Back to the Future?
Land Use, Mobility & Accessibility
in Metropolitan China

11.953
Day 23
C. Zegras

Contents

• Remember the Developing World…..?
• Motorization!
• China: Motorization and its Challenges
• Land Development: Patterns and Forces
• The End of Jobs-Housing Balance?
• Shanghai and Rail Transit
• Introduction to the Final Assignment
Motorization

• Income and per capita motor vehicle fleets
  – At national level, 90%
  – At the urban level, 80%
• Still considerable variation, due to
  – Population densities, urbanization levels, vehicle production (national industrial policy), vehicle prices, etc.
  – Particularly at urban level…

China

• Average travel rate: 1000 kilometers/year
  – Europe: 15,000
  – US: 24,000
• Motorization
  – Approximately 9 cars per 1000 persons
  – National car sales growing by ~70% per year in 2000s
  – National car manufacturing growing by ~80 percent per year.
Dynamic Motorization: Auto/Light Truck Fleets

Figure by MIT OCW. W.-S. Ng and Schipper, 2005.

Dynamic Motorization Concerns: Oil Consumption

Figure by MIT OCW. W.-S. Ng and Schipper, 2005.
### Dynamic Motorization Concerns: Air Pollution

<table>
<thead>
<tr>
<th>City</th>
<th>CO (%)</th>
<th>HC (%)</th>
<th>NOx (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing (2000)</td>
<td>77</td>
<td>78</td>
<td>40</td>
</tr>
<tr>
<td>Shanghai (2000)</td>
<td>86</td>
<td>96</td>
<td>56</td>
</tr>
<tr>
<td>Guangzhou (2000)</td>
<td>84</td>
<td>50</td>
<td>45</td>
</tr>
</tbody>
</table>

W.-S. Ng and Schipper, 2005.
Dynamic Motorization Concerns: Accidents?

Dynamic Motorization/Urbanization Concerns: Other?
China’s Automobile Industry

- Now world’s third largest automobile producer
- “Pillar” of national economic development plans since 1988
- In 2004, China enacted fuel economy standards that are stricter than US standards
- Uncertainties over future vehicle demand composition
  - i.e., will the trend towards larger, heavier vehicles (SUVs) prevail?
- Motor vehicle emission standards now exist
  - Euro II-equivalent standards already implemented in Shanghai and Beijing

W.-S. Ng and Schipper, 2005.

Motor Vehicle Projections…

W.-S. Ng and Schipper, 2005; NAE, CAE, NRC, 2003.
Dynamic Metropolitan-ization: Government Responses

One Main Issue: Excessive Density

- National Development Standards
  - Require more parking, wider streets, higher per capita living space
  - Density Guidelines:
    - 10,000 – 12,500 persons per square km
  - Infrastructure guidelines, “road coverage”:
    - 8-15% for smaller cities; 15-20% for larger cities
    - Averages, including parallel 2-wheeler streets, parking and pedestrian facilities

NAE, CAE, NRC, 2003.

Dynamic Metropolitan-ization: Government Responses

Another Main Issue: “Privatization”

- Municipalities allowed to acquire land and “lease” land (conveyance fees)
  - 40 (commercial), 50 (ind.), 70 (resid.) year terms
  - lump sum, up-front payments
  - Huge source of local government revenues
- Municipalities also collect taxes on land
- Expropriation
  - Rural compensation lower than urban…
- Break up of the “work unit” model…
## Time and NMT Share: Commuting

<table>
<thead>
<tr>
<th>Moving Patterns</th>
<th>Number of workers</th>
<th>Commute time</th>
<th>Non-motorized transport</th>
<th>Share of non-motorized travel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within sub-districts</td>
<td>161</td>
<td>30.0</td>
<td>121</td>
<td>75.2%</td>
</tr>
<tr>
<td>Beyond sub-districts</td>
<td>570</td>
<td>34.5</td>
<td>396</td>
<td>69.5%</td>
</tr>
<tr>
<td>Beyond District</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>956</td>
<td>42.8</td>
<td>515</td>
<td>53.9%</td>
</tr>
<tr>
<td>Parallel</td>
<td>337</td>
<td>42.7</td>
<td>154</td>
<td>45.7%</td>
</tr>
<tr>
<td>Inward</td>
<td>105</td>
<td>30.7</td>
<td>81</td>
<td>77.1%</td>
</tr>
<tr>
<td>Outward</td>
<td>514</td>
<td>45.5</td>
<td>280</td>
<td>54.5%</td>
</tr>
</tbody>
</table>

Yang, 2005.
### Commute Time = \( f(?) \)

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>Std. Beta</th>
<th>T-Stat</th>
<th>Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>55.594</td>
<td></td>
<td>15.425</td>
<td>0.000</td>
</tr>
<tr>
<td>Private_motor</td>
<td>-30.387</td>
<td>-0.193</td>
<td>-8.504</td>
<td>0.000</td>
</tr>
<tr>
<td>Workunit_bus</td>
<td>-19.708</td>
<td>-0.230</td>
<td>-8.969</td>
<td>0.000</td>
</tr>
<tr>
<td>Walk</td>
<td>-48.433</td>
<td>-0.333</td>
<td>-14.573</td>
<td>0.000</td>
</tr>
<tr>
<td>Bicycle</td>
<td>-31.901</td>
<td>-0.530</td>
<td>-19.430</td>
<td>0.000</td>
</tr>
<tr>
<td>Worker&gt;2</td>
<td>3.242</td>
<td>0.43</td>
<td>1.918</td>
<td>0.055</td>
</tr>
<tr>
<td>Reluctant</td>
<td>5.895</td>
<td>0.095</td>
<td>4.027</td>
<td>0.000</td>
</tr>
<tr>
<td>Affirmative</td>
<td>-4.779</td>
<td>-0.080</td>
<td>-3.684</td>
<td>0.000</td>
</tr>
<tr>
<td>Income</td>
<td>-0.064</td>
<td>-0.035</td>
<td>-1.568</td>
<td>0.117</td>
</tr>
<tr>
<td>Beyond_subdistrict</td>
<td>5.451</td>
<td>0.087</td>
<td>2.313</td>
<td>0.021</td>
</tr>
<tr>
<td>Beyond_district</td>
<td>9.184</td>
<td>0.153</td>
<td>3.648</td>
<td>0.001</td>
</tr>
<tr>
<td>Move_inward</td>
<td>-6.326</td>
<td>-0.052</td>
<td>-2.183</td>
<td>0.029</td>
</tr>
<tr>
<td>Move_outward</td>
<td>3.694</td>
<td>0.057</td>
<td>2.032</td>
<td>0.042</td>
</tr>
</tbody>
</table>

R2 = 0.261  
Yang, 2005.

### Interpretations & Implications?
Dynamic Metropolitan-ization:  
Impacts

Decentralizing forces
• Land cheaper on fringe
• Rural conversion generates more revenues for municipalities
• Growing demand for “campus”-like settings
• Government promotion of the “concentrated dispersion” model…
Shanghai

- During 1990s, MV fleet grew by 30,000-50,000 vehicles per year.
- Average density in the range 14,000-40,000 persons per sq. km
  - NY Metro Area: 4,500
- Recent Years
  - Massive infrastructure investments
    - $10 bn b/w 1991-1996: bridges, tunnel, inner ring road, first subway line
  - 2000 development plan
    - 200 kms of rail, 6 BRT corridors; 520 kms of new highways

Motorization Management

- Various vehicle restrictions in place
  - Freight place and time restrictions
  - High registration fees ($2,500) and purchase taxes (10%) for private cars
  - Cap of 50,000 new vehicle registrations per year (as of 1998)
  - Bans/restrictions on many motorized two-wheelers
  - Also, bans on bicycles in some parts of city
- Motorization Rate
  - ~40 to 60 private vehicles per 1000 persons

NAE, CAE, NRC, 2003.
Shanghai Socioeconomics & Demographics

- Average personal incomes increasingly rapidly
  - Growing income disparity
  - Still significant low-income population, including “floating” pop.
- Larger than national average share of over 65
- Current population growth (official) 0.42% per year
  - 18-21 million by 2020

Evolution in Income Distribution

Zhao, 2003.
Age Distribution

Age Distribution in year 2001

Trip Rate: Estimated and Expected
(Average Daily Trips/Capita)

Zhao, 2003.
Shanghai: Mode Share Evolution

ITDP, 2005.

Public Transport Mode Shares

Zhao, 2003.
Shanghai Urban Development Strategy

• Monocentricity to polycentricity
• Plan for five levels of hierarchical urban structure
  – CBD, Sub-Centers, Specialized Centers, District Centers, Community Centers
  – Aim to follow rail…

Rail Transit Network and Centers/Sub-Centers
Per Capita Living Area

Zhao, 2003.

Rail Transit: Achieving its Aims?
### Rail Transit: Ridership Effects

#### Trip Purposes

<table>
<thead>
<tr>
<th>Year</th>
<th>Work</th>
<th>School</th>
<th>Personal Business</th>
<th>Shopping</th>
<th>Recreational</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>20.4%</td>
<td>6.6%</td>
<td>3.3%</td>
<td>26.8%</td>
<td>30.5%</td>
<td>12.5%</td>
</tr>
<tr>
<td>2002</td>
<td>24.6%</td>
<td>3.8%</td>
<td>4.7%</td>
<td>33.9%</td>
<td>17.4%</td>
<td>15.6%</td>
</tr>
<tr>
<td>2003</td>
<td>36.5%</td>
<td>5.2%</td>
<td>10.9%</td>
<td>28.6%</td>
<td>9.4%</td>
<td>9.4%</td>
</tr>
</tbody>
</table>

Pan and Zhang, 2005.

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#### Rail Transit: Ridership Effects

#### Mode Choice

<table>
<thead>
<tr>
<th>Mode</th>
<th>Before</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metro</td>
<td>50%</td>
<td>70%</td>
</tr>
<tr>
<td>Bus</td>
<td>60%</td>
<td>50%</td>
</tr>
<tr>
<td>Car</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Walk</td>
<td>20%</td>
<td>10%</td>
</tr>
<tr>
<td>Bicycle</td>
<td>10%</td>
<td>15%</td>
</tr>
<tr>
<td>Powered Bicycle</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Motorcycle</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Other</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

Pan and Zhang, 2005.
Rail Transit Effects: Trip Times

Pan and Zhang, 2005.

Rail Transit Effects: Trip Distribution

Pan and Zhang, 2005.
Rail Transit Effects: Development

Pan and Zhang, 2005.

Rail Transit Impacts:
Land Use Changes at Xin-Zhuang Station

Pan and Zhang, 2005.
Rail Transit Impacts: Problems with Analysis?