Auction vs. Lottery

China’s Experiments in Managing Automobile Growth

Jinhua Zhao

May 10, 2013
Beijing 1982

Motor Vehicles in Beijing

Bicycle Mode Share in Beijing

- 1986: 63%
- 2000: 39%
- 2005: 30%
- 2009: 20%
- 2010: 16%
China Hype and China Bashing

- GDP: 9.5% per year for 30 years
- Urbanize 370m people without slum
- Raise hundreds of millions of people from poor
- Million miles of road, billions of square feet of housing
- Biggest CO₂ emitter
- Severe pollutions
- Political reform
- Inequality
  - urban – rural; east – west; within city
  - from one extreme to another extreme
China vs. US
Measured by 21 different indicators: manufacturing output, exports and fixed investment.
Urbanization in China 2010-2040

United Nations, Department of Economic and Social Affairs, Population Division:
World Urbanization Prospects, the 2009 Revision. New York 2010
Beyond index

PM2.5 Jan 12, 2013
Beijing 755; NYC 19
Extraordinary growth calls for extraordinary measures
Beijing Subway
Subtleties in Bold Design
WHICH COUNTRIES BUY THE MOST CARS?

CHINA: 18,350,000
USA: 12,775,346
BRAZIL: 3,400,000
GERMANY: 3,170,000
JAPAN: 2,689,074
RUSSIA: 2,600,000
FRANCE: 2,204,200
INDIA: 1,950,000
UK: 1,939,275
ITALY: 1,750,000

While China has become the world's largest automotive market in terms of sales volume, the U.S. market still leads the world in terms of total sales revenue.

The story of two billion cars...

Source: Sperling and Gordon 2009 Two Billion Cars: Driving Toward Sustainability
Overall growth conceals variation among cities!

and associated policy interventions
Shanghai vs. Beijing

Motor vehicles

Beijing (15%)
Shanghai (7.6%)

Million Vehicle

2001 2002 2003 2004 2005 2006 2007 2008 2009 2010

0 1 2 3 4 5 6

Shanghai
Beijing
Households owing a car in 2011

- Shanghai: 18%
- Beijing: 38%
Bidding to Drive: License Auction in Shanghai
Bidders, licenses and bidding prices

![Chart showing trends in price, number of bidders, and license plate issued from 2002 to 2012.](chart)

- **Price (1,000 CNY)**
- **Number (1,000s)**

Legend:
- License plate issued
- Average successful bid price
- Number of bidders
4-6 Billion CNY Annual Revenue

- **Annual revenue**: Orange bars
- **Annual licenses issued**: Blue dots

Transit Subsidy: 2.5 billion

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual Revenue (Billions CNY)</th>
<th>Number of licenses (1,000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>6.7</td>
<td></td>
</tr>
</tbody>
</table>
A Great Policy?

• Demand management: dampen growth of cars

• Financing tool: provide a large, stable and growing source of revenue
Discussions

Shanghai’s Auction • Public Acceptance

Beijing’s Lottery • Superficial Fairness

Gauging the public • Pricing Mechanism

Policy Mobility • SG→SH→BJ→GZ→World
Discussions

Shanghai’s Auction • Public Acceptance

Beijing’s Lottery • Superficial Fairness

Gauging the public • Pricing Mechanism

Policy Mobility • SG⇒SH⇒BJ⇒GZ⇒World
Do people accept it?

The most expensive piece of iron in China!

Core policy drivers

- Effectiveness (perceived)
- Affordability
- Equity

{ Public Acceptance
Framework of Public Acceptance

Context
- Congestion
- Awareness

Effectiveness
- Effectiveness
- Affordability

Equity
- Core policy drivers
  - Private vehicle auction
  - Government vehicle
  - Comparison to other cities
  - Transparency

Implementation
- Implementation Process
- Unintended Consequences
  - Overall licensing process
  - Information provision
  - Bidding process
  - Speculation
  - Non Local license

Preference Variations
- Car Behaviour & Attitude
  - Car ownership
  - Car use
  - Car dependence
  - Car pride
- Location & Transit
  - Transit Access
  - Commuting distance
  - House location
- Socioeconomics
  - Income
  - Residence
  - Age
  - Gender
  - Having Children
  - Education

Other Policy Options
- Congestion charges
- Parking charges
- Fuel taxes

License Auction Policy Acceptance
- Current Acceptance
- Change of Acceptance
- Expectation of Others’ Acceptance
Primary Data Collection in Shanghai

• **2011 survey**
  - Purposeful sampling
  - Personal contacts
  - 1100 employees from nine companies
  - Not weighted
  - 524 valid responses

• **2012 survey**
  - Professional survey company

• **Data weighting**
  - 6th Census in 2010: Local and migrants
  - Age, Gender, Income, Education, Location, Hukou

• **Final dataset**
  - 1389 valid responses
  - Representative along the above 6 dimensions
Policy Intervention Necessity

High congestion level

Government intervention necessary
# Psychometric Measurement of Public Acceptance

<table>
<thead>
<tr>
<th>Indicators measuring policy acceptance (Likert-scale questions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X9</td>
</tr>
<tr>
<td>X10</td>
</tr>
<tr>
<td>X11</td>
</tr>
<tr>
<td>X12</td>
</tr>
<tr>
<td>X13</td>
</tr>
</tbody>
</table>

Reliability of measurement (Cronbach’s alpha = 0.75)
Overall Acceptance

43% negative
30% neutral
27% positive
Core policy drivers

Effect       Affordability                                    Equity
-2.0         -1.5                                        -1.0
-0.5         0.0                                         0.5
0.0          1.0                                         1.5
1.5          2.0

Effectiveness Affordability Government vehicles Comparison with other cities Transparency in revenue usage

Strongly Positive

Strongly Negative
Preference Variation

Dependent Variables
- Acceptance
- Effectiveness
- Affordability
- Equity

Independent Variables
- Car ownership and license, car mode share
- House location, commuting distance
- Age, gender, income, education, hukou, household size, children

Structural Equation Model: implementation: Mplus; CFI/TLI > 0.9; RESEA/SRMR < 0.05

### Household Income

<table>
<thead>
<tr>
<th></th>
<th>ACCEPT</th>
<th>ACCEPT CHANGE</th>
<th>EFFECT</th>
<th>AFFORD</th>
<th>Equity In Auction</th>
<th>Vs. other cities</th>
<th>Revenue usage</th>
<th>Government vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (&lt; ¥4k)</td>
<td>0.056</td>
<td>0.054</td>
<td>-0.002</td>
<td>0.028</td>
<td>0.149**</td>
<td>0.234**</td>
<td>0.085*</td>
<td>0.011</td>
</tr>
<tr>
<td>High(&gt;¥15k)</td>
<td><strong>0.136</strong></td>
<td><strong>0.159</strong></td>
<td><strong>0.162</strong></td>
<td><strong>0.243</strong></td>
<td><strong>0.174</strong></td>
<td><strong>0.111</strong></td>
<td>0.026</td>
<td><strong>0.074</strong></td>
</tr>
</tbody>
</table>

Bases are middle income group (4k – 15k)

*p < 0.05; **p < 0.01*
## Hukou (migrants vs. locals)

<table>
<thead>
<tr>
<th></th>
<th>ACCEPT CHANGE</th>
<th>EFFECT</th>
<th>AFFORD</th>
<th>Equity Auction</th>
<th>Vs. other cities</th>
<th>Revenue usage</th>
<th>Government vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Migrant</td>
<td>-0.036</td>
<td>0.00</td>
<td>-0.012</td>
<td>0.108**</td>
<td>0.122**</td>
<td>0.098**</td>
<td>0.087**</td>
</tr>
</tbody>
</table>

Bases are local residents

*0.05 < p < 0.10; **p < 0.05
Car Owners (18%) vs. Non-Car Owners (72%)

Shanghai License (80%) vs. Non-local License (20%)
Car owners as a supporting constituency?!

- Owner’s club
- The more owners, the more the policy is supported
- 1994
- Who bought cars first?
- Irreversible
Discussions

Cases

Shanghai’s Auction
• Public Acceptance

Beijing’s Lottery
• Superficial Fairness

Gauging the public
• Pricing Mechanism

Policy Mobility
• SG→SH→BJ→GZ→World
Shanghai vs. Beijing

• Shanghai
  – Early intervention
    • Since 1994
    • Ownership control
  – Auction

• Beijing
  – No intervention
  – Until 2008
  – Use control
  – Lottery in 2011
Beijing’s License Lottery Policy

• Fixed quota: 20k
• Equal probability of winning
• No entry cost
• Require local hukou or PR*

*For temporary migrants, it requires proof of five year income tax and social security fee.

Zhao, J., T. Chen and D. Block-Schachter (2013) Superficial Fairness of Beijing’s Car License Lottery Policy
Beijing’s Lottery Policy

- Effectiveness
- Efficiency
- Equity
Motor Vehicles in Beijing

Number of vehicles (millions)

- 5th million 2009 to 2010 | 1 year
- 4th million 2007 to 2009 | 2 years
- 3rd million 2003 to 2007 | 3.7 years
- 2nd million 1998 to 2003 | 6.5 years
- 1st million 1949 to 1997 | 48 years

Yearly milestones:
- 1949
- 1951
- 1953
- 1955
- 1957
- 1959
- 1961
- 1963
- 1965
- 1967
- 1969
- 1971
- 1973
- 1975
- 1977
- 1979
- 1981
- 1983
- 1985
- 1987
- 1989
- 1991
- 1993
- 1995
- 1997
- 2001
- 2003
- 2005
- 2007
- 2009
Beijing’s Lottery: Effectiveness

Annual Motor Vehicle Growth Rate in Beijing

License Lottery
Beijing’s Lottery: Efficiency

- No cost of entry
- Odds: 1:50~1:100
- Distortion of resource allocation
- Detached from travel need
Willingness to Pay

vs.

Financial Ability to Pay
Beijing’s Lottery: Fairness

- Dimensions of equity
  - Income: rich vs. poor
  - Residence: local vs. temporary migrant
  - Time: existing owners and new buyers; 5 million

- Market Response (Circumventing the lottery)
  - Shadow price: CNY 60k~100k in 2nd hand car market
  - Corruption

- Equity at the broader scale
  - Equity between car owners
  - Equity between car users and transit users
  - Shanghai: transfer from car users to PT users
Shadow Price of Beijing license
Beijing’s Lottery Policy

- Effectiveness: Extraordinary
- Efficiency: Disaster
- Equity: Superficial
Discussions

Cases

- Shanghai’s Auction
  - Public Acceptance
- Beijing’s Lottery
  - Superficial Fairness
- Gauging the public
  - Pricing Mechanism
- Policy Mobility
  - SG → SH → BJ → GZ → World
Policy making in China is Easier?

- Fewer regulatory constraints
- Stronger government power
- Richer resources
- Elite-driven
- Lack of public participation

Authoritarian decision making

- Straightforward
- One-directional

?
Do governments gauge the public option?

- Lack of mechanism
  - Formal public participation

- Consequences
  - Implicitly gauging public opinion
    - No feedback / ignore feedback
    - Over react
Mechanism of Quota Decision Making

Supply → Quota → Price
Bidders, licenses and bidding prices

Price (1,000 CNY)

Number (1,000s)

- License plate issued
- Average successful bid price
- Number of bidders
Multivariate Autoregressive and Moving Average Model (ARMA)

- **Vector**
  - # Bidder
  - Bidding Price
  - # Quota

- **Granger causality**

- **Multivariate ARMA**

\[
\begin{align*}
\mathbf{y}_t &= \begin{pmatrix} y_{1t} \\ y_{2t} \\ y_{3t} \end{pmatrix} = \begin{pmatrix} \text{quota}_t \\ \text{bidders}_t \\ \text{bid}_t \end{pmatrix} \\
\mathbf{y}_t &= \mathbf{B} \mathbf{x}_t + \sum_{i=1}^{p} \Phi_i \mathbf{y}_{t-i} + \sum_{j=1}^{q} \Theta_j \varepsilon_{t-j} + \varepsilon_t
\end{align*}
\]

- $\mathbf{y}_t$: 3x1 vector
- $\mathbf{x}_t$: 3xM matrix
- $\Phi_i$: 3x3 matrix for each $i$
- $\Theta_j$: 3x3 matrix for each $j$
Mechanism of Quota Decision Making

\[
\text{Quota (t)} = 11.5 \text{ RoadArea} + 0.68 \text{ Quota (t-1)} + 28 \text{ Price (t-1)} + \ldots
\]

Supply $\rightarrow$ Quota $\rightarrow$ Price

*Bidding Price as a Signal for Policy Adjustment*
Affordable price range

Shanghai License Price Range (¥)

- **Acceptable price range**: ¥9,999 - ¥20,000
- **Combined effectiveness & acceptance price range**: ¥29,999
- **Government intended price range**: ¥30,000
- **Average 2011 ongoing price**: ¥48,593
Beijing: Secrecy and Suddenness

• 1994 vs. 2011

• Beijing
  – Lottery as a tight secret
  – Dec 2010: car sale rush: 24 hour services
  – Any chance of public participation
  – Not concerned or over concerned?
## Evaluation of Shanghai and Beijing’s Policies

<table>
<thead>
<tr>
<th></th>
<th>Shanghai’ Auction</th>
<th>Beijing’ Lottery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness</td>
<td>The same</td>
<td>The same</td>
</tr>
<tr>
<td>Efficiency</td>
<td>High</td>
<td>Very low</td>
</tr>
<tr>
<td>Equity</td>
<td>Mixed</td>
<td>Superficial</td>
</tr>
</tbody>
</table>
Citizen’s preference

- Beijing Transportation Research Center
- What would citizens choose?
  - Lottery or Auction
Public Acceptance (Shanghai vs. Beijing)

- **Shanghai on Auction**
- **Beijing on Lottery**

The graph compares public acceptance in Shanghai and Beijing, with categories ranging from negative to positive. The data shows a higher percentage of positive responses for Beijing compared to Shanghai.
Auction or lottery?
Public preference in Beijing
Advantages of Chinese Government

• Sensible policy vs. public mentality
• Dilemma and Difficulty
• Beijing: shy away
  – Over concerning the public opinion
  – Another example
    • Airport highway toll cancelation
Public preference: BJ vs. SH

- Beijing
- Shanghai

Auction
Lottery
Discussions

Shanghai’s Auction
- Public Acceptance

Beijing’s Lottery
- Superficial Fairness

Gauging the public
- Pricing Mechanism

Policy Mobility
- SG→SH→BJ→GZ→World
Zhao, J. and Z. Wang (2013) An Interview Based Survey of Transportation Policy Transfers in China, working paper
SH + BJ ➔ Guangzhou

- August 2012
- Total Quota
- A Hybrid: lottery and auction
  - Lottery: 50%
  - Auction: 40%
  - New energy vehicle: 10%
Guangzhou Lottery

Number of valid applicant for lottery

Monthly lottery quota

odds of winning

Thousands

Aug 8% 6%
Sept 6%
Oct 6%
Nov 5%
Dec 5%
Jan 5%
Feb 5%
Mar 5%
Guangzhou Auction

![Bar and line chart showing actual number of bidders, monthly auction quota, and actual allocation rate for Guangzhou Auction from August to March. The x-axis represents the months, and the y-axis represents the number of bidders in thousands. The bars indicate the actual number of bidders, with the line graph showing the monthly auction quota and actual allocation rate.](chart.png)
Policy Transfers

• **Singapore → Shanghai**
  - Car industry
  - City state vs. city in a region

• **Shanghai → Beijing?**
  - Bidding vs. lottery
  - Control use vs. control ownership
  - SH+BJ → Guangzhou/Xi’an → 3rd cities

• **China → World?**
  - China → other developing countries
  - China → western cities
  - Local context vs. generic human nature

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*Borrowing from the west*

*Experimenting within*

*Exporting knowledge?*
Shanghai’s Auction • Public Acceptance

Beijing’s Lottery • Superficial Fairness

Gauging the public • Pricing Mechanism

Policy Mobility • SG → SH → BJ → GZ → World
China’s Urban Transportation Policy Making
1. Cocktails of state + market combinations
### Embracing the market?

<table>
<thead>
<tr>
<th></th>
<th>Shanghai</th>
<th>Beijing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long term policy</td>
<td>From early stage motorization (1994)</td>
<td>Late + Sudden (2008, 2011)</td>
</tr>
<tr>
<td>Intervention strength</td>
<td>Strong</td>
<td>Strong</td>
</tr>
<tr>
<td>Maximum quota</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Allocation mode</td>
<td>Auction</td>
<td>Lottery</td>
</tr>
<tr>
<td>Allocation mechanism</td>
<td>Price based bidding</td>
<td>Time based queuing</td>
</tr>
<tr>
<td>Efficiency and equity</td>
<td>More efficiency</td>
<td>More equity</td>
</tr>
<tr>
<td>Consequences</td>
<td>Less distortion</td>
<td>Queuing → Price or Power</td>
</tr>
<tr>
<td>Financing ability to pay</td>
<td>Mixed of both</td>
<td>Neither</td>
</tr>
<tr>
<td>willingness to pay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market and state</td>
<td>State + market</td>
<td>State only</td>
</tr>
</tbody>
</table>
2. Tougher tradeoffs
Tougher tradeoffs

- congestion management and city openness
- efficiency and equity
- interests of different groups
- public sentiments and sensible policy choices
3. Devolution of decision making

- Urban Transportation Policies
- Experiments in Shanghai and Beijing
  - Significant
  - Significantly different
- Tolerance and Encouragement of Diversity and “Try and Error”

Highly centralized politically

Highly decentralized economically and administratively
4. Increasingly two-way interactive rather than simply top-down command and control
Auction vs. Lottery

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