Chronological Time-lags over Spatial-cycle Path: Comparative Analysis on Inter-city Agglomeration and Deglomeration of Population in Indonesia, Japan, Sweden and USA

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1. Urban Changes

Urban areas[1] are in general inclined to change dynamically. There would be no question ab that. And yet, this concern would lead us to somehow enthralling wonder of the dynamic proces of urban growth and decline. The primary purpose of the present paper is to obatain an explor insight into this wonder, through the window of analytical method of the ROXY index and theoretical framework of the spatial-cycle hypothesis. With this intention, we first examine spatial redistribution processes of population in a system of approximately thirty largest cities each of Indonesia, Japan, Sweden and the USA. Secondly, based on the results of the abc examination, we investigate the chronological time-lags appearing to exist among the four co tries with respect to spatial-cycle stages observed for their city systems.

In this paper, cities are employed as spatial units[2]. In this conncetion. Table 1 would give useful clarification of the fundamental concepts of four technical terms which are closely associa with our investigation. This table is constructed in a form of two-dimensional matrix. C dimension is dichotomously divided into intra-city (*i.e.*, within a city) and inter-city (*i.e.*, amc cities) elements. Another one is dichotomized into agglomeration (*i.e.*, convergence) and deglome tion (*i.e.*, divergence) elements. As can be explained through the position of each cell in the 2 matrix of Table 1. the term *centralization* would imply the spatial agglomeration of populat within a city towards its innerring zone[3], while the term *decentralization* would imply the spat deglomeration of population within a city from its inner-ring zone towards its outer-ring zone[4]. the term *concentration* would be implied the spatial agglomeration of population in a system

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cities towards larger cities in terms of population size, while by the term *deconcentration* would be implied the spatial deglomeration of population in a system of cities from larger cities towards less-large cities[5].

2. Saptial-cycle Path and ROXY-index Value

The spatial-cycle hypothesis which was originally conceptualized by Klaassen[6], points out the existence of cyclical tendencies underlying the phenomena of urban growth and decline. Table 2 shows the basic skeleton of an outgrowth-version[7] from the original spatial-cycle framework for the study of inter-city analysis. This outgrowth-version has the spatial-cycle path which is composed of four recursively transmuting stages. They are accelerating concentration, decelerating concentration, accelerating deconcentration, and decelerating deconcentration.

One of the indicative instruments to quantitatively trace the course along the spatial-cycle path.

Table 1 Two-dimensional Matrix for Analysis of Spatial Redistribution of City Population

Dimension composed of agglomeration and deglomeration elements / Dimension composed of intra-city and inter-city elements	Spatial agglomeration (*i.e.*, spatial convergence)	Spatial deglomeration (*i.e.*, spatial divergence)
Intra-city phenomena (*i.e.*, phenomena within a city)	Centralization	Decentralization
Inter-city phenomena (*i.e.*, phenomena among cities)	Concentration	Deconcentration

Table 2 Spatial-cycle Framework for a System of Cities: Four Stages in Process of Spatial Concentration and Deconcentration of Population

Spatial redistribution of population	Four stages appearing along spatial-cycle path	
Concentration towards larger cities	Stage-1	Accelerating concentration
	Stage-2	Decelerating concentration
Deconcentration from larger cities	Stage-3	Accelerating deconcentration
	Stage-4	Decelerating deconcentration

Source: Constructed from Kawashima and Hiraoka (1993) would be the ROXY index[8]. A type of the ROXY index which can be used for the inter-city anal is defined as shown in Table 3. This definition applies the population level of each city as weighing factor in calculation of values of the ROXY index.

Table 4 furnishes us with the possible implication[9] on the ROXY-index values. As indicatec this table, the ROXY-index value would be (i) positive and increasing for the stage of accelerat concentration, (ii) positive and decreaing for the stage of decelerating concentration, (iii) nega: and decreasing for the stage of accelerating deconcentration, and (iv) negative and increasing the stage of decelerating deconcentration. The ROXY-index value would be at or in the vicinity zero when the stage of spatial redistribution process is neutral from the phenomena of b concentration and deconcentration. Based on Tables 3 and 4, we can construct Figure 1. T wavelike-cyclic curve in this figure diagrammatically shows the movements of the spatial-cycle p in terms of changes in the ROXY-index values for the inter-city analysis.

3. Spatial-cycle Stages of Four Countries

In order to examine the stages of the spatial-cycle path for a system of cities of Indones Japan, Sweden and the USA respectevely, we applied the ROXY-index approach to the inter-c data obtained from each of the four countries. We initially intended to pick up the thirty larg cities in the year 1980 for Indonesia, Japan and the USA, and those in the year 1987 for Swed

Table 3 Definition of ROXY Index for Inter-city Analysis: With City Population Used a Weighing Factor

$$\text{ROXY Index} = \left(\frac{WAGR_{t,t+1}}{SAGR_{t,t+1}} - 1.0\right) \times 10^4$$

$$= \left\{ \frac{\sum_{i=1}^{n}(x_i^t \times r_i^{t,t+1})}{\sum_{i=1}^{n} x_i^t} \times \frac{n}{\sum_{i=1}^{n} r_i^{t,t+1}} - 1.0 \right\} \times 10^4$$

where

x_i^τ : population of city i in year τ

$r_i^{t,t+1}$: annual growth *ratio* of population in city i for the period between years t and $t+1$, which is defined as the k-th root of x_i^{t+k}/x_i^t

n : number of cities

$WAGR_{t,t+1}$: weighted average of annual growth *ratio* of population in each of n cities for the period between years t and $t+1$, which is equal, in case population level of each city is used as the weighing factor, to $\sum_{i=1}^{n}(x_i^t \times r_i^{t,t+1}) / \sum_{i=1}^{n} x_i^t$

$SAGR_{t,t+1}$: simple average of annual growth *ratio* of population in each of n cities for the period between years t and $t+1$, which is equal to $\sum_{i=1}^{n} r_i^{t,t+1}/n$

However, due to the partial unavailability of consistent time-seriese data, we omitted some cities out of the thirty (30) largest cities in each country. Eventually, we arranged the data, as shown in Tables A1 through A4 in the appendix, twenty five (25) cities in Indonesia (for the period 1961-90), twenty-three (23) cities in Japan (for the period 1960-90), twenty-six (26) cities in Sweden (for the

Table 4 Spatial-cycle Implications of ROXY-Index Values for Inter-city Analysis: With City Population Used as Weighing Factor

A	B	C	D
Sign of ROXY-index value	Pattern of spatial redistribution process of population among cities	State of changes in ROXY-index value	Speed of spatial redistribution process of population among cities
Positive	Concentration	Increasing	Accelerating
		Levelling-off	Constant
		Decreasing	Decelerating
Zero	Neutralilty from both concentration and deconcentration (*viz.* symmetric growth or decline[1])	Increasing	Start of ACon[2]
		Levelling-off	Continuation of neutrality
		Decreasing	Start of ADcon[3]
Negative	Deconcentration	Increasing	Decelerating
		Levelling-off	Constant
		Decreasing	Accelerating

Notes

(1) The spatial redistribution pattern of the 'symmetric growth or decline' conceptually includes the following three sub-patterns:

(i) Balanced growth or decline (BGD): The growth-rate curve is nearly flat, reflecting the fixed share of population by cities.

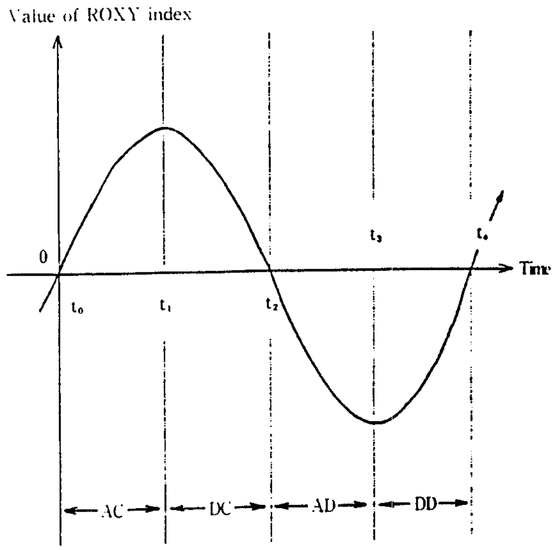
(ii) Bell-shaped growth or decline (BSGD): The growth-rate curve is bellshaped, reflecting the 'medianization' of population over cities of different sizes in population. The 'medianization' means the increases in population share by cities of medium sizes in population and, at the same time, decreases in population share by cities of smaller and larger sizes in population.

(iii) Cup-shaped growth or decline (CSGD): The growth-rate curve is cup-shaped, reflecting the 'bipolarization' of population over cities of different sizes in population. The 'bipolarization' means the increases in population share by smaller and larger cities and, at the same time, decreases in population share by medium-sized cities.

(2) The abbreviatory notation 'ACon' stands for accelerating concentration.

(3) The abbreviatory notation 'ADcon' stands for accelerating deconcentration.

Figure 1 Diagrammatic Movement of Spatial-cycle Path in terms of ROXY-index Value: Wavelike-cyclic Form set for Inter-city Analysis



Notes AC : Stage of accelerating concentration
DC : Stage of decelerating concentration
AD : Stage of accelerating deconcentration
DD : Stage of decelerating deconcentration

period 1950-87) and twenty-nine (29) cities in the USA (for the period 1960-80).

We used the above data to calculate the ROXY-index values. In this calculation, we standardized the value of the ROXY index by employing the annual growth ratio and the level of population at the midpoint in the time segment of data interval. An example of the calculation for the five-year span data, is given by Table 5 to describe our calculation method more concretely. Table 6 shows the computed results of the ROXY-index values as well as the marginal values of the ROXY index.

From this table, we obtain Figure 2. It diagrammatically illustrates, by means of wavelike-cyclic form, the course of the spatial-cycle path followed by the city system of each country. From Table 6, we also obtain Figure 3 which diagrammatically illustrates the spatial-cycle path by means of circular-cyclic form. With the help of these two figures, we might perhaps point out that the values of the ROXY index in Table 6 would suggest the followings.

(1) The city system of Indonesia seems to have been deceleratingly concentrating until the middle of the 1980s. Towards the end of the 1980s, the Indonesian city system appears to have entered into the early stage of accelerating deconcentration[10].

(2) The city system of Japan seems to have been acceleratingly deconcentrating until around the year 1970. Towards the end of the 1980s, the Japanese city system appears to have been approaching the final stage of decelerating deconcentration.

(3) The city system of Sweden seems to have been at the last stage of accelerating deconcentration in the second half of the 1960s. In the second half of the 1980s, the Swedish city system appears to have just completed the stage of decelerating deconcentration and entered into the very early

Table 5 Calculation of ROXY Index Based on Annual Growth Ratio: Example for Five-year Span Data (1980-85)

$$\text{ROXY Index} = \left(\frac{WAGR}{SAGR} - 1.0 \right) \times 10^4$$

where

$$WAGR = \sum_{i=1}^{n} \left(r_i^{\frac{1}{5}} \times \frac{X_{i,2.5}}{\sum_{j=1}^{n} X_{j,2.5}} \right) = \sum_{i=1}^{n} \left(r_i^{\frac{1}{5}} \times \frac{r_i^{\frac{2.5}{5}} \times X_{i,0}}{\sum_{j=1}^{n} \left(r_j^{\frac{2.5}{5}} \times X_{j,0} \right)} \right)$$

$$= \frac{\sum_{i=1}^{n} \left(r_i^{\frac{3.5}{5}} \times X_{i,0} \right)}{\sum_{i=1}^{n} \left(r_i^{\frac{2.5}{5}} \times X_{i,0} \right)}$$

$$= \frac{\sum_{i=1}^{n} \left\{ \left(\frac{X_{i,5}}{X_{i,0}} \right)^{\frac{3.5}{5}} \times X_{i,0} \right\}}{\sum_{i=1}^{n} \left\{ \left(\frac{X_{i,5}}{X_{i,0}} \right)^{\frac{2.5}{5}} \times X_{i,0} \right\}}$$

$$SAGR = \frac{\sum_{i=1}^{n} r_i^{\frac{1}{5}}}{n} = \frac{\sum_{i=1}^{n} \left(\frac{X_{i,5}}{X_{i,0}} \right)^{\frac{1}{5}}}{n}$$

$X_{i,0}$: Population of city i in 1980

$X_{i,5}$: Population of city i in 1985

$X_{i,2.5}$: $\left(\frac{X_{i,5}}{X_{i,0}} \right)^{\frac{2.5}{5}} \times X_{i,0}$

r_i : Five-year growth ratio of city i for the period 1980-1985

Table 6 Values of ROXY Index and Its Marginal Values

(a) ROXY Index for a System of 25 Cities in Indonesia : 1961-90

Period	1961-71	1971-80	1980-90
ROXY	75.3	34.4	−14.6
△ROXY	−4-3	−4.7	−5.2

(b) ROXY Index for a System of 23 Cities in Japan : 1960-90

Period	1960-65	1965-70	1970-75	1975-80	1980-85	1985-90
ROXY	−52.2	−111.6	−109.0	−69.2	−22.3	−18.8
△ROXY	−11.9	−5.7	4.2	8.7	5.0	0.7

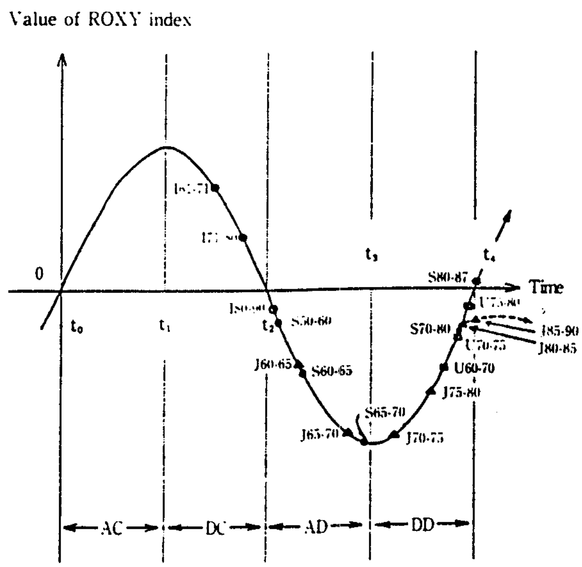
(c) ROXY Index for a System of 26 Cities in Sweden : 1950-87

Period	1950-60	1960-65	1965-70	1970-80	1980-87
ROXY	−44.5	−169.7	−297.3	−99.7	0.2
△ROXY	−16.7	−20.2	5.6	18.7	12.0

(d) ROXY Index for a System of 29 Cities in USA : 1960-80

Period	1960-70	1970-75	1975-80
ROXY	−51.7	−28.0	−11.7
△ROXY	3.2	3.2	3.3

Figure 2 Empirical Results: ROXY Index in Wavelike-cyclic Form



Notes 1. Legend

AC : Stage of accelerating concentration

DC : Stage of decelerating concentration

AD : Stage of accelerating deconcentration

DD : Stage of decelerating deconcentration

○ : Indonesia

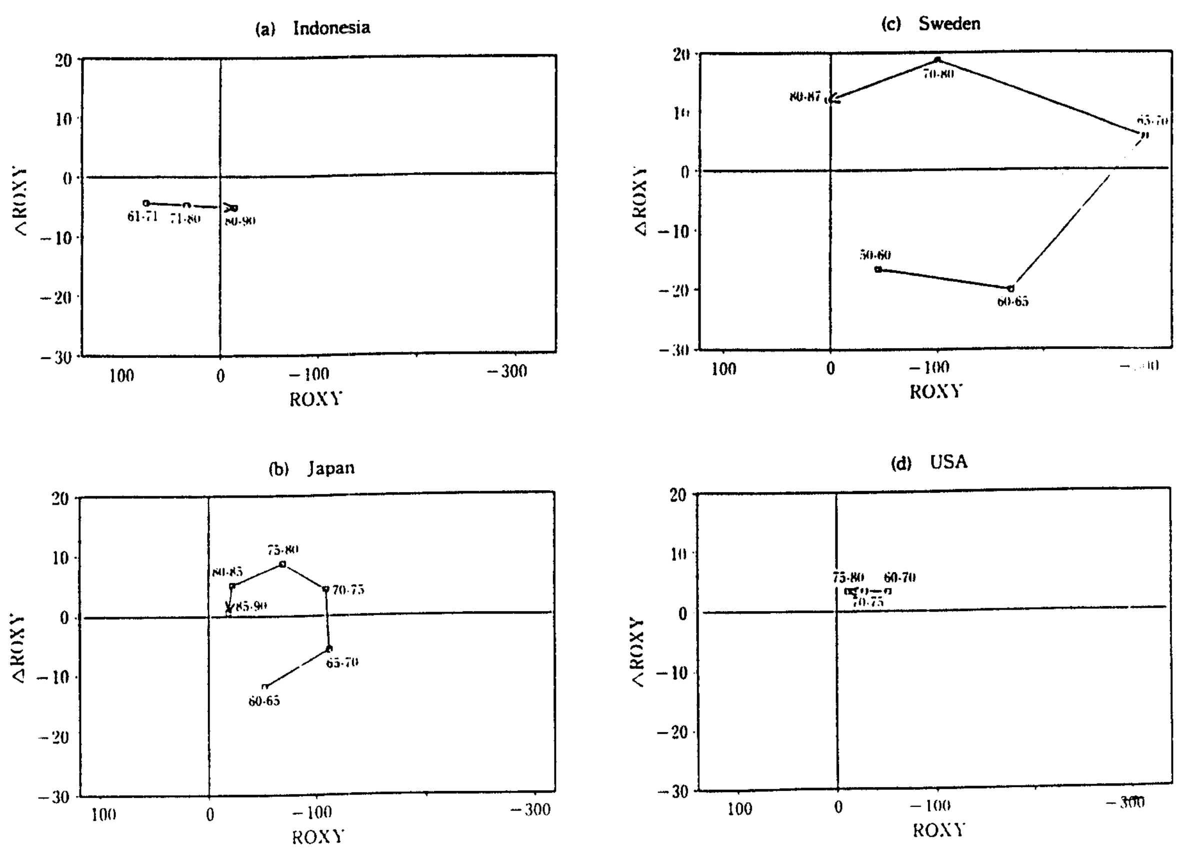
△ : Japan

● : Sweden

□ : USA

2. The scales of the vertical axis are not necessarily identical for all countries.

Figure 3 ROXY Index in Circular-cyclic Form



stage of accelerating concentration again, *videlicet* the very early stage of accelerating *reconcentration*.

(4) The city system of the USA seems to have already been at the advanced stage of decelerating deconcentration in 1960. In the late 1970s, the US city system appears to have been very close to the start of the stage of accelerating concentration, *viz*. acceleration *reconcentration*.

4. Conclusion: Is Urban Drama Predestined ?

In light of the above investigation, the Japanese city system seems to have been behind the US city system by approximately fifteen years along the spatial-cycle path of the population redistrubution. The Indonesian city system seems to have been behind Japan by at least twenty years. Meanwhile, the city system of Sweden seems to have been somewhere between the US and Japan along the spatial-cycle path. In other words, as to the course along the spatial-cycle path, there seems to exist the chronological time-lag of 15 years between the US city system and the Japanese one, and perhaps the time-lag of more than 35 years between the US city system and the Indonesian one.

The knowledge on what has been aforementioned on the time-lags over the spatial-cycle path, might be of some use in making urban policies and plannings. That is, the urban policy-makers in less-advanced countries in terms of the spatial-cycle stages, may be able to avoid repeating the same kinds of mistakes as the more-advanced countries along the spatial-cycle path have already done. Moreover, the less-advanced countries may be able to enjoy precious chances to enhance and reinforce the system and structure for general urban-necessities more timely than more-advanced countries. It is because the former countries can learn valuable lessons as to effective design and implementation of urban policies from the experiences of the latter countries.

The spatial-cycle hypothesis stresses that the basic principle of the spatial-cycle path for the system of cities can hold more or less regardless of social, economic, cultural, political, historical and geographical differences among countries. Somewhat exaggeratingly speaking, urban policy-makers have no choice in making urba plannings but move forward along the spatial-cycle path. They can neither stop the cyclical movement nor change the movement backward. They can however, depending on the purposes and strategies of urban policies, speed up or slow down the velocity of the movement along the spatial-cycle path. Or, they can also manipulate the amplitude of the cyclic curve of the spatial-cycle path, by changing the amplitude shallower or deeper.

Metaphorically speaking, in case you are an urban-policy maker, the title of the urban drama that you are supposed to direct is destined in advance. Only what you can contribute to the urban drama as policy maker, is to direct the play in front of the urban citizen more entertainingly and less boringly. It is as if you had to conduct a predetermined programme of *Othello* but you can not change the programme to *King Lear* even though you would like to choose it. All what you can manage is to create an enthralling scenario of Othello, and to appropriately assign the parts of the play to the available outstanding actors and actresses based on your policy-making ability and prospective visions. In this sense, despite of the presumable existence of the predestined direction of spatial-cycle path that you can not avoid, you can still have a chance to make your own urban policies in such a way that they would significantly increase the well-being of the urban scciety.

Notes

1) The term of urban areas would imply, in this paper, cities, metropoli, or any of other areas of population agglomeration.
2) Among conceivable spatial units, would be neibourhood-communities, census tracts, villages, towns, city centers, cities, urbanized areas, suburbs, metropolitan areas, non-metropolitan areas, megalopolitan areas, rural areas, subnational regions, nations, and sub-global areas.
3) The inner-ring zone is conceptually identical, in this paper, to the city core or city center.
4) The outer-ring zone is conceptually identical, in this paper, to the suburbs or outskirt area.
5) In case metropolitan areas instead of cities are employed as spatial units for investigation, the interpretation of the four terminologies appearing in Table 1 would remain almost similar. The only minor conceptual change, however, is that the boundary line separating the outer-ring zone from inner-ring zone within a metropolitan area tends to be delineated somewhat more outward from the urban center than the boundary-line between the two zones within a city.
6) See Klaassen and Paelinck (1979) and Klaassen *et al.* (1981) for the original concepts of the spatial-cycle framework.
7) See Kawashima and Hiraoka (1993b) for the discussion on the basic features of both original and outgrowth-versions of the spatial-cycle framework.
8) The ROXY index is actually a comprehensive measure useful for general quantitative analyses of spatial-cycle type of redistribution processes of population and other variables on socio-economic activities. For more detailed discussions on this index and results of its emprical applications, see Kawashima (1982, 1985, 1986a, 1986b, 1986c, 1987, 1989) and Kawashima and Hiraoka (1983a, 1983b).
9) When we try to understand implications given in Table 4, it should be kept in mind that conditions provided in column A are *necessary* conditions for their corresponding redistribution-patterns appearing in column B, and that conditions provided in column C are also *necessary* conditions for their corresponding speed-changes appearing in column D.
10) For the discussion on the recent urbanization phenomena as well as on deconcentration tendency of population and other socio-economic activities in Indonesia, see for example Alatas (1992) and Azis (1992).

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Appendix

Table A1 Population Level for 25 Cities in Indonesia: 1961-90

Code	Name	1961	1971	1980	1990
1	Jakarta	2973052	4579303	6503449	8222515
2	Surabaya	1007945	1556255	2027913	2473272
3	Bandung	972566	1200380	1462637	2056915
4	Semarang	503153	646590	1026671	1249230
5	Palembang	474971	582961	787187	1140918
6	Ujung Pandang	384159	434766	709038	944372
7	Malang	341452	422428	511780	695089
8	Surakarta	367626	414285	469888	503827
9	Yogyakarta	312698	341629	398727	412059
10	Banjarmasin	214096	281673	381286	480737
11	Pontianak	150220	217555	304778	397672
12	Balikpapan	91706	137340	280675	344147
13	Samarinda	69715	137782	264718	407174
14	Bogor	154092	195873	247409	271341
15	Jambi	113080	158559	230373	339908
16	Cirebon	158299	178529	223776	254477
17	Kediri	158918	178865	221830	249538
18	Manado	129912	170181	217159	318406
19	Madiun	123373	136147	150562	170050
20	Pematang Siantar	114870	129232	150376	219316
21	Pekalongan	102380	111201	132558	242714
22	Tegal	89016	105752	131728	229553
23	Magelang	96454	110308	123484	123156
24	Sukabumi	80438	96242	109994	119938
25	Probolinggo	68828	82008	100296	176906
	Total	9253019	12605844	17168292	22043230

Table A2 Population Level for 23 Cities in Japan: 1960-90

Code	Name	1960	1965	1970	1975	1980	1985	1990
1	Sapporo	615628	821217	1010123	1240617	1401758	1542979	1671742
2	Utsunomiya	239007	265696	301231	344417	377748	405375	426795
3	Chiba	258357	339850	482133	659344	746428	788930	829455
4	Tokyo	8310027	8893094	8840942	8642800	8349209	8354615	8163573
5	Yokohama	1375510	1788915	2238264	2621648	2773822	2992926	3220331
6	Niigata	325018	356302	383919	423204	457783	475630	486097
7	Kanazawa	313112	335828	361379	395262	417681	430481	442868
8	Gifu	312597	358259	385727	408699	410368	411743	410324
9	Shizuoka	350897	382799	416378	446952	458342	468362	472196
10	Hamamatsu	357098	392632	432221	468886	490827	514131	534620
11	Nagoya	1697093	1935430	2036053	2079694	2087884	2116381	2154793
12	Toyohashi	215515	238672	258547	284597	304274	322142	337982
13	Toyota	104529	136728	197193	248774	281609	308111	332336
14	Kyoto	1284818	1365007	1419165	1461050	1472993	1479218	1461103
15	Osaka	3011563	3156222	2980487	2778975	2648158	2636249	2623801
16	Kobe	1113977	1216640	1288937	1360530	1367392	1410834	1477410
17	Himeji	334520	373653	408353	436099	446255	452917	454360
18	Wakayama	285155	328657	365267	389677	401462	401352	396553
19	Takamatsu	243538	257716	274367	298997	316662	326999	329684
20	Kitakyusyu	986401	1042388	1042321	1058067	1065084	1056402	1026455
21	Oita	207151	226417	260584	320236	360484	390096	408501
22	Kagoshima	334643	371129	403340	456818	505077	530502	536752
23	Naha	223047	257177	276380	295091	295801	303674	304836
	Total	22499201	24840428	26063311	27120434	27437101	28120049	28502567

Table A3 Population Level for 26 Cities in Sweden: 1950-87

Code	Name	1950	1960	1965	1970	1980	1987
1	Stockholm	744143	806903	783643	740486	647214	666810
2	Göteborg	353687	404738	421809	451806	431273	431521
3	Malmö	191783	229388	249161	265505	233803	230838
4	Uppsala	63001	77518	86859	127448	146192	159962
5	Örebro	66839	75434	81788	115695	116969	119066
6	Norrköping	84647	90955	93801	115766	119238	119001
7	Linköping	54512	65237	71652	104642	112600	118602
8	Västeras	59877	77946	89003	116673	117487	117563
9	Jönköping	43766	50652	53309	107768	107561	108962
10	Helsingborg	71572	76574	78769	100559	101956	106982
11	Borås	58019	67069	69528	74545	102129	100395
12	Sundsvall	25706	29493	59340	64920	94742	92721
13	Eskilstuna	53363	59072	63790	94076	90354	88508
14	Gävle	46919	54768	59982	84625	87378	87474
15	Umeå	17107	22623	48858	56151	81088	86816
16	Lund	33828	40380	45670	55986	78487	84342
17	Södertälje	25300	33152	46830	75980	80045	80263
18	Halmstad	35219	39032	41067	47298	76042	77942
19	Karlstad	35625	43064	48318	72467	74068	74892
20	Skellefteå	13971	22730	24609	61912	74210	74091
21	Huddinge	21086	29490	44176	54588	66570	71910
22	Kristianstad	24038	25813	27527	55403	68883	70180
23	Växjö	20100	24041	30363	59028	64661	67350
24	Luleå	22638	30614	34853	58946	66834	66719
25	Nyköping	20427	24250	28303	46772	64099	64428
26	Karlskrona	31218	32977	31688	36405	60141	58650
	Total	2218391	2533913	2714696	3245450	3364024	3425988

Table A4 Population Level for 29 Cities in USA: 1960-80

Code	Name	1960	1970	1975	1980
1	New York	7782000	7896000	7482000	7072000
2	Los Angeles	2479000	2812000	2727000	2967000
3	Chicago	3550000	3369000	3099000	3005000
4	Philadelphia	2003000	1949000	1816000	1688000
5	Detroit	1670000	1514000	1335000	1203000
6	San Francisco	740000	716000	665000	679000
7	Washington	764000	757000	712000	638000
8	Dallas	680000	844000	813000	904000
9	Houston	939000	1234000	1357000	1595000
10	Boston	697000	641000	637000	563000
11	St Louis	750000	622000	525000	453000
12	Pittsburgh	604000	520000	459000	424000
13	Baltimore	939000	905000	852000	787000
14	Minneapolis	434000	434000	378000	371000
15	Atlanta	487000	495000	436000	425000
16	Newark	405000	382000	340000	329000
17	Anaheim	104000	166000	194000	219000
18	Cleveland	876000	751000	639000	574000
19	San Diego	573000	697000	774000	876000
20	Miami	292000	335000	365000	347000
21	Denver	494000	515000	485000	492000
22	Seattle	557000	531000	487000	494000
23	Tampa	275000	278000	280000	272000
24	Riverside	84000	140000	151000	171000
25	Phoenix	439000	582000	665000	790000
26	Cincinnati	503000	453000	413000	385000
27	Milwaukee	741000	717000	666000	636000
28	Kansas City	476000	507000	473000	448000
29	San Jose	204000	460000	556000	629000
	Total	30541000	31222000	297810000	29436000