Demand and Expectation in Guangzhou Car Licensing Policy: a behavioral analysis

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1 Introduction

The growing number of automobiles in major cities in China has been a concern to both the government and the public, as it worsens problems including congestion and air pollutions. Shanghai and Beijing are the pioneer cities that have enacted policies restricting the registration of new cars, or equivalently the allocation of number plates, through auction and lottery respectively.

Guangzhou Transportation Bureau followed suit and announced its car licensing policy on June 30, 2012 in a press conference. As Xian Xiongwei, the Director of Guangzhou Transportation Bureau mentioned during the press conference, Guangzhou held 2.405 million automobiles as of May 2012, 1.67 million of which are middle- and small-sized vehicles; the average car speed on the arterial roads in the central areas of Guangzhou has dropped by 9.6% compared to May 2011; car emissions contributed 38% of the PM2.5 in the atmosphere in the central areas of Guangzhou. “In order to improve the traffic and the atmospheric conditions systematically”, Guangzhou started its licensing policy on July 1 2012. Vehicles purchased after July 1 were not allowed to register in July, and starting in August car licenses have been allocated on a quota basis.

The Guangzhou policy is a hybrid of auction and lottery. Car licenses are allocated once a month, adding up to an annual quota of 120,000. The monthly quota of allocation consists of auction (48,000, equivalent to 40%), lottery for regular automobiles (60,000 equiv. to 50%) and lottery for “energy-saving” hybrid vehicles (12,000 equiv. to 10%).The auction has a lowest bid of 10,000 RMB, whereas the lottery is free of charge. Both the auction and the lottery take place on the 26th of each month.

The policy has not only controlled the licensing but also curbed the demand for car licenses. In 2011, 226,000 car licenses were allocated in Guangzhou; during October 2012—September 2013, only 79,000 valid bidders entered the auction. The 65% drop in demand is far more than the conventional price elasticity theory could explain. Lottery, the counterpart of auction, has gained much favor among the consumers: the average number of valid applicants in lottery each month is 125,600 and that in auction is merely 5800. The applicant-quota ratio in lottery has gone up to 35.6, meaning that the expected number of months one has to wait before getting his first license is 35.6. The policy seems to have diverted people from purchasing car licenses to waiting for a lucky month.

2 Methodology

2.1 Data description

The quantitative comparisons are mostly based on available data for allocation since August 2012 until the time by which the first draft is completed (probably including data of October 2013). The data is published monthly after the allocation process on the website of Guangzhou Automobile Information System for Quota Regulation and Control by Guangzhou Transportation Bureau. It contains the results of lottery and auction, e.g. the amount of quota, the number of valid applicants, and the average bidding price in auction.

The following figures are examples of the data.

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1 http://informationtimes.dayoo.com/html/2012-07/01/content_1752906.htm
2 If the 26th is not a business day, both are postponed to the next business day.
3 http://jtzl.gzjt.gov.cn/
This research will focus on individual auction and lottery for regular vehicles, as they represent the majority of the market for licenses and reflect individual behaviors. Only the number of people in the auction is considered as the economic demand for licenses, as these people are willing to pay a positive price. People in the lottery are thus differentiated since the lottery has an effectively zero price.

Among the total applicants, this research only considers valid applicants who actually were able to attend the entire process and thus disclose their preferences.

### 2.2 Prospect theory

This research will use prospect theory as the basis to explain why the lottery is a much more popular choice than the auction. Proposed in 1979 by Kahneman and Tversky, Prospect theory is a behavioral economic theory that describes how people make decisions under uncertainty. Whereas expected utility theory states that a consumer chooses the option which maximizes the mathematical expectation of utility that arises from the current level of assets, prospect theory says that people compare the options against a reference point and view the relative losses and gains differently. The reference point can be the current level of assets, in
which case will be similar to expected utility theory, or at an expected or aspired level (Kahneman and Tversky). Therefore, decision makers might be comparing the results of a certain option with the current level of assets or with an unreached but desired level. In the latter case, the losses and gains are defined as “deviations from the reference point”.

The perceived value of gains and losses can be drawn as a function the actual amount of gains and losses. The first psychological effect predicted by prospect theory is risk aversion. For the same amount of gain and loss, the loss has a greater absolute value than the gain. The second effect is that the perceived value of gains and losses are not linear but rather “flattening” with respect to the actual amount of gains and losses. As the amount of gains or losses increases, decision makers are less sensitive about the increment in the amount and thus the value function flattens as one moves further away from the origin. An example of a value function is drawn below.

![Value Function Diagram](image)

*Figure 3 Example of value function. The curve is steeper for loss than for gain, and it flattens as the amount of losses and gains increases.*

Prospect theory also proposes a discrepancy between the actual probability and the perceived probability of a certain outcome. While absolute certainties with probability 1 and 0 are still perceived as certainties, there is a tendency to overestimate low probabilities and underestimate high probabilities. The perceived probability is the weighting that decision makers put on each outcome. Below is an example of the weighting as a function of the actual probability of an outcome.
Figure 4 Example of weighting function drawn for uncertain probabilities. Shows overestimation of low probabilities and underestimate of high probabilities.

3 The New Market

This section will explain how the policy splits the market for car licenses into two groups of consumers with distinct attitudes and preferences.

3.1 Different consumers: the desperate and the opportunists

Currently the applicant-quota ratio is increasing and above 30, so one has a probability of at most $\frac{1}{30} \approx 3.3\%$ to get a license every month. Assuming that the ratio is held constant, the expected number of months one has to wait before getting the first license out of the lottery is calculated as follows.

$$E(n) = \sum_{t=1}^{\infty} t \left( \frac{1}{30} \right) \left( 1 - \frac{1}{30} \right)^{t-1} = 30$$

More generically, the expected number of months of waiting is equal to the applicant-quota ratio, assuming the applicant-quota ratio held constant. In other words, the applicants are willing to sacrifice 30 months in order to save the average bidding price 16,000 RMB, and a month of postponed mobility is worth only $\frac{16000}{30} \approx 533$ RMB (~90 USD). It is not in agreement with the value calculated from the average car longevity and the average car price, which is around 1,500 RMB$^4$.

$^4$ Average car lifespan is around 8 years according to Consumer Reports: [http://www.consumerreports.org/cro/index.htm](http://www.consumerreports.org/cro/index.htm).
The consumers in the market of car licenses are never a homogeneous group. Besides the common indicators such as age, gender and income, each consumer in this market is characterized by the nature of his/her demand for car licenses. For example, a consumer who owns a car usually has a more elastic demand than a consumer who does not own a car because the latter has a greater desire for mobility. In this paper, consumers with an inelastic demand for car registration are called “the desperate” because they are more willing to exchange money to increase mobility as soon as possible, while those with an elastic demand are called “opportunists” for their tendency to purchase and register cars at lower prices. For their distinctive preferences, the two groups are affected by the policy unevenly.

First of all, the two groups are likely to have different reference points when measuring the relative loss induced by the policy. Imagine the budgeting process of the two groups when the licensing policy was not in place: a desperate consumer would possibly investigate the total cost of buying a car and completing all related processes and budget appropriately, whereas an opportunist without a solid plan of purchasing a car would make the decision of purchasing after knowing the prices. Now given the options of auction and lottery, a desperate consumer is less likely to exchange some thirty months for instant increase in mobility, and the bidding price in the auction is considered an increment on the original budget. In this case, his reference point is at the original budget, or roughly the car price without the bidding price. He is less sensitive to the loss induced by the policy in addition to the cost of a car, on the flattening part of his value function. In contrary, an opportunist is likely to compare the bidding price to when the licenses were free since his budgeting for the actual car is vague but the notion of the policy is clear. The loss is perceived as relative to the zero price of licenses, on the steep part of his value function. Not subject to a time constraint, he will prefer the lottery to the auction.

Second, there is a tendency to overestimate the probability of getting a license in the lottery. Even though the chance of getting a license is almost negligible, it might appear higher to the applicants since people tend to overestimate their luck according to prospect theory. With a higher weighting, the applicants underestimate the number of months they have to wait. It is possible that their actual willingness to pay for mobility is higher than previously calculated.

### 3.2 A shift in the preference

The bidding price for car licenses can be considered a tax on car registration. The effect of tax on demand is commonly estimated using price elasticity theory. Price elasticity of demand is a measure of the significance of a good to the consumers, i.e. the change in the quantity demanded when there is a change in price. It is calculated as the percentage change in the quantity demanded divided by the percentage change in price.

\[
\varepsilon = \frac{\Delta Q}{Q} / \frac{\Delta P}{P}
\]

According to several studies on the market of automobiles, the price elasticity for cars is usually in between -1 and -4, suggesting that when the price increases by 1%, the quantity demanded will decrease by 1%—4%. The average bidding price in the auction is 16,000 RMB, and the average price of middle- and small-sized cars in China is 145,000 RMB\(^5\). Using the average car price in China is 145,000 RMB:


\(^5\) http://auto.eastday.com/eastday/finance/cys/node1202/userobject1ai562511.html
two values, the bidding price is effectively a change in the car price by 11%. As estimated by the price elasticity theory, the quantity demanded should drop by 11% to 44%. On the other hand, the policy has reduced the annual economic demand for car license by 65%, which exceeds the estimate by far.

It can be argued that price elasticity no longer applies to this case as a quantitative measure of the effect of the policy, because the new market resulting from the policy violates a fundamental assumption of the price elasticity theory. The lottery acts as an alternative as opposed to paying for licenses and has attracted a considerable number of consumers; both time and money can be used to exchange licenses, so price is no longer the only factor that affects the demand. The effect of the policy is not a movement along the demand curve but rather a shift in the demand curve, i.e. a shift in the preference of paying for car licenses.

Combining the discussion in 3.1, the exceptional decrease in economic demand can be explained by the flow of opportunists to the lottery. The opportunists thus are differentiated from the desperate consumers and voluntarily delay their demand for licenses.

### 4 Fluctuations in Prices and Demands

Table 1 Auction results from August 2012 to September 2013

<table>
<thead>
<tr>
<th>Month</th>
<th>Quota</th>
<th>Valid applicants</th>
<th>Lowest price</th>
<th>Average price</th>
<th>Sold</th>
<th>Paid</th>
<th>Percentage allocated</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012/8</td>
<td>3840</td>
<td>820</td>
<td>10000</td>
<td>22822</td>
<td>692</td>
<td>591</td>
<td>15.39%</td>
</tr>
<tr>
<td>2012/9</td>
<td>7089</td>
<td>2624</td>
<td>10000</td>
<td>14138</td>
<td>2300</td>
<td>2201</td>
<td>31.05%</td>
</tr>
<tr>
<td>2012/10</td>
<td>8728</td>
<td>4123</td>
<td>10000</td>
<td>11067</td>
<td>3504</td>
<td>3447</td>
<td>39.49%</td>
</tr>
<tr>
<td>2012/11</td>
<td>9121</td>
<td>5895</td>
<td>10000</td>
<td>10779</td>
<td>5047</td>
<td>4984</td>
<td>54.64%</td>
</tr>
<tr>
<td>2012/12</td>
<td>7977</td>
<td>5408</td>
<td>10000</td>
<td>10955</td>
<td>4543</td>
<td>4482</td>
<td>56.19%</td>
</tr>
<tr>
<td>2013/1</td>
<td>7335</td>
<td>5473</td>
<td>10000</td>
<td>10854</td>
<td>4449</td>
<td>4390</td>
<td>59.85%</td>
</tr>
<tr>
<td>2013/2</td>
<td>6785</td>
<td>3936</td>
<td>10000</td>
<td>10573</td>
<td>2994</td>
<td>2967</td>
<td>43.73%</td>
</tr>
<tr>
<td>2013/3</td>
<td>7658</td>
<td>4889</td>
<td>10000</td>
<td>10585</td>
<td>4033</td>
<td>4002</td>
<td>52.26%</td>
</tr>
<tr>
<td>2013/4</td>
<td>7553</td>
<td>8687</td>
<td>10000</td>
<td>10998</td>
<td>7553</td>
<td>7486</td>
<td>99.11%</td>
</tr>
<tr>
<td>2013/5</td>
<td>3907</td>
<td>9422</td>
<td>11600</td>
<td>12627</td>
<td>3907</td>
<td>3869</td>
<td>99.03%</td>
</tr>
<tr>
<td>2013/6</td>
<td>3954</td>
<td>10454</td>
<td>14000</td>
<td>15743</td>
<td>3954</td>
<td>3919</td>
<td>99.11%</td>
</tr>
<tr>
<td>2013/7</td>
<td>3520</td>
<td>8764</td>
<td>18700</td>
<td>20631</td>
<td>3520</td>
<td>3490</td>
<td>99.15%</td>
</tr>
<tr>
<td>2013/8</td>
<td>3550</td>
<td>6894</td>
<td>23900</td>
<td>26599</td>
<td>3550</td>
<td>3508</td>
<td>98.82%</td>
</tr>
<tr>
<td>2013/9</td>
<td>3562</td>
<td>4790</td>
<td>10000</td>
<td>30802</td>
<td>3375</td>
<td>2979</td>
<td>83.63%</td>
</tr>
<tr>
<td>2013/10</td>
<td>4103</td>
<td>4266</td>
<td>10000</td>
<td>16384</td>
<td>3191</td>
<td>3058</td>
<td>74.53%</td>
</tr>
</tbody>
</table>
Since the minimum bid every month is a fixed price of 10,000 RMB, it is reasonable that during most of the time the average bidding price is close to this value. However three anomalies occurred respectively in:

(1) August 2012;
(2) April—September 2013; and
(3) September—October 2013.

4.1 “Xian-Wai” Policy

In April 2013, the Guangzhou government held a 20-day public consultation on a policy that would restrict cars with nonlocal licenses from entering the city (the “Xian-Wai” policy, literally meaning “limiting the external ones”). As proposed, the policy would restrict nonlocal vehicles from entering the central area of Guangzhou during morning and evening rush hours and from driving on certain highways and arterial roads in the central area during specified hours in daytime on weekdays. The government probably took into consideration of the fact that Guangzhou residents could circumvent the car license restriction by obtaining nonlocal licenses from nearby cities.

The public consultation in April induced a fanatic increase in the interest of car licenses. The number of applicants for the auction doubled, while that for the lottery increased by 10%. This increases shows that Guangzhou residents have been aware of the possibility of getting nonlocal licenses as an alternative for purchasing or waiting for Guangzhou licenses.

Nevertheless, on October 29 the mayor of Guangzhou claimed that the “Xian-Wai” policy would be implemented only under “extreme congestion” on a press conference. It is expected to decrease the number of people in auction and lottery, as it will leave the option of getting nonlocal licenses open for a relative long period of time. The postponement of the “Xian-Wai” policy is probably due to the worry that the restriction will disrupt the close relationship between Guangzhou and nearby cities and impede the trade opportunities and economics of nearby cities.

http://news.21cn.com/hot/gd/a/2013/1030/08/24758498.shtml

“广州市长陈建华在 29 日答复网友提问时称，广州不到非常拥堵时不轻易实施限外”
agglomeration. The announcement has caused great disappointment among Guangzhou residents since it has made the licensing policy meaningless by allowing nonlocal vehicles in the city.

The lottery and the auction for October were held on October 28, and unusual patterns can be seen from the data. The number of valid applicants dropped by 10%, the average bidding price was 60% that of September, and only 74.53% of the quota were sold. It is suspected that the information leaked before the press conference. However, searching for “Guangzhou” and “Xianwai” before October 29 2012 on Weibo7 and Google News returns no result showing leak in such information.

4.2 August 2012—March 2013

The quota for auction in August 2012 was 3,840, while there were only 820 valid applicants and 692 among them actually entered the auction. Even if all applicants bid at the minimum price 10,000 RMB, they would have all obtained licenses. In other words, the minimum amount of government revenue in order to allocate efficiently was 6,920,000 RMB.

However, it seems that the consumers overestimated others’ willingness to pay for licenses. The average bidding price in the first month was 22,822 RMB, more than two times the minimum bid. The actual government revenue 15,790,000 was also more than two times the minimum level of efficient allocation. The government cannot be absolved of this overcharge, because it does not disclose the information of the number of applicants before or during the auction. There is complaint that the government intentionally overcharges by using the information asymmetry.

After two months of “stepping in the water”, the consumers started to bid at prices close to the minimum bid. The average bid did not exceed 11,000 RMB until April 2013. At the same time, the number of valid applicants never exceeded the monthly quota, resulting in a low rate of allocation no more than 60%.

4.3 April—September 2013

The public consultation on “Xian-Wai” policy was announced on April 8, leaving the public two weeks to fully react. The average bidding price started to increase by 15~30% each month, showing that the consumers realized the long-term importance of having Guangzhou licenses.

The number of valid applicants also increased at the beginning of this period of time, until the law of demand kicked in on July 2013, where the skyrocketing price started to decrease the demand. The price elasticity calculated at June and July 2013 is -0.52, showing an inelastic demand at this point of time triggered by the public consultation on “Xian-Wai” policy.

4.4 September—October 2013

Along with the public’s concern of the “Xian-Wai” policy, the average bidding price reached its peak in September, followed by a 46% decrease in October. At the same time, 12 applicants got licenses at the minimum bid 10,000 RMB, which is an inciting contrast to the high average bidding price.

If we consider the distribution of the bids in each month, the increasing mean value indicates either an increasing skewness or that the distribution shifts to the right. In the former

7 One of the most popular microblogging websites in China.
case, while the entire range does not shift by much, a significant number of bids occur at the high range; it is possible that the bids are bifurcated. In the latter case, the range of the distribution shifts to the right. The “dip” at the minimum price suggests that the former is a closer description of the distribution, and it is a signal to the consumers that they might be overpaying.

While the explanation above is qualitatively coherent with the fact, it might not be the sole reason. Since the “invalidation” of the “Xian-Wai” policy was announced three days after the allocation in October, there is suspicion that this information was leaked to some of the consumers before the auction started. However no evidence of such leak of information was found on Weibo and Google News.

5 Risks and Limitations of the Policy

5.1 Nonlocal vehicles

The management of nonlocal vehicles poses a dilemma to the Guangzhou government. If there is no limitation on driving nonlocal vehicles, the congestion problem will not be solved, which renders the licensing policy useless. Nevertheless, restrictions on nonlocal vehicles might affect Guangzhou’s mobility and accessibility as a trade hub.

Guangdong Province has been richest among all provinces in China with its high GDP value since the Chinese economic reform. The economy is dominated by manufacturing and processing, which concentrate in cities such as Dongguan and Foshan. Vehicle mobility is deemed as a necessity for the stakeholders in the manufacturing industry. The capital city of Guangdong Province, Guangzhou has been a historically trade center with highly vital economic activities, but it is not the absolute economic center in the entire province. Shenzhen, the second biggest city in Guangdong Province, has been a threat to Guangzhou’s leading position. It is situated in the south of Guangdong Province as well, and its proximity to Hong Kong has brought extra trade and manufacturing opportunities. Restrictions on nonlocal vehicles could decrease the mobility in Guangzhou and force the vehicles to detour. In the long run, dealers and distributors might retreat from Guangzhou and set up in Shenzhen instead.

Shanghai allocates car licenses through auction and started to restrict nonlocal vehicles in 2002. The restriction did not impact Shanghai’s economy since the city itself is the indisputable economic center of the Yangtze River Delta owning to historical and cultural reasons. While Guangzhou might be motivated to follow Shanghai, the two cities are in essentially different situations.

Another way to limit nonlocal vehicles is to cooperate with the neighbor cities so that all consumers can only register cars in the cities to which their hukou belong. It prevents Guangzhou residents from getting nonlocal licenses and still driving mostly in Guangzhou. This method has a minimum effect on congestion since it has no impact on the existing nonlocal vehicles.

5.2 Concerns of the consumers

Beholding the savage congestion, the Guangzhou residents have quite some complaints about the policy. One of the major concerns is that the entire purpose to solve congestion is not achieved. Possible reasons are that the road network still does not seem to accommodate the

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8 Greater than 20,000 RMB.
existing vehicles and that the public transit has not become a major substitute for driving. Expansions of the road network and improvements on the public transit require government revenue, and the lack of progress on such projects leads to the doubt on the usage of the government revenue. It is mentioned in the policy that the government revenue is “specifically used on public transit”, but the details of such projects cannot be found anywhere on the government websites or in government reports.

The Guangzhou residents also find the information asymmetry frustrating. It has caused overcharge in the very beginning (see 4.2), and yet the government has not increased the amount of information it discloses to the consumers. Moreover, there are two posts in online forums that express frustrations that the government staff in Guangzhou Transportation Bureau gave ambivalent explanations on details of the policy.

6 Conclusion

The car licensing policy in Guangzhou is effective in curbing the demand for licenses despite its problems in regard to the accountability of the government. The lottery option as an alternative of the auction option has differentiated consumers with different types of demands and delayed the elastic demand. The effect is not a result under the price elasticity theory but can be explained by prospect theory.

Considered the complement of the licensing policy for long, the “Xian-Wai” policy had caught attention of the public and led to several fluctuations in the auction market. The government denied the policy eventually, possibly in concern of the potential economic impacts. The ambivalence induces doubts on the effectiveness of the licensing policy and the credibility of the government.

Word count: 4017

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7  Reference

