

Agglomeration Economies and A Test for Optimal City Sizes in Japan

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Two Purposes of the Study

- ◆ Empirical estimates of agglomeration economies
 - Previous estimates
 - » limited to manufacturing industries
include service industries
 - » Jurisdictional data or population density metropolitan data
- ◆ Test whether Tokyo is too large
 - Tokyo has 30 million people
 - » Policy debates on moving the capital out of Tokyo?
 - The Henry George Theorem
 - » Pigouvian subsidy for the agglomeration externalities = total urban differential rent

The Definition of a Metropolitan Area

- SMEA by Yamada and Tokuoka
- FUC by Kawashima
- IMA by Shogo Takeuchi

»Iteration Procedure

- ◆ Integrate two municipalities if doing so increases the rate of internal employment.
If more than one pair exists, choose the one with the highest ratio.
- ◆ The joins of all combinations form new urban areas.
- ◆ Repeat the procedure until no more new integration occurs.

»Integration in relative terms

Tokyo IMA = 33,529,313

Tokyo SMEA = 27,187,116

Construction of IMA-based Data

◆ Sources of original data

–Municipal level data:

- » Number of worker at work place: 1985 Population Census
- » Population: 1985 Population Census

–Prefectural level data

- » Production (Value Added): Annual Report on Prefecture Accounts
- » Private Capital Stock: Ohkawara et. al. (1985)
- » Social Overhead Capital: Ohkawara et. al. (1985)

◆ Construction of IMA data

- » Allocate according to employment shares, etc.

Production Functions

- ◆ production function

$$f(n, k, N, G)$$

$$Y = F(N, K, G)$$

$$F_N(N, K, G) = f_n(n, k, N, G) + mf_N(n, k, N, G)$$

- ◆ Cobb-Douglas

$$Y = AK^\alpha N^\beta G^\gamma$$

- ◆ Modified Cobb-Douglas

$$Y = AK^\alpha N^{1-\alpha} N^{\gamma \ln G}$$

Estimation Results

$$\ln(Y / N) = A_0 + a_1 \ln(K / N) + a_2 \ln N + a_3 \ln(G / N)$$

Parameter	All IMAs (456)	Over 1 Mil. (17)	0.4 - 1 Mil. (34)	2-0.4 Mil. (32)	Under 0.2 M (373)
A_0	0.66 (6.47)	-0.69 (-1.54)	0.62 (0.88)	-2.50 (-1.55)	0.74 (5.89)
a_1	0.57 (12.40)	0.72 (6.30)	0.25 (4.07)	0.58 (6.68)	0.60 (10.11)
a_2	0.01 (3.08)	0.07 (2.75)	0.05 (0.96)	0.24 (1.87)	0.00 (0.06)
a_3	-0.26 (-9.06)	-0.05 (-0.32)	-0.08 (-1.00)	-0.02 (-0.15)	-0.27 (-8.42)
\bar{R}^2	0.40	0.81	0.45	0.63	0.29

$$\ln(Y / N) = A_0 + a_1 \ln(K / N) + a_2 \ln N$$

Parameter	All IMAs (456)	Over 1 Mil. (17)	0.4 - 1 Mil. (34)	0.2-0.4 Mil. (32)	Under 0.2 Mil. (373)
A_0	0.19 (1.95)	-0.77 (-2.13)	0.19 (0.34)	-2.58 (-1.73)	0.37 (2.91)
a_1	0.49 (10.02)	0.72 (6.53)	0.25 (4.05)	0.59 (6.81)	0.47 (7.54)
a_2	0.03 (6.60)	0.07 (2.93)	0.07 (1.58)	0.25 (1.98)	0.01 (1.69)
\bar{R}^2	0.30	0.81	0.43	0.63	0.15

Estimation Results #2

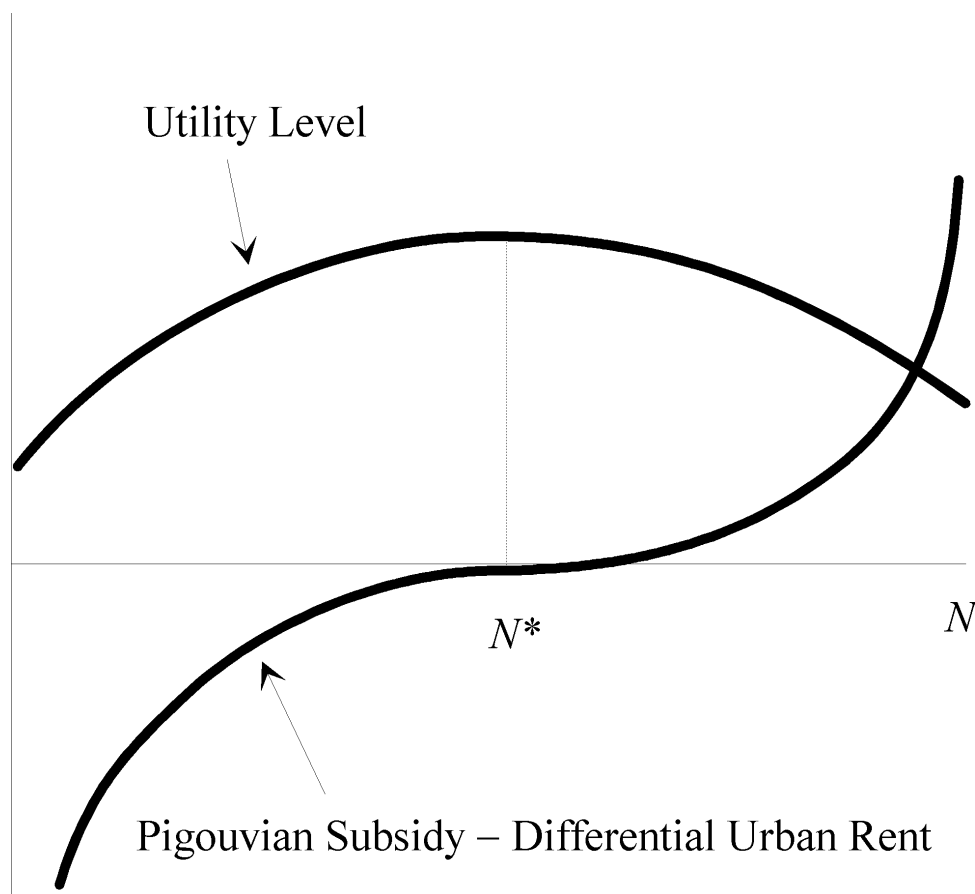
$$\ln(Y / N) = A_0 + a_1 \ln(K / N) + a_2 \ln N \ln G$$

Parameter	All IMAs (456)	Over 1 Mil. (17)	0.4 - 1 Mil. (34)	0.2-0.4 Mil. (32)	Under 0.2 Mil. (373)
A_0	0.31 (3.36)	-0.30 (-1.14)	0.67 (1.99)	-0.95 (-1.16)	0.42 (3.43)
a_1	0.48 (9.87)	0.72 (6.48)	0.25 (4.09)	0.59 (6.70)	0.47 (7.52)
a_2	0.0014 (6.89)	0.0022 (2.89)	0.0023 (1.21)	0.0081 (1.63)	0.0006 (1.61)
\bar{R}^2	0.30	0.81	0.41	0.62	0.15
Scale Economy	0.026	0.040	0.042	0.146	0.010

A Test for Optimal City Sizes

◆ The Henry George Theorem – Pigouvian Subsidy

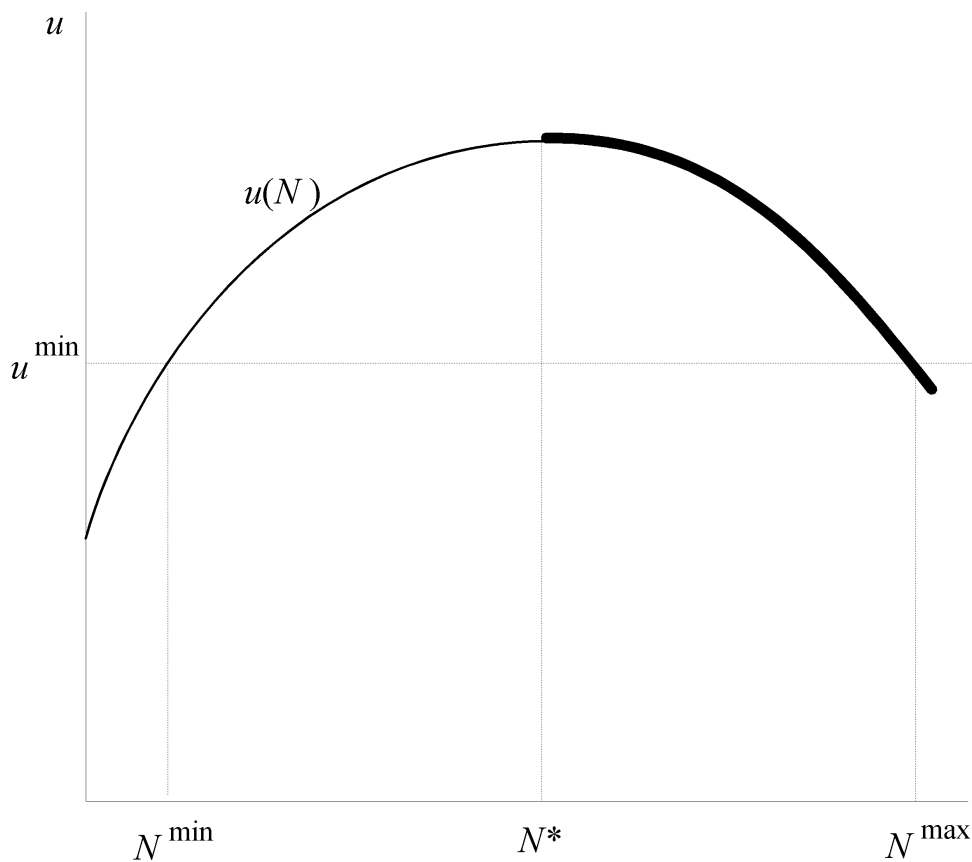
$$PS = Nm \partial f / \partial N = (\alpha + \beta - 1)Y$$



Social Overhead Capital

- ◆ pure local public goods
 - agglomeration benefits =
Pigouvian subsidy + cost of the
local public good
- ◆ impure local public goods
 - only part of the costs of the local
public goods

City sizes tend to be too large



Conjecture

- Divergence from the optimal city size is larger for larger cities.

Construction of Total Land Value Data for IMAs

- ◆ Land Value data
 - Chika Koji (Public Announcement of Land Prices by National Land Agency) for January 1st in 1985
 - Todofuken Chika Chosa (Prefectural Land Price Survey) for July 1st in 1984 and 1985
- ◆ Aggregate Land Values for 7 Types of Land Use Areas
- ◆ For municipalities with small samples, use

$$\ln P = a_0 + \sum_{i=1}^7 a_i D_i + bt$$

The Ratio Between the Total Land Value and the total Pigouvian Subsidy

Cobb-Douglas Case

IMA	Land Value (a)	Pigouvian Subsidy (b)	$\frac{(a)}{(b)}$
Tokyo	1,031,422	7,134	144.6
Osaka	402,241	3,005	133.9
Nagoya	241,461	1,791	134.9
Kyoto	121,256	569	212.9
Sapporo	33,703	336	100.4
Hiroshima	59,898	355	168.6
Fukuoka	34,730	351	99.0
Kitakyushu	46,798	335	139.8
Sendai	25,804	170	152.2
Maebashi	45,055	259	174.1
Yokkaichi	29,884	267	111.9
Okayama	40,196	302	133.0
Kurume	21,651	220	98.3
Shizuoka	33,721	207	162.7
Utsunomiya	36,961	223	165.8
Hamamatsu	46,522	204	228.1
Kumamoto	17,189	153	112.1
Average			145.4

Modified Cobb-Douglas Case

IMA	Land Value (a)	Pigouvian Subsidy (b)	$\frac{(a)}{(b)}$ (b)	Land Value – SOC (c)	$\frac{(c)}{(b)}$ (b)
Tokyo	1,031,422	4,174	247.1	961,531	230.3
Osaka	402,241	1,665	241.6	372,684	223.8
Nagoya	241,461	951	253.9	225,992	237.7
Kyoto	21,256	285	426.1	115,347	405.3
Sapporo	33,703	173	194.3	26,536	153.0
Hiroshima	59,898	178	336.7	54,762	307.9
Fukuoka	34,730	172	202.0	30,711	178.6
Kitakyushu	46,798	164	285.5	43,014	262.4
Sendai	25,804	82	314.0	22,485	273.6
Maebashi	45,055	125	360.1	41,769	333.8
Yokkaichi	29,884	129	231.9	26,770	207.7
Okayama	40,196	149	269.9	36,293	243.7
Kurume	21,651	107	203.1	18,700	175.4
Shizuoka	33,721	98	343.0	31,223	317.6
Utsunomiya	36,961	106	348.5	34,403	324.4
Hamamatsu	46,522	96	482.9	44,204	458.8
Kumamoto	17,189	73	237.1	14,999	206.9
Average			292.8		267.1

Conclusion

- ◆ The magnitudes of agglomeration economies
 - » About 25% for cities with population between 200,000 and 400,000
 - » About 7% for cities with more than 400,000 residents
 - » About 1% for cities with less than 200,000 residents.
- ◆ The coefficient for social overhead capital is either statistically insignificant or negative.

Conclusion #2

- ◆ A test of the Henry George Theorem
 - The total land values are very high compared with the total Pigouvian subsidies in all cities.
 - The ratio for Tokyo is slightly below the average for 17 largest cities in Japan.
 - The absolute difference between the differential urban rent and the Pigouvian subsidy may be extremely large.
- ◆ Elaboration and extension
 - land value estimates
 - A negative coefficient for social overhead capital: Simultaneous equation bias?
 - Microfoundation of agglomeration economies. Second best problems.