CAR OWNERS AS A SUPPORTING CONSTITUENCY OF CAR DETERRING POLICIES: PREFERENCE VARIATIONS IN SHANGHAI'S CAR LICENSING POLICY

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ABSTRACT

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 may prove an exception. Shanghai implemented a policy controlling car ownership growth by requiring new car purchasers to bid for their license through a public auction. This policy is effective in dampening car growth but also raises concern about its public acceptability. Extending a prior study examining the public acceptance at the aggregate level (Chen and Zhao, 2011), this paper examines the preference variation among local residents in their policy acceptance and its three determinants: perceived effectiveness, affordability and equity. Based on one questionnaire survey conducted among employees in nine local companies, three dimensions are used to segment the population: car ownership and license type, car mode share, and other socioeconomic characteristics. 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. Although the overall acceptance level was negative, local car-owners are actually neutral towards the policy, in contrast to greatly negative views held by non-car owners or car owners with non-local licenses. Their acceptance level also increases significantly over time. Local car owners also perceive the policy as more effective and less unaffordable, and show different emphasis on equity concerns compared to non-car owners. 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.

Keywords: car deterrence policy, public acceptance, preference variation, structural equation models

1. INTRODUCTION

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 (Wang and Zhou, 2011). Compared to other large cities in China such as Beijing, Shanghai's total car ownership growth rate was significantly lower (about half that of Beijing (Shanghai Statistic Bureau, 2011, Beijing Statistic Bureau, 2010)). Cost of the vehicle license represents a significant portion of the vehicle capital cost for residents in Shanghai (recent license prices had reached over ¥ 50,000 in 2011 (Shanghai Jinwei Automobile, 2011) which is even greater than the price of a small vehicle). 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 quite different under Shanghai's policy from other car deterring policies.

This study complements a previous paper from Chen and Zhao (2011) in which local residents' acceptability and general attitude towards the license auction policy in Shanghai were investigated. Previous results revealed a low level of current acceptance at the aggregate level. In the course of the study, the question emerged whether this result applies to all participants in the same way particularly among people with different car ownership level. 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, data collected from previous study (Chen and Zhao, 2011) has been analyzed 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, and equity concerns; (2) identify the key socioeconomic determinants of public acceptability and specifics.

The paper 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 4 and finally Section 5 follows with a summary and discussion of the key findings from this study.

2. 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 predictive models on public acceptance.

2.1 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. Raunholtz 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.

2.2 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.

2.3 Predictive 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 prove an exception and 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. 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 (Chen and Zhao, 2011) 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 (Chen and Zhao, 2011) 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 (2011). Since the same measurement indicator statements were used in this paper, 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 1 below shows the final indicators used to measure each attitudinal factor (adopted from Chen and Zhao (2011)). Cronbach's alpha values for latent variables are all greater than 0.7 indicating high reliability of the indicators.

TABLE 1 Indicator statements measuring policy acceptance, and attitude towards policy specifics (adopted from Chen and Zhao(2011))

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
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 prior work in studying public acceptance and identifying its proximal determinants (Chen and Zhao, 2011). 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 and Muthén, 1998-2010) which supplies maximum likelihood estimates based on covariance between the observed variables.

4. RESULTS

Prior work analyzed public acceptance and its determinants at the aggregate level, but this analysis does not reveal variations among people's attitudes. We segment the population into three dimensions to identify such variations, car ownership and license type, car mode share, and other socioeconomic characteristics. In addition, this study further uses structural equation models to quantify the magnitude of impact of socioeconomics on acceptance.

4.1 Car-owners as Supporting Constituency for Car Deterrence Policy

As inferred from Table 2 and Table 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 (Jin, 2006).

Previous aggregate analysis results indicated a negative overall policy acceptance among Shanghai people (Chen and Zhao, 2011). 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 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 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 another working paper (Chen and Zhao, 2011).

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 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 (Chen and Zhao, 2012).

4.2 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 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). 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 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 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). 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 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 2 Attitude variations of policy acceptance, congestion level and perceived effectiveness by car ownership and behavior, 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	0.01	**-0.28**	.24	0.40
	Master+	14%	-0.39 -0.30	0.06 0.28	**0.19** **0.25**	1.30 1.29	0.22 0.49
	p-value		0.76	0.33	0.03	0.92	0.14

TABLE 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 - College/University	7% 80%	**-0.34** **-0.50**	-0.85 -0.78	-0.56 -0.70	**-0.79** **-1.24**	**-0.94** **-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

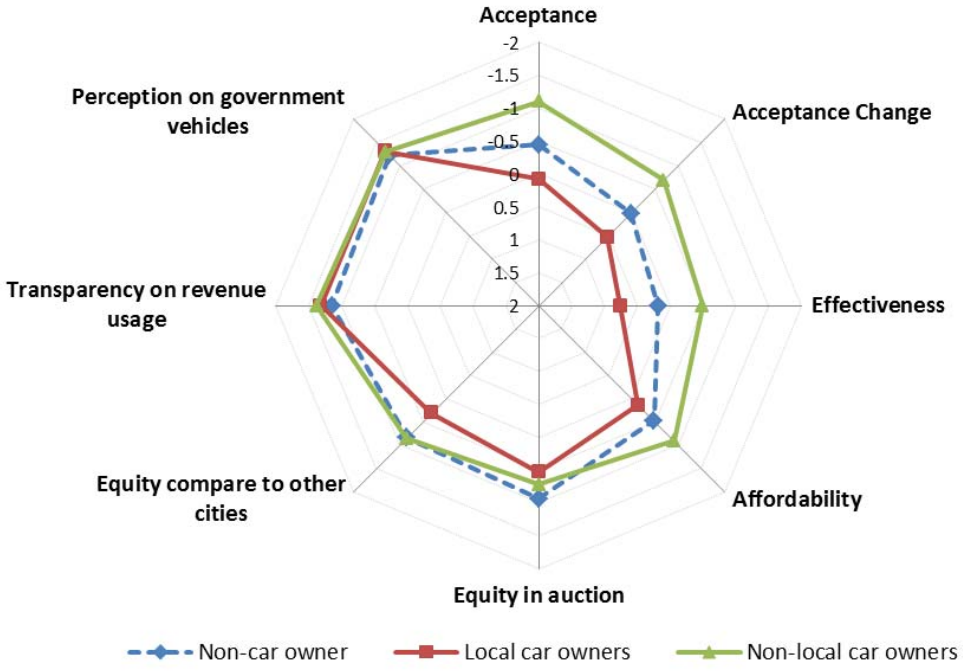

FIGURE 1 Attitude variations of car owners and non-car owners in different dimensions [a]

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

TABLE 4 Model estimations of socioeconomic variables on policy acceptance, changes and core policy specifics including perceived effectiveness, affordability, and equity b

					EQUITY			
Dependent Variables	**ACCEPT**	**ACCEPT CHANGE**	**EFFECT**	**AFFORD**	**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****
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)

5. 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 behavior 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 behavior. 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 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 quicly 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 renewl 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.

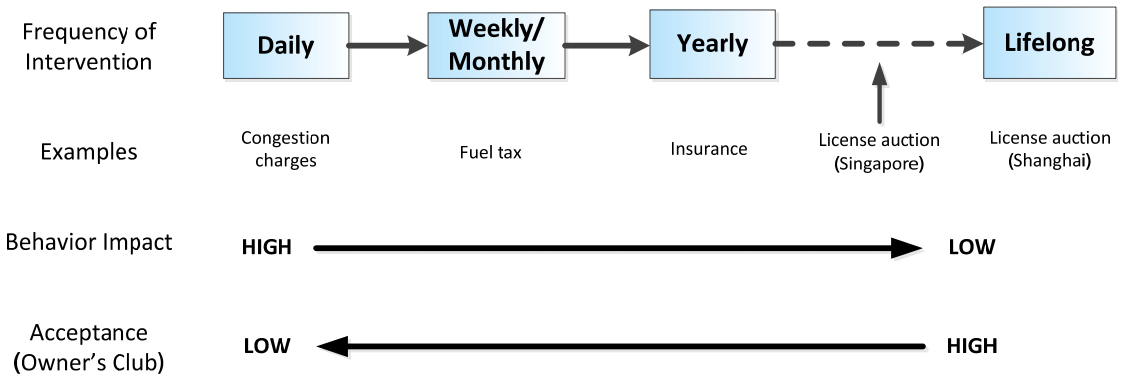

FIGURE 2 Types of government interventions with their behavior impact and public acceptance

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 (Chen and 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 working paper (Chen and Zhao, 2012)).

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