimed directly at addressing equity issues, it disadvantages the 36.8% of the population who are migrants, advantages the 4.26 million prior car owners, and does not distinguish based on mobility needs at the residential location. It raises no revenue, and thus has no means to correct for equity implications between drivers and non-drivers. Its inefficiencies result in divorcing the need for a car from the ability to have one is only compounded by lack of transparency and apparent corruption. Transport equity could be very complex and result of the equity analysis could be totally different depends on the scale of analysis. While the lottery policy is effective in controlling the growth of automobiles in Beijing, the equity obtained from the policy is superficial.

In addition to the findings presented above, this section also summarizes and provides a general comparison of the car license auction policy in Shanghai with lottery policy in Beijing in Section 6.2. Section 6.3 provides policy recommendations for policy makers to improve the policy and Section 6.4 discusses the limitation of the work. Finally, Section 6.5 extends the research and proposes future research directions.

6.2 Auction vs. Lottery

Table 6.1 below summarizes the general policy facts between car license auction policy in Shanghai and car license lottery policy in Beijing. Before 2011, Beijing only controlled usage while Shanghai started car ownership control in 1994. Shanghai took an early strategy in controlling car ownership growth when private motorization was not high and the public had not yet at the stage of buying cars. In addition, Shanghai implemented the policy in a gradual process and the public already got used to the auction policy when the middle class family started to buy cars. On the contrary, Beijing implemented the policy at a late stage of motorization when there were already large amount of cars. Beijing also introduced the lottery policy quite suddenly leaving no time for public participation or response.

Although both policies fix the quota at certain amount, monthly license quota in Shanghai is adjustable. Shanghai government announces this month's license quota one week before the auction date and the quota is adjusted every month. However, the exact method used to calculate license quota is not known even though the government announced the quota to be determined based on road capacity. Similarly, Beijing does not have a clear formula calculating the vehicle quota neither. Beijing also fixes the monthly quota at 20,000 leaving no room for adjustment each month.

In terms of the allocation mechanism, both cities used quite different approaches. Referencing Singapore, Shanghai uses auction while Beijing uses lottery. Shanghai uses price based bidding while Beijing used time based queuing mechanism. Shanghai's auction requires a cash deposit of CNY 2,000 before the applicant can join the bidding. The deposit will be used to pay off the total license price if the bidder obtains a license successfully. Such entry cost forces the bidders to make a serious thinking before joining the auction. Beijing's lottery policy, on the

other hand, requires no cost of entry. Moreover, Beijing bans second car purchase while Shanghai does not. Beijing also bans all types of license trading while Shanghai allows license transfer together with the vehicle.

In terms of the attitude towards non-local residents, Beijing's lottery qualification standard for migrants is more difficult. Although car license is free in Beijing, the policy is more protective of the local citizens than migrants. On the contrary, Shanghai's license is pricing based and ranks people according to the mixture of their willingness to pay and capacity to pay for the license. In terms of the treatment towards non-local vehicles, Beijing is also stricter as it bans non-local vehicles driving inside sixth ring road during rush hour while Shanghai only blocks the elevated expressway. Shanghai thinks location is an important key to differentiate people and issues a Plate C license to suburban residents driving outsider the Outer Ring Road only. Conversely, Beijing treats everyone living in all locations the same with no preferential treatment.

Table 6.1 Policy facts between auction and lottery

	Shanghai	**Beijing**
Long term strategy before 2011	Ownership control	Usage control
Control total quota of growth	Yes	Yes
Allocation mode	Auction	Lottery
Allocation mechanism	Price based bidding	Time based queuing
Year of introduction	Early + gradual: 1994	Late + Sudden: 2011
Cost of entry	CNY2,000 deposit	None
Quota adjustment	Adjustable	Fixed
Quota calculation	Unknown	unknown
License trading	Allow license trading together with the vehicle	none
2nd car restriction	None	yes
Migrant qualification	Easier	Difficult
NLV ban	Elevated highway during rush hour	Entire inside sixth ring during rush hour
Spatial treatment	License plate C to vehicles outside Outer Ring Road	none

Examining and comparing the different policy facts between auction and lottery also provides us with an overview of each city's characteristics (Table 6.2). Both Shanghai and Beijing exhibit strong intervention on car ownership growth as they require all purchases go through auction or lottery to get a license. However, these two cities differ by the way they embracing the market or the different mix of state-market intervention. Shanghai mixes state intervention with the market as the government controls certain aspects of the policy but allows the market allocating the license to buyers who need them the most.

This difference in state-market relationship can be seen from various other aspects in the policy. Shanghai's license auction policy hybrids state control with market liberalization. For instance, auction is market based as market determines who can get the license based on the bidding price but Shanghai government determines the monthly quota to be allocated. However, the quota determination process also involves public opinions as the government adjusts the quota based on prior months' bidding price. Beijing's lottery is based mainly on state intervention leaving little room for the market to play. Beijing fixes the monthly quota to be allocated and the allocation process is very random with no market involvement. Shanghai's auction allows license trading together with the vehicle but the government also regulates the market behaviour when it loses control or if any speculative activities occur. Traders in Shanghai have little profit to make and behave more like agents. Shadow price for license in Shanghai is kept at reasonable level close to the bidding price. Beijing, on the other hand, totally bans license trading with vehicle. Nevertheless, the market continues to react finding alternative channels of getting license through corruption, fake lawsuit, car license renting, etc. Although Beijing government intends to tightly control the policy, but market still responds and license shadow price has gone over control.

With market largely involved, Shanghai's policy is more efficiency based as the price determines who will get the license. With no or little market involvement, Beijing's policy tends to be more equity oriented even though at a superficial level. Price based bidding in the auction also creates less distortion in the allocation process. On the other hand, time based queuing mechanism in the lottery changes from queuing to pricing (or even power) through ways of corruption. As a result, rich people can still buy the license for high price in Beijing. Shanghai's auction considers both people's capacity to pay for a license and their willingness to pay while the lottery could reflect neither of them.

In terms of the policy evolution process, Shanghai's policy also shows a two-way interactive process. Car license price in the auction is also a good way to gauge public attitude. When license price is very high, it forces the government to intervene to ease public concern. Quota in the auction is also adjustable allowing the government to reflect public attitude in the policy. Beijing, on the other hand, has no direct channel to reflect public concerns.

A city's openness can also be reflected in its treatment towards the outsiders. Both Shanghai and Beijing are facing the problem with non-local vehicles and the trade-off between congestion management and economic growth of the city. Shanghai tries to balance the scale by having medium restrictions on non-local vehicles on elevated expressways but still allow them to drive freely on the surface road. Conversely, Beijing totally bans non-local vehicles in the central city (on and within fifth ring road). Restriction on migrants is also higher in Beijing. Instead of banning non-local vehicles, Shanghai collaborates with nearby cities to control non-local license registration instead of closing the boundary. Through various fine-tunings, Shanghai is groping its own way of controlling non-local vehicles and making it as an intentional policy leakage.

Beijing, however, has not yet developed regional collaboration with other cities. The lottery policy has been implemented shortly while any big policy changes haven't been seen.

Table 6.2 Comparisons between auction and lottery

	Shanghai	**Beijing**
Intervention strength	Strong	Strong
Embracing market		
Market and state	State + market	Mainly state
Efficiency and equity	More efficiency	More equity
Allocation mechanism	Price based bidding	Time based queuing
Consequences	Less distortion	Queuing → Price or Power
Financing ability to pay vs. willingness to pay	Mixed of both	Neither
Increasingly two-way interactive policy design		
Gauging the public	Via bidding price	No direct channel
Learning and Adjusting	Adjustable quota	Fixed quota
congestion management vs. city openness		
Restriction of NLV	Medium	High
Restriction of Migrants	Medium	High
Regionally collaboration	Yes	To be examined
Strategic about leakage	Yes	To be examined

6.3 Policy Recommendations

This thesis also proposes several recommendations to improve the auction and lottery policies in Shanghai and Beijing. We propose to improve the car license auction policy in Shanghai by sub-categorizing the auction, forming a dedicated policy website to improve transparency and information provision to the public, and using parking charges as a way to control non-local vehicles. We also recommend Beijing's car license lottery policy treating people at different locations differently based on mobility need and setting certain level of entry cost to lottery. Both Shanghai and Beijing should reduce the privilege for government vehicles and they could also consider change the lifelong license entitlement to a certain fixed period and supplement car ownership policy with usage control measures. Detailed recommendations are presented below.

Current auction system in Shanghai has no sub-categories and the higher bid gets the license despite the vehicle price. This is unfair to low income people who wants to buy small vehicles to bid together with the rich in one auction as the license price sometimes could be more expensive than the vehicle price the low income (a small economic vehicle usually costs CNY 50,000 to CNY 100,000 which is the price of a Shanghai license). Singapore's experience in auction sub-categorization is a good reference to Shanghai. Singapore sub-categorizes the auction depending on vehicle type as cars, goods vehicles and buses, motorcycles. Prior to May 1999, Singapore had seven categories in the auction but it later reduced to five. The rationale for introducing sub-categorization in Singapore was also to allay fears that the quota system would favor the rich. By holding separate auctions for each category, it was envisioned that lower-income motor vehicle buyers would not have to bid against wealthier motor vehicle buyers for quota. This was particularly why Singapore has four categories for cars depending on their engine capacity prior to 1999: small cars (category 1); medium sized cars (category 2); large cars (category 3); and luxury cars (category 4). Singapore later combined them into two categories for cars: cars 1600 cc and below, and cars 1600 cc and above. Shanghai could reference this sub-categorization depending on engine capacity, but the implementation needs to be cautious as sub-categorization may be undesirable sometimes as it may result in underutilization of the total quota.

Previous studies showed fixing quota for each category may be purely a guessing game with no actual benefits in improving equity for low income group. Because the demand for cars at different categories are unknown with any degree of precision, the percentage of quota allocate to each category becomes a guessing game and over half of the time the guesses have been off the mark in Singapore (Tan, 2001). Quotas for small and medium sized cars often have

been set too low and the quotas for large and luxury cars have been set too high relative to their demands.

In addition to sub-categorization, Singapore also has an open category that can be registered to any vehicle types. The rationale for the open category was to introduce flexibility in the vehicle mix and quotas for the different categories are based on their proportion in the total vehicle population at the end of the previous year. Shanghai could also consider using similar open category to allow flexibility in the composition of the car population and allow mix in the vehicle type. However, previous study showed that most of the open category license in Singapore is used in larger vehicles which may lead to a shift towards larger cars and away from smaller cars (Tan, 2001).

Shanghai's auction combines individual vehicle with private company in one auction. It could also consider separate the two and sets higher reserved price for company vehicle quota. Sub-categorization can be desirable under certain conditions depending on the environment and the objective of the authorities, but more detailed analysis needs to be taken and better formula in calculating the quota should be studied based on Singapore's experience.

Improving transparency of the revenue usage and updating policy changes are also important to increase public acceptance. Thus, Shanghai should form a dedicated website documenting all the policy fine-tunings and updating the auction results and revenue collected every month. In addition, Shanghai should make public the detailed usage information of the revenue to local residents to improve their trust in the government and to avoid corruption.

High penetration of non-local vehicles in Shanghai causes many problems and parking is a good way to control non-local vehicles. Shanghai government could ask car owners to register their license when purchasing parking spaces. The first thing practitioners need to know in any

transport policy is the total amount of vehicles in Shanghai but unknown non-local vehicles' penetration adds uncertainty to the total car volume. Car owners purchasing parking spaces provide a good opportunity for the authority to register their car licenses. Also, this becomes easier to differentiate car owners who are visitors or doing business trips in Shanghai versus those who live and work in Shanghai but chooses non-local licenses as a way to avoid the auction policy. If price is the key for some residents getting non-local licenses, then requiring different parking charges to different license types could be an option to further increase cost of owning a non-local vehicle. This, as a result, would reduce the price differential between local and non-local licenses as well as decrease the incentives for Shanghai residents getting non-local license in the future.

Shanghai government may also risks to be criticized as local protective if it treats non-local vehicles so differently. With the high penetration of non-local vehicles in Shanghai, high restriction on non-local vehicles may raise public concern. Also, the difference in parking charges need to be studied as to what extent it will be effective in deterring people from getting non-local license but does not raises too much concerns as discrimination against migrants.

License lottery in Beijing focuses on equity but it does not consider spatial equity. Beijing could include space in the policy design to treat people with different mobility needs differently. Similar to Shanghai, Beijing could consider issuing suburban license as well. There may be various ways that Beijing could use to allocate this license. Beijing needs to make a tradeoff in the extent of treatment and the type of restriction on suburban license. For instance, Beijing could allow suburban residents to register to a license directly without waiting in the lottery but instead imposing harsh restriction on the suburban license to ensure effectiveness of the lottery policy and to avoid equity concerns among urban residents. Or, Beijing could set a

separate lottery to allocate suburban license and imposes minor restrictions. By separating from urban residents, suburban residents still get a higher chance of winning than single lottery drawing.

There are also different ways Beijing could use to differentiate people when imposing restrictions. Beijing could restrict suburban license by time or by area they can drive. For example, Beijing could restrict suburban license from driving during rush hour or it could specify suburban license to be used only outside the central city. However, it is more complicated in choosing a differentiator based on location in Beijing than that in Shanghai. Shanghai only has three ring roads with a much smaller land area. It chooses the Outer Ring Road as the differentiator for suburban license which is easier to manage. Beijing, on the contrary, has six ring roads which are hard to manage and difficult to choose the dividing line for suburban license. Beijing also need to be cautious on the degree of restriction on suburban license to be fair to urban residents but also does not causes too much inconvenience that raises public concern.

Having no entry cost, Beijing's license lottery is inefficient as the allocation mechanism does not match the results with people's mobility needs To improve efficiency and vertical equity with regard to mobility needs, Beijing government should require an entry cost into the lottery to filter out non-serious participants in the lottery pool. However, there are still many questions that need to be answered in future studies as at what level should the entry cost be set? Should it be considered as administration cost for the lottery process or be counted as another type of government revenue? How should the government use the money collected? The entry cost should be high enough for people to give a serious thought before applying, but not too high

to cause concerns. In addition, Beijing should make the lottery process public to Beijing residents either online or through media to avoid black-case work and corruption in the process.

Although car ownership policies in Shanghai and Beijing effectively dampen vehicle growth rate, but the total number of vehicles continue to grow. Continuing releasing quota every month cannot cap the total volume. Both cities could consider reducing the quota gradually or limit the license entitlement from lifelong to a certain fixed duration referencing Singapore. This could also ease the equity concern between prior and new car owners in Beijing as prior car owners are no longer exempted from the policy.

Moreover, resident in both cities have low perception of government vehicles. Further usage control on government vehicles in addition to capping the total volume is necessary such as dismantling their privilege to a greater extent. Car ownership policy only controls vehicle growth but it does not ease congestion. Thus, supplementing car ownership policy together with usage restriction as congestion charges would be more effective to control congestion.

6.4 Limitations

This research also contains many limitations. Firstly, this thesis uses questionnaire survey as the main method since a larger sample size could be obtained to represent the general public's attitude. Questionnaires are also tend to be more objective research tool, but results obtained can be limited by many factors: faulty questionnaire design, sampling errors, biased questions, wording in the language used, misunderstanding of the questions, and faulty interpretation of the results. Results of the survey could be biased depends on what type of questions are included in the questionnaire and the importance of the questions are usually depended on the researcher which could be misleading. Wording of questions is particularly important when we used

multiple indicator statements to describe a factor in this thesis. Various indicator statements are included to describe a single factor. For instance, we use statements as "I support license auction in Shanghai", and "I accept the license auction policy" to measure policy acceptance. But the tiny wording difference may affect people's choices. Someone may think they accept the policy but they may not in general support it. In this thesis, we treat support and acceptance the same.

Also, both positive and negative statements are used to describe a single factor. For example, "I do not accept license auction policy" is the negative statement asking policy acceptance. The idea of using both positive and negative statements is to avoid random answers and to check if participants paid attention to questions. However, results also showed that participants tend to agree on statements then to disagree on which makes the analysis difficult. Using single indicator may also be biased. There is a tradeoff to make between the amount of information obtained and the complexity in selecting the best question to use. Also, meaning of the statements may be different when translate the questionnaire into Chinese.

Secondly, the questionnaire survey in Shanghai focused on the working population while Beijing's survey was more representative of the general public as it was distributed online through an online survey company. Because Shanghai's survey was collected by the researcher and no reward are given, many respondents did not complete the questionnaire and only a small sample size was collected. Additional survey in Shanghai through online survey company similar to that in Beijing may provide larger samples more representative of the general public.

Thirdly, in the questionnaire design, some of the equity dimensions in Chapter 5 as spatial equity and revenue transfer are not included. Public attitude towards these equity dimensions, therefore, are unknown. Moreover, a structural equation model comparing the determinants of

policy acceptance in both policies cannot be built because the indicator factors measuring proximal determinants as equity are not the same. Each policy has its own equity concerns which make them not comparable.

In addition to questionnaire survey, this study does not use other data collection methods as personal interviews which may provide more detailed information about the subject. Interviews with the local policy maker could provide more insights into how transport policy is designed in each city. Interviews with transportation planners and professionals could provide more suggestive ideas to improve the policies and more critical views towards the policies. Most importantly, interviews with local residents could provide more useful insights as how they think about the policy and how to improve their acceptability. It may also help to catch aspects that are missing in the questionnaire survey. Interview with other interest groups as local car dealers could provide more information on many subjects as how do they register non-local license for Shanghai residents, and how do they trade license.

6.5 Future Research

Growing demand for mobility leads to rapid car ownership growth and various transport policies have been adopted in Chinese cities. This thesis examines the car ownership policy in Chinese mega cities with a particular focus on car license auction policy in Shanghai with a comparison to car license lottery policy in Beijing. Car ownership policy contains a variety of topics that extends out beyond this thesis.

6.5.1 Determinants of public acceptance

Public acceptance is the key to successful implementation of transport policies. This thesis discusses the preference variation towards the policy. However, it does not evaluate the

contributing factor to public acceptance. Chapter 3 of the thesis develops a structural equation model but it only identifies socioeconomic determinants of policy acceptance. Future research could improve the SEM model through adding more variables to increase the explained variance of the model. Possible variables influencing policy acceptance in addition to socioeconomics include: (1) policy attitude; (2) personal impact; (3) car attitude including car dependence and pride; and (4) familiarity or knowledge about the policy.

Based on the acceptance framework developed in Chapter 2, core policy specifics that may affect acceptability are perceived effectiveness, affordability of license, equity concerns and implementation process. Similar to any transport policy, a higher perception on the effectiveness of the policy may also lead to positive support of the policy. The more affordable people think themselves are, then the less economic impact they will receive from the policy. Thus, they will be more supportive of the policy to constrain others buying cars. Equity concerns may include various dimensions. In Shanghai's case, equity includes equity in the auction, transparency of revenue usage, perception on government vehicles, and equity comparing to other cities with no car ownership control. Personal impact may also influence policy acceptability because people's current condition determines how they would think about the policy and how does the policy affect them. For example, someone may think the policy is not fair but he already has a license while the auction policy in general has positive impact on him. Thus, he may still be in favor of the policy although he is not happy with the specifics.

In addition to policy attitude, people's attitude towards car may also be highly correlated with their support of the policy constraining car ownership. Car attitude could include various aspects as reliability of car, convenience of car, dependence on car, pride of car, and etc. Of these, dependence on car and pride of car are two interesting factors to look at. A low dependency on

car may lead to higher support of the auction policy to control growth. However, the direction of car pride on acceptance may go either way. People having higher car pride may have high desire to buy cars and therefore less acceptable. Or, they may be more supportive of the policy as they want to make Shanghai license more luxury to satisfy the pride of owning cars. Lastly, increasing familiarity or knowledge about the policy may also increase policy acceptance.

Above-mentioned are only for Shanghai's auction policy and many do not apply to license lottery in Beijing. License lottery policy having no entry cost does not have the problem with affordability. In the socioeconomics, urgency to buy vehicles may be a more significant factor contributing to acceptance because the mechanism lottery uses is time-based queueing. License lottery also has different equity concerns as stated in Chapter 5. For instance, Beijing's lottery has equity concerns between prior and new car owners. However, Shanghai implemented the policy long time ago and all car buyers get local license through the auction. Although Beijing does not have problems in transparency of revenue usage, the inability of the lottery to collect revenue is another type of equity concern as mentioned in Chapter 5. Future research may also compare the models for each policy to investigate which factors contribute the most to each policy. In order to do that, future research may need to find similar indicators to measure different factors for both policies. Thus, better indicator measurements need to be added to the questionnaire.

6.5.2 Singapore vs. Shanghai

Chapter 4 provides a short policy comparison between license auction policies in Singapore and Shanghai. A detailed comparison not only statistically but dynamically in time between these two policies would be valuable. Shanghai and Singapore are the two cities having

very similar car ownership policy and both implemented the policy early at the beginning of 1990s. In addition to the current policy specifics, the evolution process of the two policies overtime would be interesting to look at. How do the governments fine-tune the policies to better suit their local context? Which are governments' focuses when they adjust the policies? Is efficiency more important as to collect more revenue? Or is equity more important as to better design the auction. Are the changes mainly technical issues in the bidding process or do them reflect governments' interest in various aspects? Although both places implemented policies during the similar period, are there any differences in the local context that affect the result of the policy (eg. Motorization rate when the policy is implemented, if the city has auto industry, etc.)?

Comparison between the two auction policies may provide insights for Shanghai policy makers to improve the policy. Various research questions could be asked. , For example, how does Singapore categorize vehicles in the auction? How does Singapore calculate the quota and how does it deal with speculation activities or black-case work in the policy? How does Singapore's bidding process compare to that in Shanghai? Is license trading also a problem in Singapore? All these questions are potential topics that need further investigation.

Public attitude towards these two policies are also interesting. License price in Singapore is much more expensive than that in Shanghai and Singapore car owners need to renew their license once every 10 years. All vehicles in Singapore are imported since it does not have a local car industry. Owning a car in Singapore is a luxury combining the car price with license price. How would public acceptance of the auction policies differ among residents in these two places? If only looking at the two auction policies, Singapore's policy is much stricter and it would not be surprised to see Singapore residents less in favor of their policy comparing to Shanghai residents. To exemplify, Chapter 3 finds that local license owners in Shanghai are policy

supports. We argue that Shanghai's auction policy is unique as it gives lifelong entitlement of the license to car owners while Singapore residents need to renew licenses and experience the same pain repetitively. Singapore car owners, compared to that in Shanghai, may be less supportive of the auction policy. Future research may also examine preference variation towards Singapore's policy among local residents by conducting survey in Singapore.

6.5.3 Joint car ownership and license decision model

Chapter 4 of this thesis describes the non-local vehicle phenomenon in Shanghai as a result of policy transfer. Public attitude towards the dilemma is also collected through questionnaire. In addition to public attitude towards non-local vehicles, we also want to understand public behavior as what factors affect their car license choice. Better understanding of people's license choice may help policy makers design more efficient policy controlling non-local license in Shanghai. A joint decision model examining the decision of ownership (own versus not own) and the license type choices (local, non-local, and plate C licenses) could be developed to explore local residents' car and license type decisions. In addition to license types, the purchase channel for license could also be examined as if Shanghai residents get license through dealership or themselves and what factors influence the decision.

Possible variables contributing to car ownership and license type decisions include: (1) people's financial capacity; (2) impact of nonlocal restriction on daily travel cost; (3) connection to other cities; (4) attitude towards auction policy and license price; (5) attitude towards non-local vehicles; (6) respect of government regulation; and (7) legitimacy of the government policy and perception. People's financial capacity affects their sensitivity to the license price. Socioeconomic variables as income and education may all have significant impact. Non-local

restriction on people's daily travel and the cost associated with that may also have significant impact on license choice. Characteristics as whether the participants need to commute during the restricted rush hour and whether if they need to use the elevated expressway during commuting may affect the convenience of having a non-local license. On the other hand, Shanghai residents' connection to other cities also affects their convenience of obtaining non-local licenses and influences their license decisions.

Furthermore, attitude toward the auction policy may affect people's license choice but the causality could go both ways. For instance, someone who does not support the license auction policy may choose non-local license instead. Conversely, people's license choices also affect their support of the policy as non-local license holders are very negative about the policy as evidenced in Chapter 3. In addition to the general attitude, individual's acceptable price range to car license may have higher impact on license choice than actual income. Residents could have a high income but price car license less than CYN 10,000. Thus, any license price beyond that would not be worth it. Non-local license holders may include those who cannot afford the high price of Shanghai license or they could just simply don't think license worth that amount of money.

Moreover, attitude toward non-local vehicles may influence people's license decisions such as the convenience of having non-local license in Shanghai, effectiveness of current restriction, social image concern, necessity for further restriction, and if Shanghai should totally ban non-local vehicles. Also, attitude towards legitimacy of non-local license in Shanghai and their respect of government regulation could affect license decisions as well. If the public do not think non-local vehicles are legitimate and they strictly follow government regulation, they may be less likely to choose non-local license.

6.5.4 Efficiency vs. equity tradeoff

Shanghai's auction is price-based bidding which is very efficient. The auction tightly connects people's travel needs and willingness to pay with the allocation process. Bidding price for license in Shanghai on one hand reflects people's willingness to pay and on the other hand indicates their capacity to pay. On the contrary, Beijing's car license lottery reflects neither. With no entry cost, the lottery allocates license in a random process. Such focus is designed to address equity problems but efficiency in allocating license is a disaster. License auction and lottery policies are good examples showing how Shanghai and Beijing prioritize when making transport policies.

Efficiency refers to maximizing total social benefits and allocating license to people who need them the most. Equity refers to fair distribution of the resources as fair allocation of license quota. Shanghai focuses more on the efficiency side but it is criticized for only benefiting the rich. Low income people in Shanghai are not affordable of local license. Differently, Beijing allocates license randomly for free. High income people in Beijing have no alternative choices but wait in the lottery pool. Everyone in the lottery is treated the same with no exceptions but the shortcoming for this "fair" allocation is urgent people do not have other ways of getting license. Although fairness in Beijing's lottery policy is more at the superficial level as stated in Chapter 5, the lottery is designed to address the equity problem and Beijing seems to prioritize more on equity than efficiency. Future research could include comparing the two policies and finding evidences demonstrating the government's tradeoff in efficiency and equity.

Efficiency and equity tradeoff can be examined from various perspectives: researchers', governments', and public's perspectives. We can examine the policy specifics systematically

from researchers' perspective. Government's perspective may be obtained through interviews with government officials to examine their goals when making policy decisions. Lastly, public's perspective could also be obtained using questionnaire survey. Our questionnaire includes various equity dimensions in both policies, but it does not include enough indicators to measure efficiency. Future research could find better measure of efficiency in these two policies. To better measure this tradeoff, we could also design some experimental questions that provide different choices to elicit preferences for efficiency relative to equity in transport policies.

6.5.5 Other interest groups – car dealers

This thesis focuses on public perception toward car ownership policy, but there are also other interest groups influenced by the policy. Local car dealers are the one receiving largest negative impact under both the auction and lottery policies in Shanghai and Beijing. Both Shanghai and Beijing constrain the amount of license quota issued every month to slow down car fleet growth. Car sales are affected in both cities but the impact is more severe in Beijing due to the sudden introduction and also the design of the allocation mechanism.

Shanghai implemented the auction policy at an early stage of motorization. Local car dealers already get used to the way of bidding for license through almost 20 years of implementation. Beijing car dealers, on the other hand, were surprised by the lottery policy that implemented suddenly at the end of 2010. Many car dealerships in Beijing hardly survived under the policy as a result of low car sales.

Car dealers in Shanghai and Beijing respond in different ways to cover their loss. Shanghai car dealers provide services to bid for their customers to get rid of the cumbersome process of bidding. They also help residents getting non-local licenses. Although there are

speculative activities among car dealers hoarding up licenses and push up the bidding price, but the size of the loopholes and the profit margin are small. This can be reflected by the shadow price of Shanghai license which is very close to the on-going bidding price. Car dealers in Shanghai serve more like agents rather than speculators making profits because the profit margin in Shanghai is very small as the license has already been attached to a market value.

On the contrary, Beijing license lottery does not give any monetary value to the license which leaves more room for car dealers to skip. Because the low odds of winning and the mismatch between license allocation and urgent car buyers, Beijing car dealers provide car license renting services to their customers who are urgent to drive. They also find alternative channels to get around with the lottery as corrupting the government officials. Beijing car license is free, but the shadow price could go way high beyond Beijing car dealers on one hand are more difficult and have more restriction, but on the other hand they also have higher profit margins which give them higher motivation to cheat in the policy.

Future research could compare car dealers' behavior and attitude toward the policies in Shanghai and Beijing. Interviews with selected car dealers in both cities would provide more insights.

6.5.6 Guangzhou's hybrid policy

Following Shanghai and Beijing, Guangzhou also started control car license quota in August 2012 (just one and half year after Beijing implement the lottery policy). Surprisingly, Guangzhou had borrowed the idea from both Beijing and Shanghai and created a hybrid model allocating fifty percent of the quota through lottery and forty percent through auction. The rest of the quota is allocated to new energy car.

The auction and lottery policy each has its own advantage and shortcomings. Suitability of the policy depends on local context. The auction policy is more efficient and generates revenue to compensate the externalities for non-car drivers. However, the high license price is not affordable. Beijing's license lottery is fair in terms of treating the rich and poor the same but not efficient in license allocation. Urgent car buyers have no ways of getting license while lottery winners sometimes do not buy cars or push earlier their car purchase plan. Urgent car buyers would be more in favour of Shanghai's auction while low income group may prefer the lottery policy in Beijing. Guangzhou's hybrid model is designed to combine the benefits from both policies. However, does a hybrid model combine advantages of both models or does it simply adds more complexity?

Guangzhou implemented the policy quite recently which provides researcher a chance to look at how public attitude evolve before and after the implementation. Future research may examine public attitude swing before and after the actual implementation of the policy, and also how will the policy influence people's car purchase plan.

In addition, Guangzhou's hybrid model is also interesting in terms of its influence on people's psychological behavior when combining license of a high price with license that is free. Before Beijing implemented the free lottery policy, Shanghai residents are only comparing themselves to cities with no ownership control. Although Shanghai residents think it's unfair to restrict freedom of driving compared to other cities, many agree on the effectiveness of the auction policy in controlling car ownership growth for Shanghai. However, once Beijing implemented a similar car ownership policy but allocates license for free, this may change how other people think of the auction policy. Before you see one policy that is expensive but also effective, but now Beijing proves that there is other way of controlling car ownership without

any cost. Having similar effectiveness in dampening car growth rate, the attractiveness of the license being free is so irresistible. This situation gets more complicated in Guangzhou when it has both options available for local residents.

Theoretically, when people are facing with a choice of selecting one of several available products, they will choose the option with the highest cost-benefit difference. In Guangzhou's case, people may weigh the time they are willing to wait for the license in the lottery versus the price they are willing to pay for the license to decide which option they would choose. However, Shampanier et al. propose (Shampanier, Mazar, & Ariely, 2007) a theory on the "special price about zero" arguing that decisions about free (zero price) products differ. People do not simply subtract costs from benefits but instead they perceive the benefits associated with free products as higher. They appear to act as if zero pricing of a good not only decreases its cost, but also adds to its benefits. Future research may include studying this impact of free license on public policy choice.

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Appendices

Appendix A - List of Survey Companies in Shanghai

Pilot Company	Kaomaike Marine Technology Ltd.
Industry category	Ship design
Size of the company	62 employees
Survey method	Online
Location	Zone 3
Company 1	China Shipbuilding NDRI Engerring Co., Ltd (CSSC)
Industry category	Shipbuilding, engineering, sales, design
Size of the company	200 employees
Survey method	Paper based
Location	Zone 1
Company 2	Shanghai Petroleum and Chemical Equipment Corporation Ltd.
Industry category	Chemical plant
Size of the company	100 employees
Survey method	Online
Location	Zone 3
Company 3	Ninth Design and Research Institute of CSSC
Industry category	Design and engineering
Size of the company	500 employees
Survey method	Online and paper based
Location	Zone 1
Company 4	Engtek International Trading Ltd.
Industry category	Sales
Size of the company	20 employees
Survey method	Online
Location	Within Inner Ring Road
Company 5	Rongsheng Heavy Industry
Industry category	Engineering, design
Size of the company	150 employees
Survey method	Online and paper based
Location	Within Inner Ring Road
Company 6	Shanghai Maric Marine Design and Research Institute
Industry category	Engineering research institute
Size of the company	100 employees
Survey method	Paper based
Location	Within Inner Ring Road
Company 7	Changxing Island Shipyard
Industry category	Marine engineering, design, and shipbuilding
Size of the company	100 employees
Survey method	Paper based
Location	Outside Outer Ring Road
Company 8	Shanghai Waigaoqiao Shipbuilding Company
Industry category	Marine engineering, design, and shipbuilding
Size of the company	200 employees
Survey method	Paper based
Location	Zone 3
Company 9	Shanghai Zhongjian Architectural Design Institute Co., Ltd
Industry category	Marine engineering, design, and shipbuilding
Size of the company	20 employees
Survey method	Online
Location	Zone 1

Appendix B – Shanghai Questionnaire

1. Introduction

1. Please indicate your awareness of the following policy states:

	Yes, I know.	No, I don't know
Shanghai municipality uses vehicle license auction policy to control and limit the number of license plates released each month.	◯	◯
Shanghai's vehicle license auction takes place on every third Saturday of each month.	◯	◯
The price for a Shanghai license plate on February 2011 has increased over ¥40,000.	◯	◯
Shanghai vehicle license include the urban plates (Plate A/B/C/D/E/F) and suburban plate (Plate C). Car owners who want to register urban plates will have to go through the license auction but Plate C do not. But vehicles with Plate C are only allowed to drive outside Outer Ring Road in Shanghai.	◯	◯
When the vehicle has been scrapped, each car owner can apply to keep the original license quota for future vehicles, but the car owner need to operate the vehicle for at least 3 years before it is scrapped.	◯	◯
Car owners need to apply to keep the license quota within 6 months after the old vehicle has been scrapped, otherwise the government will put the quota back for auction.	◯	◯
Vehicles with nonlocal licenses are prohibited to drive on elevated road during rush hours (Monday to Friday between 7:30 – 9:30 a.m. and 16:30 – 18:30 p.m.). Violating vehicles being caught will be fined for ¥ 200.	◯	◯
Starting from February 25th in 2011, Shanghai government has installed Traffic Control Photographic Systems to catch vehicles with nonlocal licenses driving on elevated road during rush hours.	◯	◯

2. Vehicle Ownership

1. How many cars does your household own?

◯ 0 ◯ 1 ◯ 2 ◯ 3+

3.

1. What is the purchasing year, brand, and model for the cars your household owns? (Please fill in chronologically according to the year of purchase)

First car - Year _____

First car - Brand _____

First car - Model _____

Second car - Year _____

Second car - Brand _____

Second car - Model _____

2. Where did your household get the cars?(Please follow the order in the previous question)

	Bought a new car	Bought a used car	Company car	Rent	From family members and friends	Shared with others
First car	◯	◯	◯	◯	◯	◯
Second car	◯	◯	◯	◯	◯	◯

3. How did your household get the vehicle licenses?

	Bid Shanghai license myself	Car dealer or trader bid the Shanghai license for me	Bought Shanghai license from secondhand market	Bought nonlocal license myself	Bought nonlocal license through dealership or traders	Shanghai Plate C used only outside Outer Ring
First car	◯	◯	◯	◯	◯	◯
Second car	◯	◯	◯	◯	◯	◯

4. What are the prices of your household's vehicle licenses?

First car

Second car

5. How many kilometers did each of the cars drive in 2010?

	< 2,000km	2,000km - 5,000km	5,000km - 10,000km	10,000km - 15,000km	15,000km - 20,000km	20,000km - 25,000km	25,000km - 30,000km	> 30,000km
First car	◯	◯	◯	◯	◯	◯	◯	◯
Second car	◯	◯	◯	◯	◯	◯	◯	◯

4. Vehicle Usage and Travel Behavior

1. Do you drive?

◯ Yes ◯ No

2. How many years have you been driving? (If you don't drive, please fill in 0)

3. What is the distance from your home to the nearest public transit station?

	< 0.25km	0.25 - 0.5km	0.5km - 1km	1km - 2 km	> 2km
Subway	◯	◯	◯	◯	◯
Bus	◯	◯	◯	◯	◯

4. How far is your workplace from home?

- ◯ < 1 km
- ◯ 1km - 1.9 km
- ◯ 2km - 4.9 km
- ◯ 5 km - 9.9 km
- ◯ 10 km - 14.9 km
- ◯ 15 km - 19.9 km
- ◯ 20 km - 29.9 km
- ◯ 30 km+

5. How long does it take you to your workplace from home? (single trip)

- ◯ <5 mins
- ◯ 5-15 mins
- ◯ 15-30 mins
- ◯ 30-45 mins
- ◯ 45-60 mins
- ◯ 60-90 mins
- ◯ more than 90 mins

6. Please indicate the most frequent travel mode used for the following trip purposes:

	Commuting	Personal Business (e.g. bank, hospital)	Entertainment (eg. dinner, social)	Shopping
Car as driver	◯	◯	◯	◯
Car as passenger	◯	◯	◯	◯

7. How often do you use each of the following travel modes?

	6-7 days a week	5 days a week	3-4 days a week	1-2 days a week	Once every 2 or 3 weeks	once a month	less than often	never
Car as driver	◯	◯	◯	◯	◯	◯	◯	◯
Car as passenger	◯	◯	◯	◯	◯	◯	◯	◯
Bus	◯	◯	◯	◯	◯	◯	◯	◯
Subway/Train	◯	◯	◯	◯	◯	◯	◯	◯
Bike	◯	◯	◯	◯	◯	◯	◯	◯
Walk	◯	◯	◯	◯	◯	◯	◯	◯
Taxi	◯	◯	◯	◯	◯	◯	◯	◯
Motorcycle	◯	◯	◯	◯	◯	◯	◯	◯

8. What is your percentage of car trip in all trips? (Please indicate 0 if you don't drive at all)

5. Driving Attitude and Car Dependence

Please answer the following car attitude questions whether you have car or not. If you don't drive, please answer according to your expectation.

1. Please indicate your attitude towards Shanghai's traffic condition:

	Strongly agree	Partially agree	Neutral	Disagree	Strongly disagree
Shanghai's traffic is very congested.	◯	◯	◯	◯	◯

2. Please indicate your attitude towards car reliability:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Driving is more reliable.	◯	◯	◯	◯	◯
Driving can take me to my destination on time.	◯	◯	◯	◯	◯
Time spend on driving is more controllable.	◯	◯	◯	◯	◯
Drivings sometimes takes longer than I have expected since there are many uncertainties in the traffic.	◯	◯	◯	◯	◯

3. Please indicate your attitude towards car pride:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
I feel proud of owning a car.	◯	◯	◯	◯	◯
Driving meets my self-esteem to some extent.	◯	◯	◯	◯	◯
I have a sense of accomplishment after buying a car.	◯	◯	◯	◯	◯
Car is only one kind of transportation tool which would not give me any sense of pride.	◯	◯	◯	◯	◯
Having a car has nothing to do with vanity.	◯	◯	◯	◯	◯

4. Please indicate your attitude towards car convenience:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Driving makes my life more convenient.	◯	◯	◯	◯	◯
Driving can help me get more things done.	◯	◯	◯	◯	◯
My life would be very inconvenient if I cannot drive.	◯	◯	◯	◯	◯
Having a car, I can go at anytime.	◯	◯	◯	◯	◯
It's very difficult to find a parking space when driving outside.	◯	◯	◯	◯	◯

5. Please indicate your attitude towards car dependence:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
My lifestyle depends on car.	◯	◯	◯	◯	◯
I want to drive less, but I cannot find other suitable alternative transit.	◯	◯	◯	◯	◯
Because of my lifestyle and my house location, I cannot use other transportation modes except driving.	◯	◯	◯	◯	◯
Car changed my lifestyle and life quality.	◯	◯	◯	◯	◯
having a car has no influence on my life.	◯	◯	◯	◯	◯

6. Please indicate your attitude towards social image of having a car:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Use travel modes other than driving is not suitable for my personal image.	◯	◯	◯	◯	◯
Car is a sign of social status.	◯	◯	◯	◯	◯
Having a car has nothing to do with one's social image.	◯	◯	◯	◯	◯
Driving has no influence on my personal image.	◯	◯	◯	◯	◯

7. Would you consider the problem of environmental pollution when buying a car?

◯ I won't consider much of the environmental problem, and this will not affect my decision of buying a car.

◯ I will consider the environmental problem, but this will not affect my decision of buying a car.

◯ I will consider the environmental problem, but it will afect my choice of car type.

◯ affect my choice of buying a car.

◯ I will consider the environmental problem of having a car, and decide to not buy a car.

6. Vehicle License Auction Policy Attitude

1. Do you think government should take further action to solve the traffic congestion problems in Shanghai?

◯ Strongly agree ◯ Partially agree ◯ Neutrual ◯ Partially disagree ◯ Strongly disagree

2. Please indicate your acceptance level of Shanghai's license auction policy:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
I support the quota auction policy in Shanghai.	◯	◯	◯	◯	◯
Although the auction policy has been implemented for more than 17 years, I still cannot accept it.	◯	◯	◯	◯	◯
I hope the auction policy can continue to be implemented in Shanghai.	◯	◯	◯	◯	◯
Shanghai government should not use the license auction policy to mitigate congestion.	◯	◯	◯	◯	◯
I cannot accept the license auction policy since there are a lot of problems and loopholes.	◯	◯	◯	◯	◯
If voting, I would not vote for the license auction policy to continue implement.	◯	◯	◯	◯	◯
I have already got used to people getting license through license auction.	◯	◯	◯	◯	◯
My acceptance towards the auction policy has increased a lot throughout years.	◯	◯	◯	◯	◯

3. What is your expectation of other people's acceptance level towards the license auction policy?

- ◯ Other people have already accepted this policy.
- ◯ Other people still cannot accept this policy
- ◯ Other people do not care about this policy.

4. Please indicate your attitude towards the effectiveness of the auction policy:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Shanghai government has mitigated congestion effectively by using the license auction policy.	◯	◯	◯	◯	◯
Without the auction policy, there will be a rapid growth of car ownership and the traffic condition in Shanghai will be even worse.	◯	◯	◯	◯	◯

5. Please indicate your attitude towards affordability of Shanghai's license:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Many people cannot afford the high license price.	◯	◯	◯	◯	◯
Shanghai license price is still within my financial ability.	◯	◯	◯	◯	◯
The high price of the Shanghai license has made cars only for rich people.	◯	◯	◯	◯	◯
I don't really care about the price of the license plate as long as I can get one and drive my car.	◯	◯	◯	◯	◯

6. Please indicate your attitude towards equity in the auction policy:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
The auction policy is not fair since all private vehicles are auctioned together despite their price and type.	◯	◯	◯	◯	◯
Shanghai's license auction policy is not fair, since it makes the road that is constructed using revenue collected from all residents only for rich people.	◯	◯	◯	◯	◯
The high price of the license plate has made cars only for the rich.	◯	◯	◯	◯	◯

7. Please indicate your attitude towards government vehicles:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
There should be more restriction on licenses for government financed vehicles than on private vehicles.	◯	◯	◯	◯	◯
Government should reduce the licenses issued per month for government financed vehicles to lower the ratio of government vehicles on Shanghai's road.	◯	◯	◯	◯	◯
Government should restrict the vehicle licenses each government department can bid.	◯	◯	◯	◯	◯
There should be more licenses released for government vehicles since they will make government agencies' job more convenient.	◯	◯	◯	◯	◯

8. Please indicate your attitude towards equity in Shanghai's policy compare to other cities:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Driving in cities outside Shanghai has more freedom since buying a vehicle licenses does not need to go through the auction process.	◯	◯	◯	◯	◯
The auction policy is not fair since it makes Shanghai residents pay more than residents in other cities do to enjoy the same freedom of driving.	◯	◯	◯	◯	◯
The vehicle license lottery policy in Beijing is fairer than Shanghai's auction policy, since you can join the lottery and have a chance of winning a license despite your financial ability.	◯	◯	◯	◯	◯

9. Please indicate your attitude towards transparency in revenue usage:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
I do not know the usage of the revenue collected from the auction.	◯	◯	◯	◯	◯
Shanghai should make the revenue usage transparent to the public for auditing.	◯	◯	◯	◯	◯
The revenue collected from the auction is for government use which does not need to be transparent to the public.	◯	◯	◯	◯	◯

10. Please indicate your attitude towards convenience of obtaining a license in Shanghai:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Getting a license plate through auction is very time consuming in Shanghai and there is no guarantee of winning.	◯	◯	◯	◯	◯
You have to apply for a temporary driving permit to drive before you bid a license in the auction, and it is very inconvenient since each permit can only be used for a maximum of 15 days and each car owner can apply for only 3 times.	◯	◯	◯	◯	◯
The whole process of getting a vehicle licnese is very complicated and time consuming in Shanghai.	◯	◯	◯	◯	◯
Car owners who did not win the license in this month's auction have to wait for another month which is very time consuming since the license auction takes place only once every month.	◯	◯	◯	◯	◯

11. Please indicate your attitude towards bidding process and technology:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Using internet and phone bidding is not very reliable since sometimes one failed to place a bid successfully due to network paralysis or congestion in the phone line.	◯	◯	◯	◯	◯
Bidders could not obtain the detailed bidding information using internet and phone bidding.	◯	◯	◯	◯	◯
There are many loopholes in the bidding process which makes it hard to be fair and transparent.	◯	◯	◯	◯	◯
There might be speculation and black case work in the bidding process.	◯	◯	◯	◯	◯

12. Please indicate your attitude towards policy information provision:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Shanghai's auction policy keeps changing which I cannot find a place to check the exact rule and specification.	◯	◯	◯	◯	◯
I cannot update my knowledge of the changes made in the policy.	◯	◯	◯	◯	◯
Car owners often realize the policy changes after they have been fined.	◯	◯	◯	◯	◯

13. Under current policy, what is your acceptable price range for a Shanghai license?

◯ < ¥100
◯ ¥100 - ¥499
◯ ¥500 - ¥999
◯ ¥1,000 - ¥4,999
◯ ¥5,000 - ¥9,999
◯ ¥10,000 - ¥19,999
◯ ¥20,000 - ¥29,999
◯ ¥30,000 - ¥39,999
◯ ¥40,000 - ¥49,999
◯ ¥50,000 - ¥60,000
◯ > ¥60,000

14. If you are the policy designer, which price range do you think would effectively ease congestion and being publicly accepted at the same time?

_____

15. Except improving public transit, plase indicate your attitude towards effectiveness of the following transportation instruments in congestion mitigation:

	Very effective	Partially effective	Neutral	Partially ineffective	Ineffective
License auction policy	◯	◯	◯	◯	◯
Congestion charges	◯	◯	◯	◯	◯
Parking charges	◯	◯	◯	◯	◯
Fuel tax	◯	◯	◯	◯	◯

16. Except improving public transit, plase indicate your attitude towards acceptance of the following transportation instruments in congestion mitigation:

	Very acceptable	Partially acceptable	Neutral	Partially not acceptable	Not acceptable
License auction policy	◯	◯	◯	◯	◯
Congestion charges	◯	◯	◯	◯	◯
Parking charges	◯	◯	◯	◯	◯
Fuel tax	◯	◯	◯	◯	◯

17. If you are the policy designer, please rank the following congestion mitigation policy options considering both policy effectiveness and public acceptance: (1 indicates most favorable; 4 indicates least favourable)

	Rank
License auction policy	
Congestion charges	
Parking charges	
Fuel tax	

18. Under current policy, which type of car would you choose if you are planning to buy one?

◯ Mini ◯ Economic ◯ Business ◯ Luxury ◯ Sports

19. Under current policy, which type of car license plate would you choose if you are planning to buy a car?

◯ Shanghai license plate ◯ Nonlocal license plate

20. Will you be considering the value increase of Shanghai license plate while chosing the type of license plate?

◯ Yes ◯ No

21. If current license auction policy is cancelled, which type of car would you choose if you are planning to buy a car?

◯ Mini ◯ Economic ◯ Business ◯ Luxury ◯ Sports

7. Nonlocal License Plate Attitude

1. Please indicate your attitude towards the nonlocal vehicles in Shanghai:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Shanghai car owners having nonlocal licenses drive on Shanghai's road had made the congestion even worse.	◯	◯	◯	◯	◯
Car owners with nonlocal licenses driving in Shanghai has water down the effectiveness of the license auction policy.	◯	◯	◯	◯	◯

2. Please indicate your attitude towards convenience of nonlocal license:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Annual check of vehicles with nonlocal license is very inconvenient.	◯	◯	◯	◯	◯
Purchase and sale of vehicles with nonlocal license need to be in the purchasing cities which makes it very inconvenient.	◯	◯	◯	◯	◯
Vehicles with nonlocal license cannot drive on elevated road druing rush hour which makes driving very inconvenient.	◯	◯	◯	◯	◯
Vehicles with Shanghai and nonlocal licenses make no difference in driving.	◯	◯	◯	◯	◯

3. Please indicate your attitude towards effectiveness of current restriction on nonlocal vehicles in Shanghai:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Cars with nonlocal licenses driving on elevated road during rush hours would be fined 200 yuan, which would effectively reduce the amount of nonlocal vehicles on elevated road.	◯	◯	◯	◯	◯
The Traffic Control Photographic Systems installed can effectively reduce the number of nonlocal vehicles driving on elevated road during rush hours.	◯	◯	◯	◯	◯
Shanghai's peak hour restriction had not effectively reduce the number of nonlocal vehicles on elevated road.	◯	◯	◯	◯	◯

4. Please indicate your attitude towards further restriction on nolocal vehicles:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Shanghai should cooperate with nearby cities to totally ban Shanghai residents registering nonlocal vehicle licenses.	◯	◯	◯	◯	◯
Shanghai government should totally ban nonlocal vehicles driving on Shanghai's road.	◯	◯	◯	◯	◯
Shanghai should loose the restriction on nonlocal vehicles since it has a lot of tradings with other Chinese cities.	◯	◯	◯	◯	◯
As a metropolitan, Shanghai should welcome vehicles from other cities to enter and drive freely in Shanghai.	◯	◯	◯	◯	◯

5. Please indicate your attitude towards social image of having a nonlocal license:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Having a nonlocal license sometimes do not receive the same respect from others.	◯	◯	◯	◯	◯
Having a nonlocal license do not suit my status.	◯	◯	◯	◯	◯
Having a nonlocal license will not have any effect on my personal image.	◯	◯	◯	◯	◯

8. Personal Information

1. What is your age?

2. What is your gender?

- ◯ Male
- ◯ Female

3. What is your highest education level attained?

- ◯ Secondary school and below
- ◯ Highschool
- ◯ College
- ◯ University
- ◯ Master degree or higher

4. What is your role in your company? (eg. designer, engineer, assistant, general employee, etc)

5. How many family members live in your resident?(including yourself)

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 and more

6. Do you have children (< 16 years old) living in the same household with you?

- ◯ Yes
- ◯ No

7. What is your home dwelling type?

- ◯ House/Duplex/Townhouses (1-3 floors)
- ◯ Low Rise Apartment (4-6 floors)
- ◯ Medium Rise Apartment (7-9 floors)
- ◯ High Rise Apartment (10 floors or above)

8. Your house dwellings are:

- ◯ Own (fully paid)
- ◯ Own (with mortgage)
- ◯ Other (please specify)
- ◯ Rent
- ◯ Given by family

9. What is your monthly household income in 2011?

- ◯ < ¥2,000
- ◯ ¥2,000 - ¥2,999
- ◯ ¥3,000 - ¥3,999
- ◯ ¥4,000 - ¥4,999
- ◯ ¥5,000 - ¥6,999
- ◯ ¥7,000 - ¥9,999
- ◯ ¥10,000 - ¥14,999
- ◯ ¥15,000 - ¥19,999
- ◯ ¥20,000 - ¥24,999
- ◯ ¥25,000 - ¥29,999
- ◯ ¥30,000 - ¥39,999
- ◯ ¥40,000 and more

10. How long have you been living in Shanghai?

- ◯ I was born in Shanghai
- ◯ less than 2 years
- ◯ 2 - 5 years
- ◯ 5 - 10 years
- ◯ 10 - 15 years
- ◯ More than 15 years

11. What is your resident's post code?

12. What is your address? (Only street name and number, eg. Dongan Road No.41)

13. Please fill in you email address.

14. Thank you for completing the questionnaire above and if you would like to know the results of the survey, we will send the report and analysis results to your email. If you don't want to know the results, we would not be sending anything to your email. Would you like to receive the survey reports?

◯ Yes ◯ No

15. If you have any comments on the license auction policy in Shanghai or this questionnaire, please indicate in the following comment box. Thank you very much for your support!

Appendix C – Beijing Questionnaire

Beijing Car License Lottery Policy_English

1. Introduction

1. Please indicate your awareness of the following policy states:

	Yes, I know.	No, I don't know
Beijing government holds a monthly drawing of license plate winners.	◯	◯
Car license lottery for individual holds every month on the 26th and for private company holds every two months.	◯	◯
Electric vehicles are exempted from the license plate lottery.	◯	◯
There are three registration requirements to join the lottery: live in Beijing, has no Beijing vehicle registered under the name, and holds valid driver license.	◯	◯
Residents live in Beijing qualify for the application include the following: (1) residents hold Beijing hukou; (2) policy forces and serviceman; (3) foreign residents who have lived in Beijing for at least one year; (4) holds a residence permit; (5) holds temporary residence and paying social insurance and personal income tax continuously for five year.	◯	◯
License plate winners from the lottery have to buy a car within six months or will lose their license.	◯	◯
License obtained from the lottery are not transferable.	◯	◯
The lottery drawing results are available afterwards by phone or on the internet.	◯	◯
Car owners already registered has to sell or scrape their old car in order to buy a new one and they can get a license quota directly without joining the lottery.	◯	◯
People buying car as a gift to someone cannot retain their car license. The gift recipient will also need to get a car license through the lottery.	◯	◯
Purchasers of secondhand cars also need to get a car license through the lottery.	◯	◯

2. Vehicle Ownership

1. How many cars does your household own?

◯ 0 ◯ 1 ◯ 2 ◯ 3+

3.

Beijing Car License Lottery Policy_English

1. What is the purchasing year, brand, model, and price for the cars your household owns? (Please fill in chronologically according to the year of purchase)

First car - Year	
First car - Brand	
First car - Model	
First car - Price	
Second car - Year	
Second car - Brand	
Second car - Model	
Second car - Price	

2. Where did your household get the cars?(Please follow the order in the previous question)

	Bought a new car	Bought a used car in secondhand market	Company car	Rent	Gift from family members and friends	Shared with others
First car	◯	◯	◯	◯	◯	◯
Second car	◯	◯	◯	◯	◯	◯

3. How did your household get the vehicle licenses?

	Bought a Beijing license before the lottery policy began	Won a license plate through the lottery	Bought Beijing license from secondhand market	Rent a license from car dealers	Bought nonlocal license myself	Bought nonlocal license through dealership or traders
First car	◯	◯	◯	◯	◯	◯
Second car	◯	◯	◯	◯	◯	◯

4. If you hold a nonlocal license, please indicate the origin place of the car license: (eg. Suzhou, Zhejiang, Anhui, etc)

First car	
Second car	

5. How many kilometers did each of the cars drive in 2011?

	< 2,000km	2,000km - 5,000km	5,000km - 10,000km	10,000km - 15,000km	15,000km - 20,000km	20,000km - 25,000km	25,000km - 30,000km	> 30,000km
First car	◯	◯	◯	◯	◯	◯	◯	◯
Second car	◯	◯	◯	◯	◯	◯	◯	◯

4. Vehicle Usage and Travel Behavior

Beijing Car License Lottery Policy_English

1. Do you drive?

◯ Yes ◯ No

2. How many years have you been driving? (If you don't drive, please fill in 0)

3. What is the distance from your home to the nearest public transit station?

	< 0.25km	0.25 - 0.5km	0.5km - 1km	1km - 2 km	> 2km
Subway	◯	◯	◯	◯	◯
Bus	◯	◯	◯	◯	◯

4. How far is your workplace from home?

◯ < 1 km
◯ 1km - 1.9 km
◯ 2km - 4.9 km
◯ 5 km - 9.9 km
◯ 10 km - 14.9 km
◯ 15 km - 19.9 km
◯ 20 km - 29.9 km
◯ 30 km+

5. How long does it take you to your workplace from home? (single trip)

◯ <5 mins
◯ 5-15 mins
◯ 15-30 mins
◯ 30-45 mins
◯ 45-60 mins
◯ 60-90 mins
◯ more than 90 mins

6. How often do you use each of the following travel modes?

	6-7 days a week	5 days a week	3-4 days a week	1-2 days a week	Once every 2 or 3 weeks	once a month	less than often	never
Car as driver	◯	◯	◯	◯	◯	◯	◯	◯
Car as passenger	◯	◯	◯	◯	◯	◯	◯	◯

7. Would you commute during peak hour during weekdays (7:00 am - 9:00 am, and 17:00 pm - 19:00 pm Monday to Friday)?

◯ Yes ◯ No

8. What is your percentage of car trip in all trips? (Please indicate 0 if you don't make any trips by car at all)

Beijing Car License Lottery Policy_English

9. How often do you commute on and within the 5th ring Road?

- ◯ 6-7 days/week
- ◯ 5 days/week
- ◯ 3-4 days/week
- ◯ 1-2 days/week
- ◯ once every 2-3 weeks
- ◯ once per month
- ◯ never

5. Vehicle License Lottery Policy Attitude

1. Have you participated in the car license lottery?

- ◯ I have joined and won a car license through the lottery.
- ◯ I have joined but I'm still waiting for a license.
- ◯ I haven't joined, but I'm planning to apply.
- ◯ I haven't joined, and I'm not planning to apply.
- ◯ I haven't joined, and I'm not qualified to apply.

2. If you have joined the license lottery, how long have you been waited?

- ◯ 1 - 2 months
- ◯ 2 - 4 months
- ◯ 4 - 6 months
- ◯ 6 - 9 months
- ◯ 9 - 12 months
- ◯ more than 12 months
- ◯ I've never been in the lottery

3. What's the longest waiting time you can accept?

- ◯ 1 - 2 months
- ◯ 2 - 4 months
- ◯ 4 - 6 months
- ◯ 6 - 9 months
- ◯ 9 - 12 months
- ◯ 1 - 2 years
- ◯ more than 2 years

4. What's your atttitude towards current traffic condition in Beijing?

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Beijing's traffic is very congested.	◯	◯	◯	◯	◯

5. Do you think government should take further action to solve the traffic congestion problems in Beijing?

◯ Strongly agree ◯ Partially agree ◯ Neutral ◯ Partially disagree ◯ Strongly disagree

Beijing Car License Lottery Policy_English

6. Please indicate your acceptance level of Beijing's license plate lottery policy:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
I support the license plate lottery in Beijing.	◯	◯	◯	◯	◯
I hope the license lottery policy will continue in Beijing.	◯	◯	◯	◯	◯
I cannot accept the license plate lottery policy since there are a lot of problems and loopholes.	◯	◯	◯	◯	◯
If voting, I would not vote for the license plate lottery policy to continue.	◯	◯	◯	◯	◯
Beijing's government should not use the license plate lottery policy to mitigate congestion.	◯	◯	◯	◯	◯
I am already used to people getting licenses through the license plate lottery.	◯	◯	◯	◯	◯
Although the car license lottery policy has been implemented over 1 year, I still cannot accept it.	◯	◯	◯	◯	◯
My acceptance level towards the policy has increased a lot after 1 years' implementation.	◯	◯	◯	◯	◯

7. What is your expectation of other people's acceptance level towards the license plate lottery policy?

◯ Other people have already accepted this policy.

◯ Other people cannot accept this policy

◯ Other people do not care about this policy.

8. Please indicate your attitude towards the effectiveness of the license plate lottery policy:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Beijing's government has effectively mitigated congestion using the license plate lottery policy.	◯	◯	◯	◯	◯
Without the auction policy, there will be rapid growth of car ownership and the traffic conditions in Beijing will be even worse.	◯	◯	◯	◯	◯
The license lottery policy hasn't been implemented long enough,it is too early to say if the policy has been effective.	◯	◯	◯	◯	◯
The lottery policy will not be very effective in easing congestion since it is only a superficial strategy.	◯	◯	◯	◯	◯
Car license lottery policy is effective in easing congestion in the long term.	◯	◯	◯	◯	◯

Beijing Car License Lottery Policy_English

9. Please indicate your attitude towards the qualification requirement of registration in the lottery policy:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
The requirement for registration is too strict since people holding a temporary residence will need to pay social insurance and income tax continuously for 5 years.	◯	◯	◯	◯	◯
The registration requirement is unfair to migrant workers since they have to hold a working residence, or temporary residence and paying social insurance and income tax continuously for 5 years, while Beijing and foreign residents don't need to.	◯	◯	◯	◯	◯
It is fair to restrict people already having vehicles registered under their names from joining the lottery.	◯	◯	◯	◯	◯
The lottery policy is not fair since it restricts the migrant workers from buying cars in Beijing.	◯	◯	◯	◯	◯
Beijing's lottery qualification examination on migrants is fair.	◯	◯	◯	◯	◯

10. Please indicate your attitude towards equity in the lottery policy:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
The policy is fair since all people are treated the same and every one has the same chance of winning.	◯	◯	◯	◯	◯
Beijing's license plate lottery is unfair because there are too many loopholes and ways to around it.	◯	◯	◯	◯	◯
Even with the lottery policy, there are still some people who can get license directly through connections.	◯	◯	◯	◯	◯
The policy is fair to require car owners getting cars as gift or buying cars in secondhand market to get license through the lottery process first which prevents license trading.	◯	◯	◯	◯	◯
The lottery policy is not fair to people buying cars after the policy since car owners before the policy don't need to go through this process.	◯	◯	◯	◯	◯

11. Please indicate your attitude towards government vehicles:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
There should be more restrictions on licenses for government-financed vehicles than on private vehicles.	◯	◯	◯	◯	◯
Beijing government announced to not allocate any new license quota to government vehicles which is fair.	◯	◯	◯	◯	◯
Although Beijing government will not increase any new government vehicle licenses, they could still get around with it to get car licenses.	◯	◯	◯	◯	◯
Government financed vehicles increases the convenience for government officials and the quota should be increased.	◯	◯	◯	◯	◯
There should be a reduction in the amount of licenses each government department can hold.	◯	◯	◯	◯	◯

Beijing Car License Lottery Policy_English

12. Please indicate your attitude towards equity in Beijing's policy compared to other cities:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Car purchase in Beijing has to go through the lottery process which is unfair comparing to cities without the policy.	◯	◯	◯	◯	◯
The vehicle license lottery policy in Beijing is fairer than Shanghai's auction policy, since you can join the lottery and have a chance of winning a license regardless of your financial ability.	◯	◯	◯	◯	◯
Compare to Shanghai's license auction policy, Beijing's lottery policy is only fair at the superficial level.	◯	◯	◯	◯	◯

13. Please indicate your urgency in getting a car in Beijing?

◯ I have to get a car now.

◯ I need to buy a car, but I can still wait.

◯ I already have a car, and I don't have plan to buy another one in short term.

◯ I don't have a car and I have no plan of getting one.

14. Please indicate the effect of the current lottery policy on your future plan of buying cars in Beijing:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
I will continue to wait for a car license through the lottery.	◯	◯	◯	◯	◯
I have postponed plans to buy a car.	◯	◯	◯	◯	◯
I no longer want a car because of the policy.	◯	◯	◯	◯	◯
The policy will make me look for a nonlocal license outside Beijing	◯	◯	◯	◯	◯
I will consider to buy an electric car since it is exempt form the lottery policy.	◯	◯	◯	◯	◯
I will buy a car from the secondhand market.	◯	◯	◯	◯	◯
I will consider renting cars.	◯	◯	◯	◯	◯
The lottery policy has no effect on me since I've already have a car and don't want buy another.	◯	◯	◯	◯	◯
The lottery policy has no effect on me since I don't want to buy cars.	◯	◯	◯	◯	◯

Beijing Car License Lottery Policy_English

15. Please indicate your initial plan of buying cars without the lottery policy:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
I will buy a new car with Beijing license.	◯	◯	◯	◯	◯
I will buy a used car from secondhand market with Beijing license.	◯	◯	◯	◯	◯
I will still buy nonlocal license.	◯	◯	◯	◯	◯
I will buy electrical car.	◯	◯	◯	◯	◯
I wil rent a car.	◯	◯	◯	◯	◯
I don't want to buy a car.	◯	◯	◯	◯	◯

16. Please indicate your attitude towards the lottery process:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Getting a car license in Beijing through the lottery process is very time consuming.	◯	◯	◯	◯	◯
The odds of getting a license in Beijing's lottery is very low.	◯	◯	◯	◯	◯
Waiting time in the license lottery is very long.	◯	◯	◯	◯	◯
Car license lottery process is very convenient since it takes place every month and you only need to apply for it once. Unsuccessful applicants will be placed into next month's lottery automatically.	◯	◯	◯	◯	◯
There are too many documents needed for lottery application and the verification process is too strict and time consuming.	◯	◯	◯	◯	◯
The waiting time for a car license in the lottery is quicker than I expected.	◯	◯	◯	◯	◯

17. Please indicate your attitude towards the drawing format:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
It is not possible for the drawing process to be transparent since only the first few drawings could be watched in real time.	◯	◯	◯	◯	◯
Although lottery registrants could get the results through internet and telephone, they cannot obtain the detailed information on the drawing process.	◯	◯	◯	◯	◯
There are many loopholes in the drawing process which makes it hard to be fair and transparent.	◯	◯	◯	◯	◯
There might be speculation and black case work in the drawing process.	◯	◯	◯	◯	◯

18. Please indicate your attitude towards policy information provision:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
I cannot update my knowledge of the changes made in the policy.	◯	◯	◯	◯	◯
Lottery registrants often realize the policy changes when it is too late.	◯	◯	◯	◯	◯
Policy changes are noticed very timely for me to update the changes.	◯	◯	◯	◯	◯

Beijing Car License Lottery Policy_English

19. which of the car ownership policy would you prefer if you are planning to buy a car?

◯ Car license lottery policy (Beijing) ◯ Car license auction policy (Shanghai)

20. If you are hired to plan transportation policy in Beijing, and consider both policy effectiveness and acceptability, which of the policies would you choose?

◯ Car license lottery policy (Beijing) ◯ Car license auction policy (Shanghai)

21. What's the impact of Beijing's current lottery policy on your personal interest?

◯ Very positive ◯ Slightly positive ◯ Neutral ◯ Slightly negative ◯ Very negative

22. If Beijing change the policy to Shanghai's auction, how would that affect you personal interest?

◯ Very positive ◯ Slightly positive ◯ Neutral ◯ Slightly negative ◯ Very negative

23. In order to ease traffic congestion, Beijing government has to use other instruments in combination with improving public transit system. We will consider both the policy effectiveness and public acceptability of each instrument. Please indicate your atttiude towards the following transportation instruments in terms of their effectiveness in congestion mitigation first:

	Very effective	Slightly effective	Ineffective
License plate lottery policy (Beijing)	◯	◯	◯
License plate auction policy (Shanghai)	◯	◯	◯
Congestion charges	◯	◯	◯
Parking charges	◯	◯	◯
Fuel tax	◯	◯	◯
Tail plate driving ban	◯	◯	◯

24. Except policy effectiveness, please indicate your acceptance towards the following transportation instruments:

	Very acceptable	Partially acceptable	Neutral	Partially not acceptable	Not acceptable
License plate lottery policy (Beijing)	◯	◯	◯	◯	◯
License plate auction policy (Shanghai)	◯	◯	◯	◯	◯
Congestion charges	◯	◯	◯	◯	◯
Parking charges	◯	◯	◯	◯	◯
Fuel tax	◯	◯	◯	◯	◯
Tail plate driving ban	◯	◯	◯	◯	◯

Beijing Car License Lottery Policy_English

25. Please indicate your attitude towards the following statements:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
I think it's fine to disobey some rules if I think it doesn't make sense.	◯	◯	◯	◯	◯
I think one should strictly follow government regulation no matter if it is appropriate or not.	◯	◯	◯	◯	◯
If other people do not follow government regulation, then I don't need to neither.	◯	◯	◯	◯	◯
I will do the things that I think is right even it may has conflict with government regulation.	◯	◯	◯	◯	◯
It's ok to disobey government regulation since the government's enforcement and punishment on violation of regulation is not harsh.	◯	◯	◯	◯	◯

26. Under current lottery policy, which type of car would you choose if you are planning to buy one?

◯ Mini ◯ Economic ◯ Business ◯ Luxury ◯ Sports

27. Under current lottery policy, which type of car license plate would you choose if you are planning to buy a car?

◯ Beijing license plate ◯ Nonlocal license plate

28. Government needs to make trade-off in overall efficiency and fairness of allocating public resources when drafting transportation policies. Based on the current condition in Beijing, which factor do you think Beijing government should be more focused on when drafting transportation policies?

◯ Efficiency ◯ Equity

29. Which type of car would you choose if you are planning to buy a car before the lottery policy starts?

◯ Mini ◯ Economic ◯ Business ◯ Luxury ◯ Sports

6. Nonlocal License Plate Attitude

Beijing Car License Lottery Policy_English

1. Please indicate your attitude towards the convenience of nonlocal licenses:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Annual check of vehicles with nonlocal licenses is very inconvenient.	◯	◯	◯	◯	◯
Purchase and sale of vehicles with nonlocal licenses need to be in the purchasing cities to make it very inconvenient.	◯	◯	◯	◯	◯
Restriction banning nonlocal vehicles driving within the 5th ring road during peak hour makes it very inconvenient.	◯	◯	◯	◯	◯
There is no difference in driving with a Beijing license or nonlocal license.	◯	◯	◯	◯	◯

2. Please indicate your attitude towards effectiveness of current restrictions on nonlocal vehicles in Beijing:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Beijing's peak hour driving ban for nonlocal vehicles on and within the 5th Ring Road has effectively reduced the number of nonlocal vehicles on the road.	◯	◯	◯	◯	◯

3. Do you think the government should increase the restriction on nonlocal vehicles in Beijing?

◯ The government should increase restriction.

◯ It is not necessary to have any changes on the current restriction on nonlocal vehicles.

◯ The government should loosen the restriction.

4. Please indicate your attitude towards furture restrictions on nonlocal vehicles:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Beijing should cooperate with nearby cities to totally ban Beijing residents registering nonlocal vehicle licenses.	◯	◯	◯	◯	◯
Beijing government should totally ban nonlocal vehicles driving on Beijing roads.	◯	◯	◯	◯	◯
Beijing should loose restrictions on nonlocal vehicles since it has strong economic ties with other Chinese cities.	◯	◯	◯	◯	◯
As a metropolitan area, Beijing should welcome vehicles from other regions to enter and drive freely in the city.	◯	◯	◯	◯	◯

5. Please indicate your attitude towards the social image of having a nonlocal license:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Those with a nonlocal license sometimes do not receive the same respect from others.	◯	◯	◯	◯	◯
Having a nonlocal license does not suit my status.	◯	◯	◯	◯	◯
Having a nonlocal license will not have any effect on my personal image.	◯	◯	◯	◯	◯

7. Driving Attitude

Beijing Car License Lottery Policy_English

Please answer the following car attitude questions whether you have car or not. If you don't drive, please answer according to your expectation.

1. Please indicate your attitude towards car pride:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
I feel proud of owning a car.	◯	◯	◯	◯	◯
Driving meets my self-esteem to some extent.	◯	◯	◯	◯	◯
I have a sense of accomplishment after buying a car.	◯	◯	◯	◯	◯
A car is only one kind of transportation tool and wouldn't give me any special sense of pride.	◯	◯	◯	◯	◯
Having a car has nothing to do with vanity.	◯	◯	◯	◯	◯

2. Please indicate your attitude towards car dependence:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
My lifestyle depends on a car.	◯	◯	◯	◯	◯
I want to drive less, but I cannot find other suitable alternatives.	◯	◯	◯	◯	◯
Because of my lifestyle and my house location, I cannot use other transportation modes except driving.	◯	◯	◯	◯	◯
Car changed my lifestyle and life quality.	◯	◯	◯	◯	◯

3. Please indicate your attitude towards social image of having a car:

	Strongly agree	Partially agree	Neutral	Partially disagree	Strongly disagree
Use travel modes other than driving is not suitable for my personal image.	◯	◯	◯	◯	◯
A car is a sign of social status.	◯	◯	◯	◯	◯
Having a car has nothing to do with one's social image.	◯	◯	◯	◯	◯
Driving has no influence on my personal image.	◯	◯	◯	◯	◯

8. Personal Information

1. What is your age?

2. What is your gender?

◯ Male ◯ Female

3. What is your highest education level attained?

◯ Highschool or less ◯ University

◯ College ◯ Master degree or higher

Beijing Car License Lottery Policy_English

4. What is your role in your company? (eg. designer, engineer, assistant, sales person, general employee, etc)

5. How many family members live in your resident?(including yourself)

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5 and more

6. Do you have children (< 16 years old) living in the same household with you?

- ◯ Yes
- ◯ No

7. What is your home dwelling type?

- ◯ House/Duplex/Townhouses (1-3 floors)
- ◯ Medium Rise Apartment (7-9 floors)
- ◯ Low Rise Apartment (4-6 floors)
- ◯ High Rise Apartment (10 floors or above)

8. Your house dwellings are:

- ◯ Own (fully paid)
- ◯ Given by family
- ◯ Own (with mortgage)
- ◯ Company residence
- ◯ Rent
- ◯ Other (please specify)

9. What is your monthly household income in 2011?

- ◯ < ¥2,000
- ◯ ¥2,000 - ¥2,999
- ◯ ¥3,000 - ¥3,999
- ◯ ¥4,000 - ¥4,999
- ◯ ¥5,000 - ¥6,999
- ◯ ¥7,000 - ¥9,999
- ◯ ¥10,000 - ¥14,999
- ◯ ¥15,000 - ¥19,999
- ◯ ¥20,000 - ¥24,999
- ◯ ¥25,000 - ¥29,999
- ◯ ¥30,000 - ¥39,999
- ◯ ¥40,000 and more

10. How long have you been living in Beijing?

- ◯ less than 2 years
- ◯ 2 - 5 years
- ◯ 5 - 10 years
- ◯ 10 - 15 years
- ◯ More than 15 years
- ◯ Born in Beijing

Beijing Car License Lottery Policy_English

11. Which of the following do you belong?

- ◯ Beijing resident (with Beijing hukou)
- ◯ Foreign resident (including Hongkong, Macau, and Taiwan)
- ◯ Nonlocal resident, but hold Beijing working residence permit
- ◯ Nonlocal resident, but has Beijing temporary residence permit
- ◯ Nonlocal resident, but do not has temporary or working residence permit
- ◯ Other (please specify)

12. What is your resident's postal code?

13. Which area do you live in?

- ◯ Within 2nd Ring Road
- ◯ Between 2nd - 3rd Ring Road
- ◯ Between 3rd - 4th Ring Road
- ◯ Between 4th - 5th Ring Road
- ◯ Between 5th - 6th Ring Road
- ◯ Outside 6th Ring Road

14. What's your hukou city? (eg. Beijing, Shanghai, Tianjing)

15. Please select the following that apply to you:

- ☐ I have close relatives in cities outside Beijing.
- ☐ I have worked in cities outside Beijing.
- ☐ I have attended school in cities outside Beijing.
- ☐ I have business and trading with non-local cities.
- ☐ My have friends or close relatives who have non-local hukou but live in Beijing.
- ☐ None of these apply.

16. How often do you use each of the following travel modes?

	6-7 days a week	5 days a week	3-4 days a week	1-2 days a week	Once every 2 or 3 weeks	once a month	less than often	never
Bus	◯	◯	◯	◯	◯	◯	◯	◯
Subway/Train	◯	◯	◯	◯	◯	◯	◯	◯
Bike	◯	◯	◯	◯	◯	◯	◯	◯
Walk	◯	◯	◯	◯	◯	◯	◯	◯
Taxi	◯	◯	◯	◯	◯	◯	◯	◯
Motorcycle	◯	◯	◯	◯	◯	◯	◯	◯

Beijing Car License Lottery Policy_English

17. Please fill in you email address.

18. If you have any comments on the license plate lottery policy in Beijing or this questionnaire, please indicate in the following comment box. Thank you very much for your support!

Appendix D – Sample Mplus Code

TITLE: Policy Acceptance, Policy Attitude

```
DATA:
    FILE IS Acceptance.txt;
VARIABLE:
    NAMES ARE
    UserID  X1-X8   Carown    License   Mileone Miletwo
    Subway  Bus ComDist ComTime  X32-X39 Carmode CONGEST
    X42-X64   X67-X75  X77-X115   X118-X129   X134-X147
    Age  Gender  Edu  HavChild   Income  HhSize  Residen   Location;
Missing are All (-9999);
USEVARIABLES are
    X67 X71 X74-X75
    WithChild    CarTripH    CarTripL    Young   Old
    IncomeL IncomeH EduLow  EduHigh ComDistS    ComDistL
    LocalB    Zone2   Zone3   Zone4   Male    CarSH  CarNL;
DEFINE:
    IncomeL = (Income <= 3);
    IncomeH = (Income >= 8);
    Male = (Gender == 1);
    Young = (Age < 30);
    Old = (Age >= 50);
    LocalB = (Residen == 1);
    Zone2 = (location == 2);
    Zone3 = (location == 3);
    Zone4 = (location == 4);
    EduLow = (Edu <= 2);
    EduHigh = (Edu == 5);
```

```
        CarSH = (License == 1);
        CarNL = (License == 2);
        WithChild = (Havchild == 1);
        ComDistS = (ComDist <= 3);
        ComDistL = (ComDist >= 6);
        CarTripL = (Carmode < 30);
        CarTripH = (Carmode > 70);
ANALYSIS:
    PROCESSORS=8;
MODEL:
  ACCEPT  BY  X67  X71  X74  X75;
  ACCEPT  ON
        WithChild   CarTripH   CarTripL   Young   Old
        IncomeL IncomeH EduLow  EduHigh ComDistS   ComDistL
        LocalB   Zone2   Zone3   Zone4   Male   CarSH  CarNL;
   X75      WITH      X75;
OUTPUT:
                TECH4 MODINDICES SAMPSTAT STANDARDIZED;
PLOT:
        TYPE IS PLOT3;
```

TITLE: Attitude towards Non-local Vehicles (Effectiveness of Current Restriction, and Necessity for Further Restriction)

DATA:

FILE IS Acceptance.txt;

VARIABLE:

NAMES ARE

UserID X1-X8 Carown License Mileone Miletwo

Subway Bus ComDist ComTime X32-X39 Carmode CONGEST

X42-X64 X67-X75 X77-X115 X118-X129 X134-X147

Age Gender Edu HavChild Income Hhsize Residen Location;

Missing are All (-9999);

USEVARIABLES are

X138-X140 X141-X144

HavChild Young Senior

IncomeL IncomeH EduLow EduHigh ComDistS ComDistL

SubLow SubHigh BusLow BusHigh ShBorn LiveL LiveS HouseS HouseL

Zone2 Zone3 Zone4 Male CarYSH CarYNon;

DEFINE:

IncomeL = (Income <= 3);

IncomeH = (Income >= 8);

Male = (Gender == 1);

Young = (Age < 30);

Old = (Age >= 50);

LocalB = (Residen == 1);

Zone2 = (location == 2);

Zone3 = (location == 3);

Zone4 = (location == 4);

EduLow = (Edu <= 2);

```
        EduHigh = (Edu == 5);
        CarSH = (License == 1);
        CarNL = (License == 2);
        WithChild = (Havchild == 1);
        ComDistS = (ComDist <= 3);
        ComDistL = (ComDist >= 6);
        CarTripL = (Carmode < 30);
        CarTripH = (Carmode > 70);
        SubLow = (Subway >=4);
        SubHigh = (Subway <=2);
        BusLow = (Bus >=4);
        BusHigh = (Bus <=2);
        HouseS = (HhSize <= 2);
        HouseL = (HhSize >=4);
ANALYSIS:
    PROCESSORS=8;
MODEL:
  RESTRICT   BY  X138-X140;
  FUTURE  BY  X141-X144;
  RESTRICT  ON   WithChild   Young   Senior
        IncomeL IncomeH  EduLow  EduHigh   ComDistS   ComDistL
        SubLow  SubHigh BusLow  BusHigh LocalB  HouseS  HouseL
        Zone2   Zone3   Zone4   Male   CarSH   CarNL;
  FUTURE  ON   WithChild   Young   Senior
        IncomeL IncomeH EduLow  EduHigh   ComDistS   ComDistL
        SubLow  SubHigh BusLow  BusHigh LocalB  HouseS  HouseL
        Zone2   Zone3   Zone4   Male   CarSH   CarNL;
```

```
   RESTRICT    WITH    FUTURE;
   X143    WITH    X144;
OUTPUT:
                TECH4 MODINDICES SAMPSTAT STANDARDIZED;
PLOT:
        TYPE IS PLOT3;
```