

Urban Transformation and carbon footprint of mega-cities in Japan and China

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Topics

- v Rapid urbanization in Asia
- v Large sources of carbon emissions
- v Energy efficiency improvements and the externality of cities
- v Urban transformation and carbon consequence

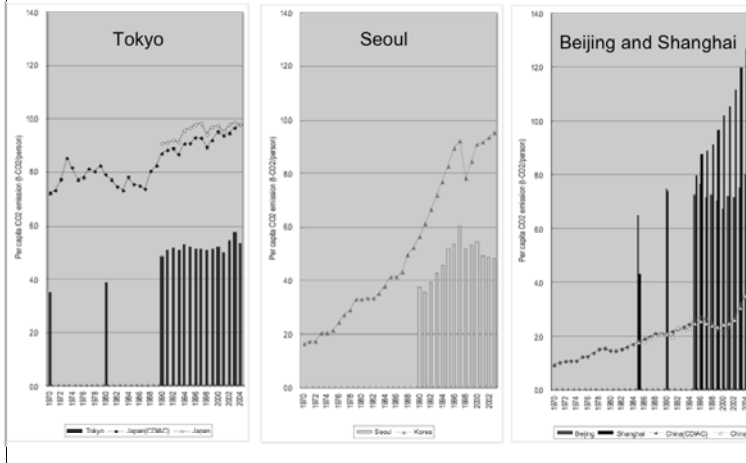
Urbanization in Asia

- v Rapid urbanization:
 - Average annual growth rate of urban population in 1990's:
 - 3.0% in East Asia and the Pacific; and 3.2% in South Asia(>>2.1% the world average)
- v Potential of urban growth:
 - Population of developing countries living in cities:40% today è 52% by 2020
 - (75% already in Latin America and the Caribbean)
- v The scale of urbanization of Asia:
 - 2,605 million by 2030, exceeding twice the size of current Chinese population (53% of the world's urban population)
- v Cities and Asia:
 - 11 out of 20 mega-cities (over 10 million), 17 out of 30 cities of 5-10 million, 184 out of 364 cities of 1-5 million, 225 out of 455 cities of 0.5-1 million

World Energy Outlook 2008 Chapter 8: Energy Use in Cities

- v About two-third of the world's energy – an estimated 7,900 Mtoe in 2006 – is consumed in cities, even though only around half of the world's population lives in urban area. City residents consume more coal, gas and electricity than the global average but less oil.
- v Increase in urbanization through to 2030 are projected to drive up city energy use to almost 12,400 Mtoe in the Reference Scenario. By 2030, cities are responsible for 73% of the world's energy use. Some 81% of the projected increase in energy use in cities between 2006 and 2030 comes from non-OECD countries.

Gap of per capita CO2 between city and country

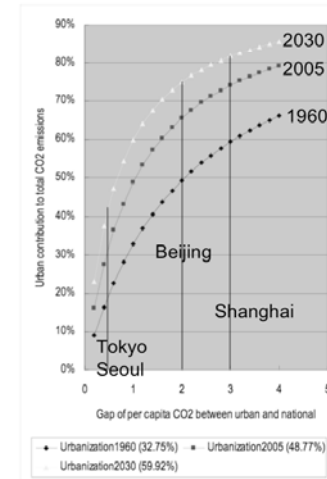


City and CO2 emission

- Urbanizing world
 - World: 32.75% (1960) => 48.77% (2005) => 60% (2030)
 - Developing East Asia and the Pacific: 16.76% (1960) => 41.45% (2005)

- If per capita CO2 emission in cities is twice larger than that in national average, then cities contributes 66% of CO2 emissions under current level of urbanization.

- Better understanding of the gap in per capita CO2 between city and national would be good start to have overall contribution of cities to global carbon emissions.



Urbanization, GDP and per capita CO2 emission

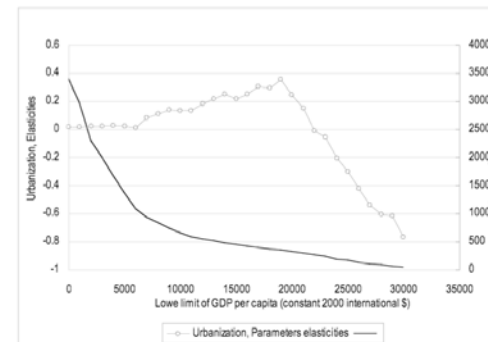
Dependent Variable:
CO2 emission (metric tons per capita)

Independent Variable:
Urban population (% of total)
Manufacture, value added (% of GDP)
GDP per capita (constant 2000 US\$)

Period: 1960-2006
Countries: 163 countries
Observations: 3,396
Data Sources: World Development Indicator 2007
Model: Random Effect Tobit Regression model

Urbanization, GDP and per capita CO2 emission

By eliminating lower income countries and refining the sample with higher income countries, elasticity of urbanization to per capita CO2 emission changes. In the range of per capita GDP between 21,000 and 22,000, the elasticity turns to be negative.

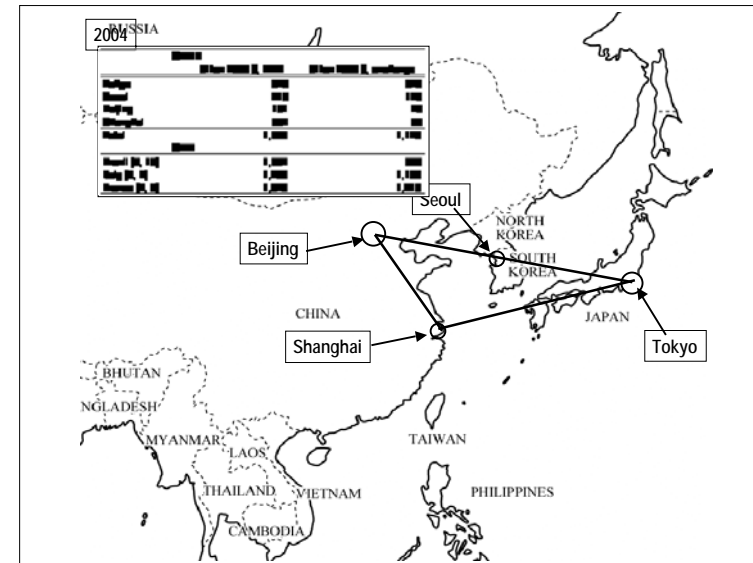


Goals through comparative study

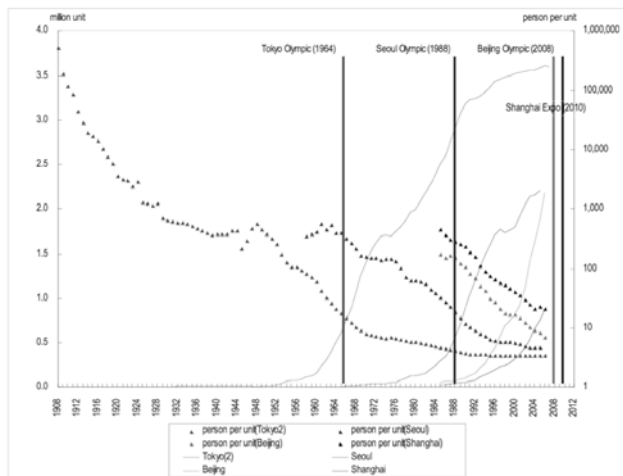
- v To understand dynamic relationships among urbanization, economic development, industrial structure changes, *total* direct CO2 emissions and indirect CO2 emissions of cities.
- v To find common pattern of the relationship between urban transformation and carbon footprint and then identify policy implications toward sustainable cities.

Objective of the study

- v To empirically measure direct and indirect CO2 emissions over the last ten years in Tokyo and Beijing for comparison

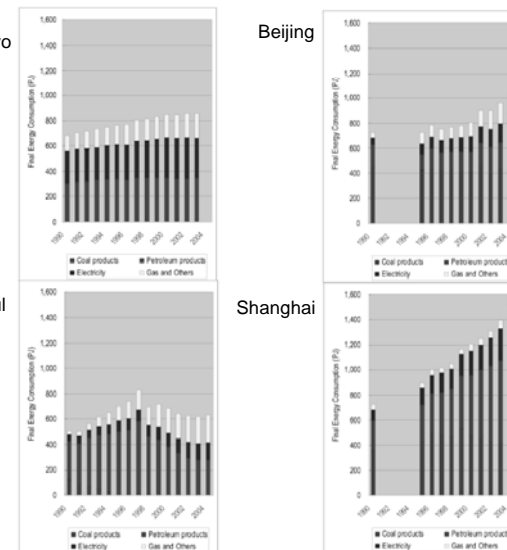


Urban development pattern of East Asian mega-cities (Passenger vehicle ownership)

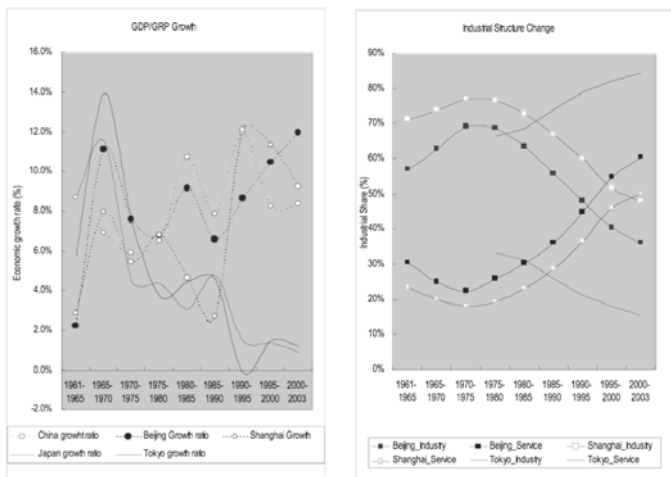


Final Energy Consumption 1990-2004

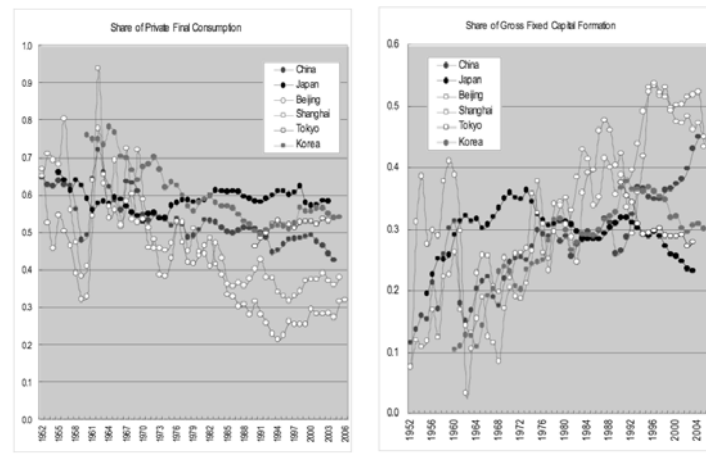
- Coal products
- Petroleum products
- Electricity
- Gas and others



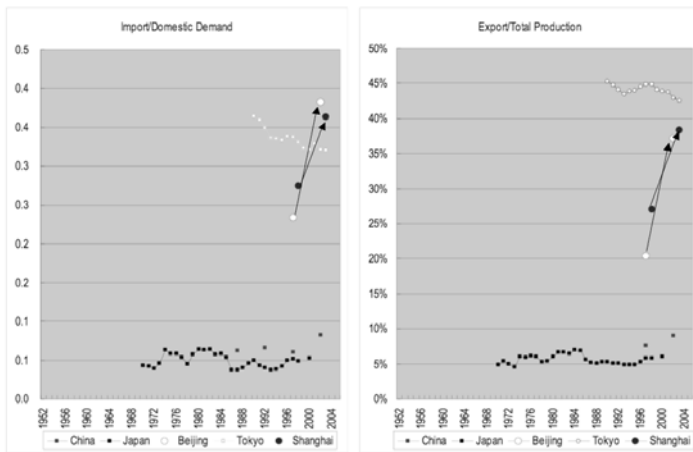
Phase of economic development and industrial transformation



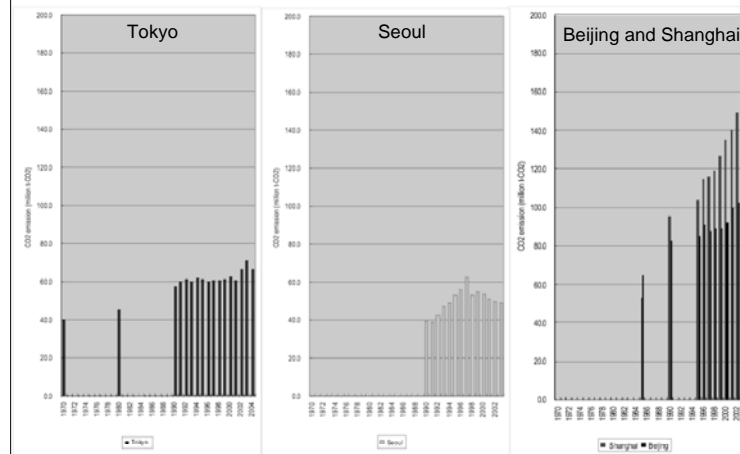
Consumption vs Investment



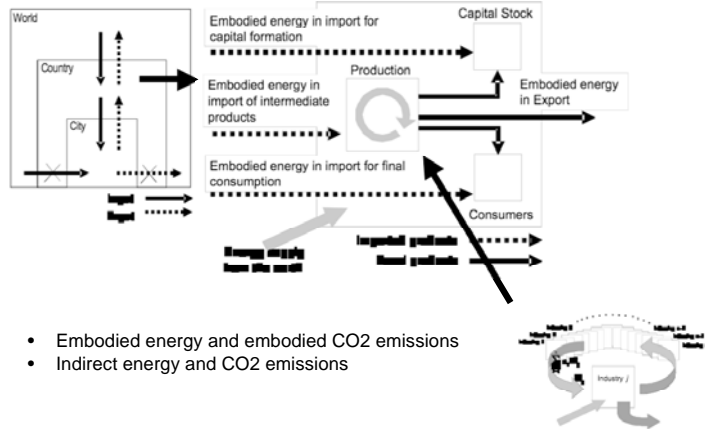
Economic external dependency



CO2 emissions from Tokyo, Beijing, Seoul and Shanghai



Methodological framework: Carbon footprint analysis with regional input-output energy model



- Embodied energy and embodied CO2 emissions
- Indirect energy and CO2 emissions

Model

Embodied carbon Intensity:

National

City

Carbon balance of city:



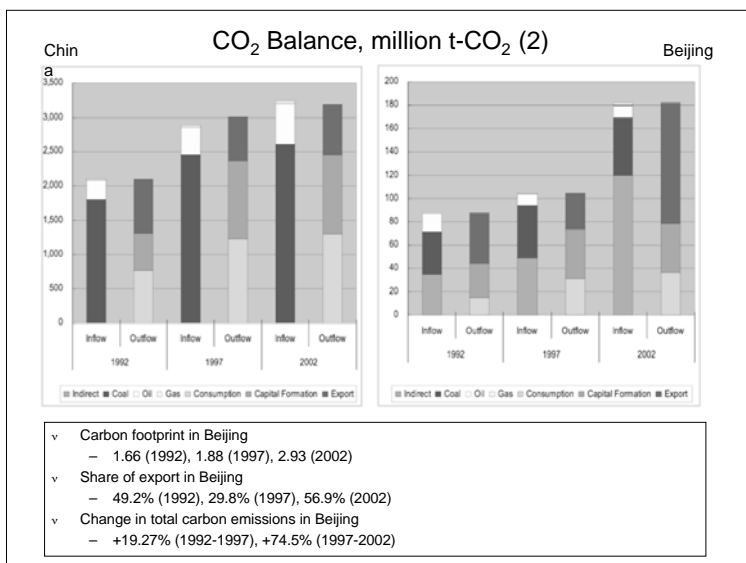
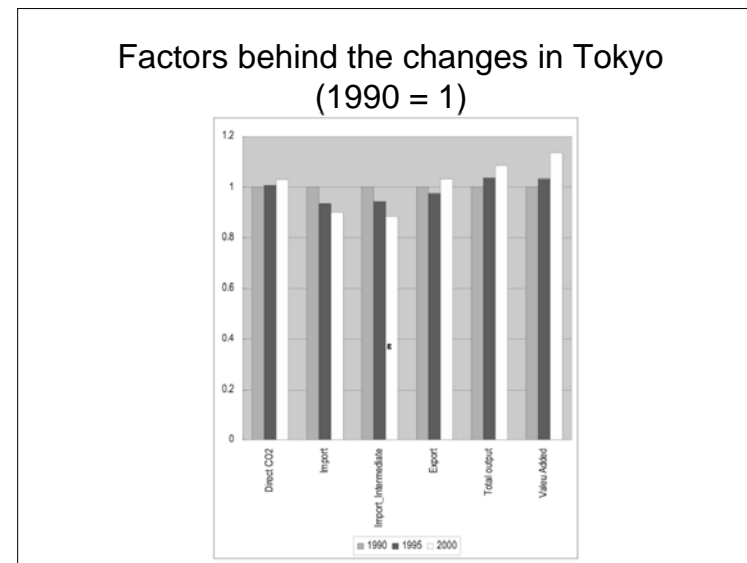
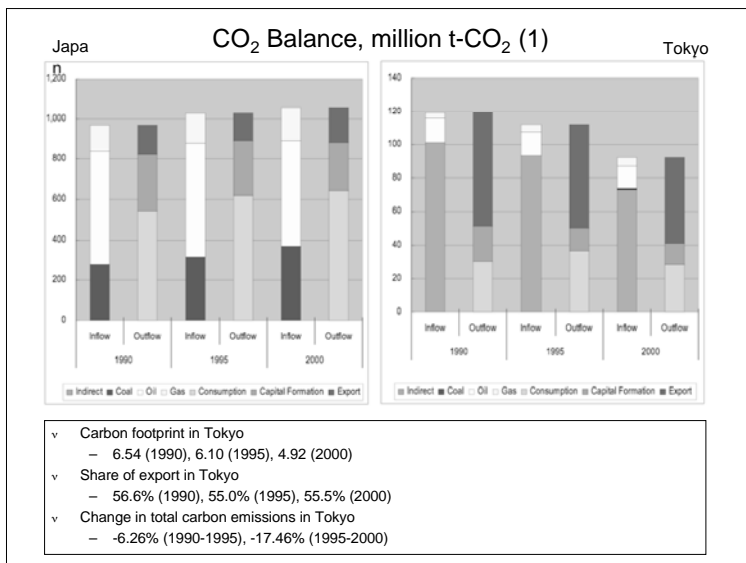
Sectors and years

- | | |
|-----------------------------------|---|
| 1 High-tech | 20 Other manufacturing products |
| 2 Mining | 21 Transportation |
| 3 Metal | 22 Electricity, gas and heat supply |
| 4 Textile | 23 Other energy and waste disposal |
| 5 Wood and timber products | 24 Construction |
| 6 Food and paper | 25 Chemical and allied products |
| 7 Chemical products | 26 Other metal |
| 8 Other chemicals | 27 Other |
| 9 Petroleum and coal products | 28 Energy conversion and transformation |
| 10 Rubber products | 29 Plastic products |
| 11 Mineral products | 30 Nonmetallic mineral |
| 12 Iron and steel | 31 Other, food, waste recovery services |
| 13 Nonferrous metals | 32 Other public services |
| 14 Metal products | 33 Business services |
| 15 Mineral machinery | 34 Personal services |
| 16 Machine machinery | 35 Other and unknown supplies |
| 17 Transportation equipment | 36 Wholesale |
| 18 Other transportation machinery | |
| 19 Machine machinery | |
| 20 Machine products | |

Japan and Tokyo: 1990, 1995, 2000
 China and Beijing: 1992, 1997, 2002

Allocation of carbon contents in cross boundary energy commodities

- √ Thermal electricity and Heat
 - There is no CO2 emissions at the end use
 - Energy inputs and CO2 emissions of generation is allocated to electricity sector.
 - Embodied CO2 emissions in imported electricity is expected to be large.
- √ Other energy commodities
 - Energy and carbon contents are captured at end use sectors.
 - Transformation losses are may not fully captured for the imported commodities.



Some comparisons

- Direct CO₂ emissions
 - Beijing(1992)/Tokyo(1990) 2.88
 - Beijing(1997)/Tokyo(1995) 3.03
 - Beijing(2002)/Tokyo(2000) 3.31
- Total CO₂ emissions (Direct + Indirect)
 - Beijing(1992)/Tokyo(1990) 0.73
 - Beijing(1997)/Tokyo(1995) 0.93
 - Beijing(2002)/Tokyo(2000) 1.97

Summary of findings

- ∨ Beijing directly emit more CO2 than Tokyo and the gap is widening.
- ∨ Tokyo has declined total CO2 emissions including direct and indirect CO2 emissions for the period 1990 and 2000, while Beijing has sharply increased total CO2 emissions from 1997 to 2002 by approx. 75%.
- ∨ Carbon footprint in Tokyo is still high in 2000 as 4.92, while that in Beijing was jumped to 2.93 in 2002 from 1.88 in 1997.
- ∨ Total CO2 emissions in Beijing has surpassed those in Tokyo in late 90s.

Discussions 1

- ∨ Most of electricity is supplied to Tokyo from outside by TEPCO (Tokyo Electric Power Company), where physical and economic transactions may not be consistently same. Therefore, the results here might be underestimated for indirect CO2 emissions in Tokyo.
- ∨ Cross checking is required to validate the robust results between primary supply and final demand of energy commodities, especially electricity and heat.

Discussion 2

- ∨ Cities are efficient in nature?
- ∨ Income effects, efficiency improvement vs urban transformation?
- ∨ Better urbanization?
- ∨ Externality and responsibility?

Thank you for your attention