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Centralization and Suburbanization: ROXY Index Analysis for Five Railway-line Regions in Tokyo Metropolitan Area

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Contents

Abstract

The phenomena of centralization and suburbanization are examined for the five major railway-line regions in the Tokyo metropolitan area during the 1960-90 period. Klaassen's spatial-cycle framework is employed as a theoretical scheme and the ROXY index approach is used as a methodological instrument. The results show that, for the 1985-90 period, the Chuo-line region was at a most advanced stage along the circular path in the spatial-cycle framework, followed by the Tokaido-line, the Sobu-line, the Takasaki-line and the Joban-line regions respectively. In the 1960's, the Takasaki-line region was at a more advanced stage than the Sobu-line region. Their relative order seems to have been reversed around 1980, in the 'spatial-cycle race.' The results also show that the spatial-cycle framework can be improved by adding to it a new interpretation arguing for the existence of the possible spatial-cycle path which would follow the stages of centralization, accelerating suburbanization, decelerating suburbanization, and accelerating resuburbanization (instead of reurbanization).

Key Words

Centralization, Metropolitan Analysis, Population Changes, ROXY Index, Spatial Cycles, Suburbanization, Tokyo, Urban Economics, Urbanization

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1. Introduction: Tokyo Metropolitan Area as Functional Urban Region

It can perhaps be reasonably recognized that the data set of socio-economic variables by metropolitan area would be as equally important as the data by existing administrative area in order to conduct fruitful urban and regional studies. In light of this, it is regrettable that Japan has no officially designated metropolitan areas and that therefore no data have been officially published on metropolitan areas in Japan yet. Taking into account these realities, in the first half of the 1970s, Kawashima delineated with Glickman geographical boundaries of the functional urban regions (FURs)[1] as Japanese metropolitan areas. Based on the 1970 population census data, they set up eighty-five FURs which would correspond conceptually to the Standard Metropolitan Statistical Areas (SMSAs)[2] in the USA. By use of these 1970-version of FURs as spatial units in his investigations, Kawashima has carried out a number of studies[3] of both inter-metropolitan analyses and intra-metropolitan analyses on the spatial redistribution processes of socio-economic activities.

The results of the 1990 population census were recently published. Kawashima *et al.* (1993) have taken this opportunity to delineate the geographical boundaries of the 1990-version of FURs. In their attempt, they built a set of eighty-eight (88) FURs. This set of FURs, comprising 1,607 administratively defined localities, has the total population of 103,635,477 sharing 83.8% of the national population of Japan in 1990. The average population of FURs for the year 1990 was 1,177,676. In the case of the 1970-version of FURs, the set comprises 1,021 administratively defined localities and has the total population of 74,731,359 which shares 71.4% of the national population in 1970. The average population of FURs in 1970 was 889,659.

The 1990-version of FURs reveal that the Tokyo FUR is the largest in terms of population. The Tokyo FUR (1990) consists of 152 administratively defined localities extending over six prefectures (Kanagawa, Tokyo, Saitama, Tochigi, Ibaraki and Chiba prefectures), while the 1970-version of the Tokyo FUR consists of 121 administratively defined localities. In this paper, we investigate the fundamental characteristics of the spatial processes of centralization and suburbanization within the area of the Tokyo FUR. For this purpose, we examine five major railway-line regions situated in the Tokyo FUR: the Chuo-line region, the Takasaki-line region, the Joban-line region, the Tokaido-line region, and the Sobu-line region. In our investigation, we employ as a theoretical scheme the spatial-cycle hypothesis[4] originally conceived by Klaassen (1979) and Klaassen *et al.* (1981), and we choose as a methodological instrument the ROXY index approach[5] developed by Kawashima.

In Section 2, we will discuss population changes in each region for the period between 1960 and 1990. In Section 3, the stages of centralization and suburbanization along the circular path in Klaassen's spatial-cycle framework, will be comparatively investigated over the five railway-line regions[6]. In the concluding section, we administer the Roxyian approach[7],

本論文目次

Table 1 Localities for Five Railway-line Regions

[a] Chuo-line region

Code	Locality
13102	Chuo-ku
13101	Chiyoda-ku
13104	Shinjuku-ku
13113	Shibuya-ku
13114	Nakano-ku
13115	Suginami-ku
13203	Musashino-shi
13204	Mitaka-shi
13210	Koganei-shi
13206	Fuchuh-shi
13214	Kokubunji-shi
13215	Kunitachi-shi
13202	Tachikawa-shi
13212	Hino-shi
13201	Hachioji-shi
14424	Fujino-machi

[b] Takasaki-line region

Code	Locality
13106	Taito-ku
13118	Arakawa-ku
13117	Kita-ku
11203	Kawaguchi-shi
11223	Warabi-shi
11204	Urawa-shi
11220	Yono-shi
11205	Ohmiya-shi
11219	Ageo-shi
11231	Okegawa-shi
11233	Kitamoto-shi
11217	Kohnosu-shi
11304	Fukiage-shi
11206	Gyohda-shi

[c] Joban-line region

Code	Locality
13106	Taito-ku
13118	Arakawa-ku
13121	Adachi-ku
13122	Katsushika-ku
12207	Matsudo-shi
12220	Nagareyama-shi
12217	Kashiwa-shi
12222	Abiko-shi
8217	Toride-shi
8563	Fujishiro-shi
8208	Ryuhgasaki-shi
8219	Ushiku-shi

[d] Tokaido-line region

Code	Locality
13101	Chiyoda-ku
13103	Minato-ku
13109	Shinagawa-ku
13111	Ohta-ku
14132	Saiwai-ku
14131	Kawasaki-ku
14101	Turumi-ku
14102	Kanagawa-ku
14103	Nishi-ku
14106	Hodogaya-ku (including 14112:Asahi-ku)
14110	Totsuka-ku (including 14115:Sakae-ku)
14204	Kamakura-shi
14205	Fujisawa-shi
14207	Chigasaki-shi

本論文目次

Table 1 (Continued)

[e] Sobu-line region

Code	Locality
13101	Chiyoda-ku
13107	Sumida-ku
13106	Taito-ku
13108	Kohtoh-ku
13123	Edogawa-ku
13122	Katsushika-ku
12203	Ichikawa-shi
12204	Funabashi-shi
12216	Narashino-shi
12201	Chiba-shi
12228	Yotsukaido-shi
12212	Sakura-shi
12322	Shisui-shi
12323	Yachimata-shi

to shed a small new light upon the standard interpretation of the spatial-cycle framework.

2. Population Changes of Localities in Five Railway-line Regions in Tokyo Metropolitan Area: Five-year Growth Rates for 1960-90

Table 1 lists the member localities and their local codes for each of the five railway-line regions which we investigate. This table shows that the five regions cover seventy (70) localities in total. They are disaggregated into 16 localities for the Chuo-line region, 14 localities for the Takasaki-line region, 12 localities for the Joban-line region, 14 localities for the Tokaido-line region, and 14 localities for the Sobu-line region.

Table 2 shows the airline distance from the central business district (CBD) of Tokyo city to the center of each locality for five railway-line regions[8]. We will call this distance the CBD distance for each locality. Table 2 also lists populations[9] for each locality of the five regions, for every five year from 1960 to 1990. From this table we can see that the distance from the CBD of Tokyo to the farthest constituent locality is 55.5km for the Chuo-line region (which had a population of 3,041,679 in 1990), 58.0km for the Takasaki-line region (with a population of 2,626,281), 48.0km for the Joban-line region (with a population of 2,658,037), 50.1km for the Tokaido-line region (with a population of 3,667,126), and 49.8km for the Sobu-line region (with a population of 4,038,255).

Table 3 shows the five-year growth rate of population for each locality of the five regions. For the period between 1960-

Table 2 CBD Distance and Population for Localities of Five Railway-line Regions in Tokyo FUC

[a] Chuo-line Region

(unit of distance: km)

Code	Distance	1960	1965	1970	1975	1980	1985	1990
13102	1.1	161,299	128,017	103,850	90,097	82,700	79,973	68,041
13101	2.1	116,944	93,047	74,185	61,656	54,801	50,493	39,472
13104	5.7	413,690	413,910	390,657	367,218	343,928	332,722	296,790
13113	6.1	282,687	283,730	274,491	263,815	247,035	242,442	205,625
13114	9.6	351,360	376,697	378,723	373,075	345,733	335,936	319,687
13115	11.7	487,210	536,792	553,016	560,716	542,449	539,842	529,485
13203	18.5	120,337	133,516	136,959	139,493	136,895	138,783	139,077
13204	18.5	98,038	135,873	155,693	164,852	164,449	166,252	165,564
13210	23.7	45,734	76,350	94,448	102,703	102,412	104,642	105,899
13206	25.8	82,098	126,235	163,173	182,379	191,980	201,972	209,396
13214	27.5	39,098	64,911	81,259	88,155	91,014	95,467	100,982
13215	29.2	32,609	43,477	59,709	64,404	64,154	64,881	65,833
13202	31.0	81,951	100,699	117,057	138,097	142,600	146,523	152,824
13212	33.2	43,394	67,979	98,557	126,754	145,417	156,031	165,928
13201	40.3	164,622	207,753	253,527	322,558	387,162	426,654	466,347
14424	55.5	8,659	8,473	8,295	8,571	9,470	10,186	10,729
Total	——	2,529,730	2,797,459	2,943,599	3,054,543	3,052,199	3,092,799	3,041,679

[b] Takasaki-line Region

(unit of distance: km)

Code	Distance	1960	1965	1970	1975	1980	1985	1990
13106	4.2	318,889	286,324	240,769	207,649	186,048	176,804	162,969
13118	6.7	285,480	278,412	247,013	217,905	198,126	190,061	184,809
13117	8.9	418,603	452,064	431,219	419,996	387,458	367,579	354,647
11203	14.8	173,692	249,112	305,886	345,547	379,357	403,015	438,680
11223	18.0	50,952	69,715	77,225	76,312	70,876	70,408	73,620
11204	23.2	174,437	221,323	269,397	331,145	358,180	377,235	418,271
11220	26.0	40,840	51,746	62,802	71,045	72,326	70,597	79,060
11205	28.0	169,996	215,646	268,777	327,696	354,082	373,022	403,776
11219	36.5	38,889	54,776	110,792	146,359	166,244	178,587	194,947
11231	40.2	21,309	28,108	38,717	48,034	55,746	61,499	69,029
11233	44.0	15,483	20,576	31,699	46,632	50,888	58,114	63,929
11217	48.0	31,868	36,526	41,990	51,632	57,085	60,565	72,435
11304	54.5	12,095	14,482	17,247	18,775	22,606	24,990	26,928
11206	58.0	54,746	56,152	60,135	66,069	73,205	79,359	83,181
Total	——	1,807,279	2,034,962	2,203,668	2,374,796	2,432,227	2,491,835	2,626,281

本論文目次

Table 2 (Continued)

[c] Joban-line Region

(unit of distance: km)

Code	Distance	1960	1965	1970	1975	1980	1985	1990
13106	4.2	318,889	286,324	240,769	207,649	186,048	176,804	162,969
13118	6.7	285,480	278,412	247,013	217,905	198,126	190,061	184,809
13121	8.4	408,768	514,717	571,791	609,025	619,961	622,640	631,163
13122	10.5	376,724	446,059	462,954	442,328	420,187	419,017	424,801
12207	17.8	86,372	160,001	253,591	344,552	400,870	427,443	456,210
12220	23.5	25,672	39,166	56,485	82,936	106,635	124,682	140,059
12217	28.6	63,745	109,239	150,635	203,063	239,199	273,128	305,058
12222	31.7	27,063	33,216	49,240	76,218	101,061	111,659	120,628
8217	36.5	22,582	26,179	40,287	52,821	71,246	78,608	81,665
8563	41.4	12,606	13,002	16,309	20,407	26,464	29,757	32,744
8208	45.6	33,581	34,917	37,267	40,569	43,131	48,857	57,238
8219	48.0	16,131	17,203	19,372	27,674	40,170	51,926	60,693
Total	——	1,677,613	1,958,435	2,145,713	2,325,147	2,453,098	2,554,582	2,658,037

[d] Tokaido-line Region

(unit of distance: km)

Code	Distance	1960	1965	1970	1975	1980	1985	1990
13101	2.1	116,944	93,047	74,185	61,656	54,801	50,493	39,472
13103	2.4	267,024	241,539	223,978	209,492	201,257	194,591	158,499
13109	8.1	427,859	423,015	397,302	366,058	346,247	357,732	344,611
13111	11.6	706,219	755,535	734,990	691,337	661,147	662,814	647,914
14132	15.6	632,975[1)]	854,866[1)]	155,549	148,756	138,585	137,306	142,320
14131	16.9	632,975[1)]	854,866[1)]	251,906	216,569	199,148	193,954	200,056
14101	19.8	230,377	255,755	256,403	242,808	231,477	237,083	250,100
14102	24.9	172,068	196,559	207,319	213,654	201,794	188,952	194,506
14103	27.6	104,173	104,352	97,906	89,015	80,539	78,858	76,978
14106	28.0	143,804	229,724	327,953	377,337	390,747	419,468	432,585
14110	37.1	113,514	155,645	248,696	339,420	401,973	444,116	453,773
14204	44.3	98,617	118,329	139,249	165,552	172,629	175,495	174,307
14205	44.9	124,601	175,183	228,978	265,975	300,248	328,387	350,330
14207	50.1	68,054	100,081	129,621	152,023	171,016	185,030	201,675
Total	——	3,206,229	3,703,630	3,474,035	3,539,652	3,551,608	3,654,279	3,667,126

[Note] 1) These figures are for the population of Kawasaki-shi. Saiwai-ku (14132) and Kawasaki-ku (14131) were designated as *ku* (ward) in April 1972. Before that, each of them was simply a part of Kawasaki-shi, and therefore their population statistics are not available from the national population census for the years 1960 and 1965.

Table 2 (Continued)

[e] Sobu-line Region

(unit of distance: km)

Code	Distance	1960	1965	1970	1975	1980	1985	1990
13101	2.1	116,944	93,047	74,185	61,656	54,801	50,493	39,472
13107	3.8	331,843	317,856	281,237	250,714	232,796	229,986	222,944
13106	4.2	318,889	286,324	240,769	207,649	186,048	176,804	162,969
13108	4.9	351,053	359,672	355,835	355,382	362,270	388,927	385,159
13123	10.0	316,593	405,139	446,758	473,656	495,231	514,812	565,939
13122	10.5	376,724	446,059	462,954	442,328	420,187	419,017	424,801
12203	16.8	157,301	207,988	261,055	319,272	364,244	397,822	436,596
12204	20.0	135,038	223,989	325,426	423,160	479,437	506,966	533,270
12216	24.0	42,167	64,477	99,951	117,851	125,154	136,365	151,471
12201	31.7	241,615	332,188	482,133	659,356	746,430	788,930	829,455
12228	36.5	16,623	19,778	26,375	37,401	59,236	67,008	72,157
12212	41.7	36,869	40,941	60,433	80,804	101,180	121,213	144,688
12322	45.8	6,093	6,040	6,259	8,465	12,807	17,463	19,298
12323	49.8	25,387	25,173	25,357	28,511	31,939	37,532	50,036
Total	——	2,473,139	2,828,671	3,148,727	3,466,205	3,671,760	3,853,338	4,038,255

65, Matsudo-shi of the Joban-line region attained the highest five-year growth rate (85.25%) among all seventy localities. For the same period, Chuo-ku of the Chuo-line region indicated the lowest five-year growth rate (−20.63%). For the period 1985-90, on the other hand, Yachimata-shi of the Sobu-line region attained the highest five-year growth rate (33.32%) while Chiyoda-ku (which is included in the Chuo-line region, the Tokaido-line region and the Sobu-line region as well) indicated the lowest five-year growth rate (−21.83%). Comparing the five railway-line regions for the period 1960-65, the Joban-line region as a whole attained the highest growth rate (16.74%), while the Chuo-line region as a whole indicated the lowest five-year growth rate (10.58%). For the period 1985-90, the Takasaki-line region as a whole attained the highest five-year growth rate (5.40%), while the Chuo-line region as a whole indicated the lowest five-year growth rate (−1.65%).

Keeping in mind this background information on the five railway-line regions, Figure 1 can be constructed from Table 3. This figure provides us with five-year growth-rate curves for the six five-year periods by railway-line region. Through these curves, we can visually understand, on both temporal and spatial bases, the population changes in the level of the five-year growth rate for each railway-line region. It would be worthwhile to notice in this figure the three *general* characteristics of growth-rate curves for each railway-line region, as follows:

(1) As time goes by, the peak point of the growth-rate curve shifts from localities with a shorter CBD distance to localities with a longer CBD distance (i.e., the exis-

Table 3 Five-year Growth Rates (%) of Population for Localities of Five Railway-line Regions in Tokyo

[a] Chuo-line Region

(unit of distance: km)

Code	Distance	1960-1965	1965-1970	1970-1975	1975-1980	1980-1985	1985-1990
13102	1.1	-20.63	-18.88	-13.24	-8.21	-3.30	-14.92
13101	2.1	-20.43	-20.27	-16.89	-11.12	-7.86	-21.83
13104	5.7	0.05	-5.62	-6.00	-6.34	-3.26	-10.80
13113	6.1	0.37	-3.26	-3.89	-6.36	-1.86	-15.19
13114	9.6	7.21	0.54	-1.49	-7.33	-2.83	-4.84
13115	11.7	10.18	3.02	1.39	-3.26	-0.48	-1.92
13203	18.5	10.95	2.58	1.85	-1.86	1.38	0.21
13204	18.5	38.59	14.59	5.88	-0.24	1.10	-0.41
13210	23.7	66.94	23.70	8.74	-0.28	2.18	1.20
13206	25.8	53.76	29.26	11.77	5.26	5.20	3.68
13214	27.5	66.02	25.19	8.49	3.24	4.89	5.78
13215	29.2	33.33	37.33	7.86	-0.39	1.13	1.47
13202	31.0	22.88	16.24	17.97	3.26	2.75	4.30
13212	33.2	56.66	44.98	28.61	14.72	7.30	6.34
13201	40.3	26.20	22.03	27.23	20.03	10.20	9.30
14424	55.5	-2.15	-2.10	3.33	10.49	7.56	5.33

[b] Takasaki-line Region

(unit of distance: km)

Code	Distance	1960-1965	1965-1970	1970-1975	1975-1980	1980-1985	1985-1990
13106	4.2	-10.21	-15.91	-13.76	-10.40	-4.97	-7.83
13118	6.7	-2.48	-11.28	-11.78	-9.08	-4.07	-2.76
13117	8.9	7.99	-4.61	-2.60	-7.75	-5.13	-3.52
11203	14.8	43.42	22.79	12.97	9.78	6.24	8.85
11223	18.0	36.82	10.77	-1.18	-7.12	-0.66	4.56
11204	23.2	26.88	21.72	22.92	8.16	5.32	10.88
11220	26.0	26.70	21.37	13.13	1.80	-2.39	11.99
11205	28.0	26.85	24.64	21.92	8.05	5.35	8.24
11219	36.5	40.85	102.26	32.10	13.59	7.42	9.16
11231	40.2	31.91	37.74	24.06	16.06	10.32	12.24
11233	44.0	32.89	54.06	47.11	9.13	14.20	10.01
11217	48.0	14.62	14.96	22.96	10.56	6.10	19.60
11304	54.5	19.74	19.09	8.86	20.40	10.55	7.76
11206	58.0	2.57	7.09	9.87	10.80	8.41	4.82

本論文目次

Table 3 (Continued)

[c] Joban-line Region

(unit of distance: km)

Code	Distance	1960-1965	1965-1970	1970-1975	1975-1980	1980-1985	1985-1990
13106	4.2	-10.21	-15.91	-13.76	-10.40	-4.97	-7.83
13118	6.7	-2.48	-11.28	-11.78	-9.08	-4.07	-2.76
13121	8.4	25.92	11.09	6.51	1.80	0.43	1.37
13122	10.5	18.40	3.79	-4.46	-5.01	-0.28	1.38
12207	17.8	85.25	58.49	35.87	16.35	6.63	6.73
12220	23.3	52.57	44.21	46.83	28.58	16.92	12.33
12217	28.6	71.37	37.89	34.80	17.80	14.18	11.69
12222	31.7	22.74	48.24	54.79	32.59	10.49	8.03
8217	36.5	15.93	53.89	31.11	34.88	10.33	3.89
8563	41.4	3.14	25.43	25.13	29.68	12.44	10.04
8208	45.6	3.98	6.73	8.86	6.32	13.28	17.15
8219	48.0	6.65	12.61	42.86	45.15	29.27	16.88

[d] Tokaido-line Region

(unit of distance: km)

Code	Distance	1960-1965	1965-1970	1970-1975	1975-1980	1980-1985	1985-1990
13101	2.1	-20.43	-20.27	-16.89	-11.12	-7.86	-21.83
13103	2.4	-9.54	-7.27	-6.47	-3.93	-3.31	-18.55
13109	8.1	-1.13	-6.08	-7.86	-5.41	3.32	-3.67
13111	11.6	6.98	-2.72	-5.94	-4.37	0.25	-2.25
14132	15.6	35.06[1)]	13.88[1)]	-4.37	-6.84	-0.92	3.65
14131	16.9	35.06[1)]	13.88[1)]	-14.03	-8.04	-2.61	3.15
14101	19.8	11.02	0.25	-5.30	-4.67	2.42	5.49
14102	24.9	14.23	5.47	3.06	-5.55	-6.36	2.94
14103	27.6	0.17	-6.18	-9.08	-9.52	-2.09	-2.38
14106	28.0	59.75	42.76	15.06	3.55	7.35	3.13
14110	37.1	37.12	59.78	36.48	18.43	10.48	2.17
14204	44.3	19.99	17.68	18.89	4.27	1.66	-0.68
14205	44.9	40.60	30.71	16.16	12.89	9.37	6.68
14207	50.1	47.06	29.52	17.28	12.49	8.19	9.00

[Note] 1) These figures are for the population of Kawasaki-shi. Saiwai-ku (14132) and Kawasaki-ku (14131) were designated as *ku* (ward) in April 1972. Before that, each of them was simply a part of Kawasaki-shi, and therefore their population statistics are not available from the national population census for the years 1960 and 1965.

本論文目次

Table 3 (Continued)

[e] Sobu-line Region

(unit of distance: km)

Code	Distance	1960-1965	1965-1970	1970-1975	1975-1980	1980-1985	1985-1990
13101	2.1	-20.43	-20.27	-16.89	-11.12	-7.86	-21.83
13107	3.8	-4.21	-11.52	-10.85	-7.15	-1.21	-3.06
13106	4.2	-10.21	-15.91	-13.76	-10.40	-4.97	-7.83
13108	4.9	2.46	-1.07	-0.13	1.94	7.36	-0.97
13123	10.0	27.97	10.27	6.02	4.55	3.95	9.93
12203	15.7	32.22	25.51	22.31	14.08	9.22	9.75
12204	19.5	65.87	45.29	30.01	13.32	5.74	5.19
12216	23.5	53.90	54.01	17.91	6.20	8.96	11.08
12201	31.7	37.49	45.14	36.76	13.21	5.69	5.14
12228	36.5	18.98	33.36	41.80	58.38	13.12	7.68
12212	41.7	11.04	47.61	33.71	25.22	19.80	19.37
12322	45.8	-0.87	3.63	35.25	51.29	36.36	10.51
12323	49.8	-0.84	0.73	12.44	12.02	17.51	33.32

tence of the tendency for the peak point to move outwards)[10].

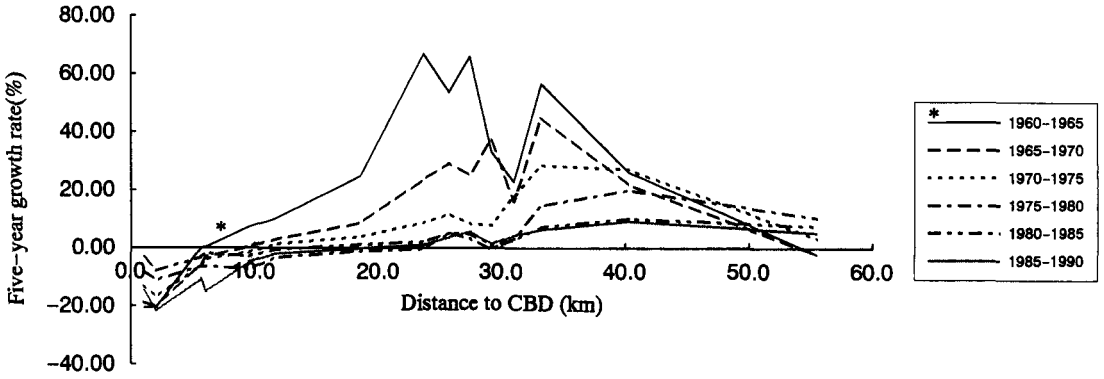
(2) As time goes by, the peak point of the growth-rate curve gradually becomes lower (i.e., the existence of a reductive tendency in maximum growth-rate value)[11].

(3) As time goes by, the growth-rate curve levels off (i.e., the existence of a flattening tendency of the growth-rate curve)[12].

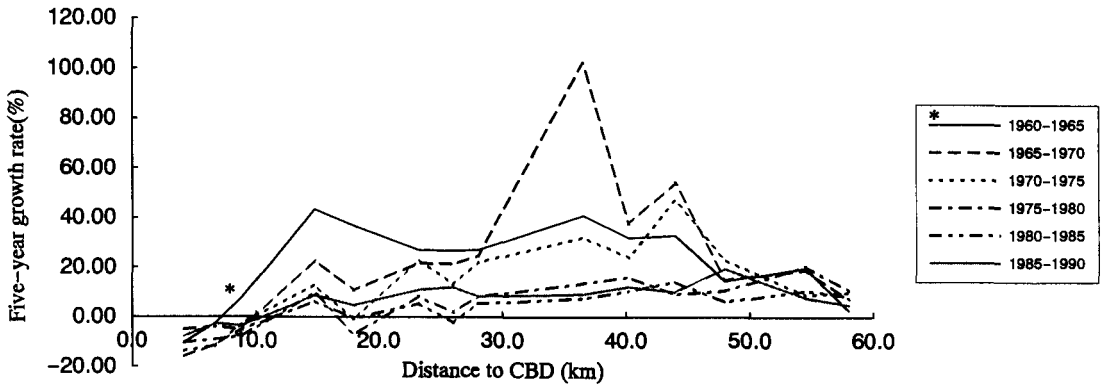
This figure can also help us notice the following features as *individual* characteristics of growth-rate curves for each railway-line region:

(1) Chuo-line region; (i) For the 1960-65 and 65-70 periods the growth-rate curve is characterized by a deep valley at its center (i.e., a deep midpoint valley). This valley corresponds to Tachikawa-shi (with CBD distance 31.0km) with five-year growth rates of 22.88% for the former period, and 16.24% for the latter period. (ii) For the 1985-90 period, the four nearest localities to the CBD of Tokyo city (with CBD distance varying from 1.1km through 6.1km) show negative five-year growth rates all of which are less than −10% (in the range of −21.83% to −10.80%). (iii) For the 1985-90 period, the growth-rate curve dips to a relatively shallow midpoint valley with the bottom close to zero altitude. This valley corresponds to Kunitachi-shi (with CBD distance 29.2km) with a five-year growth rate of 1.47% for the period.

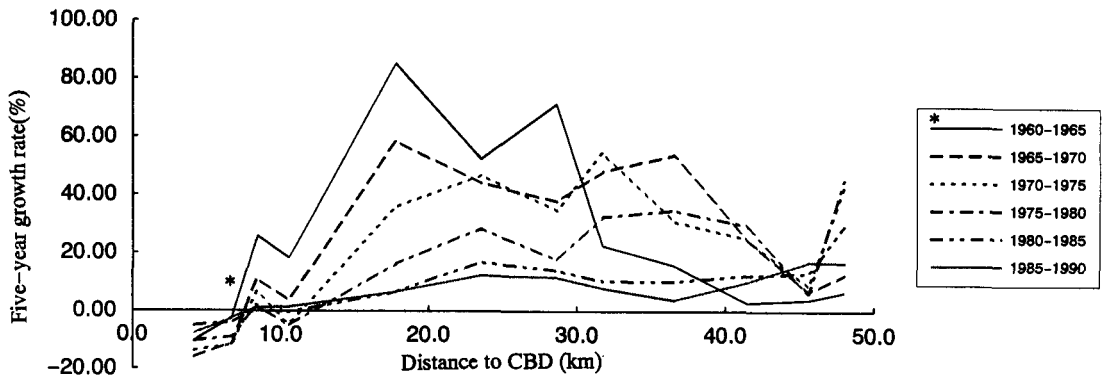
(2) Takasaki-line region; The five-year growth rate of Ageo-shi (with CBD distance 36.5km) for the 1965-70 period



(a) Chuo-line Region



(b) Takasaki-line Region



(c) Joban-line Region

Figure 1 Five-year Growth-rate Curves for Five Railway-line Regions in Tokyo FUR

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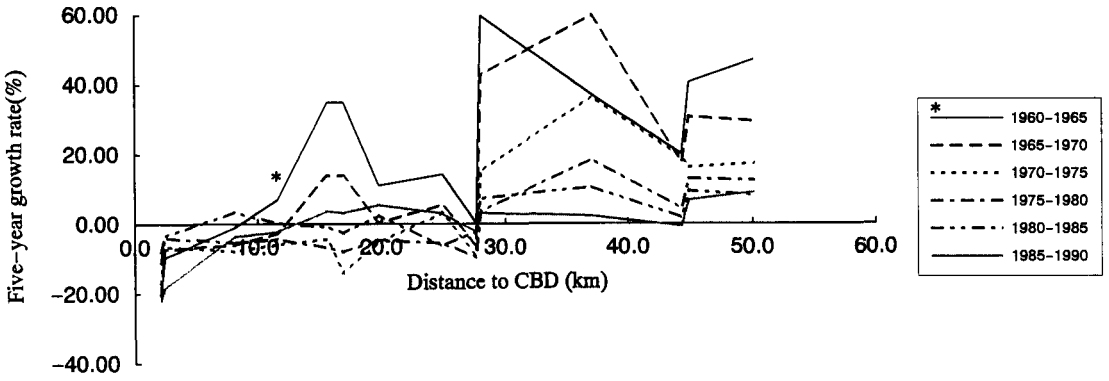
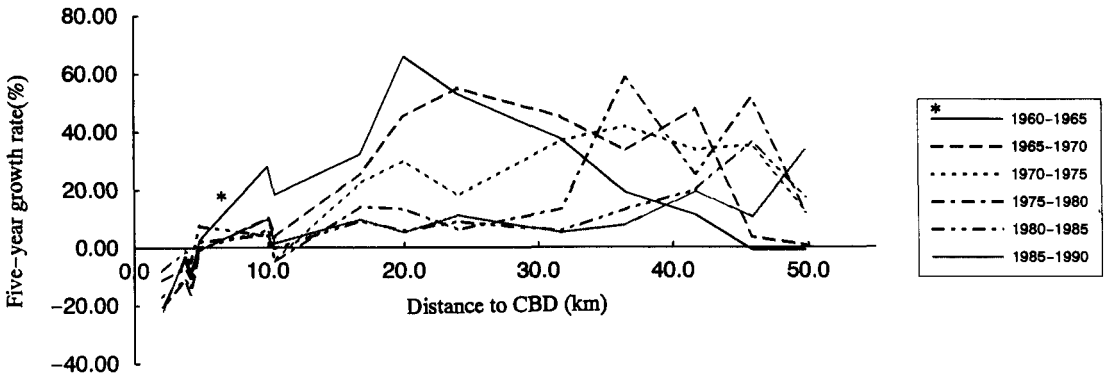


(d) Tokaido-line Region



(e) Sobu-line Region

Figure 1 (Continued)

(102.26%) is unusually high. This growth rate is the highest among the growth rates appearing in Table 3, and counteracts the second general characteristics of the growth-rate curves (i.e., the reductive tendency in maximum growth-rate value).

(3) Joban-line region; (i) For all six of the five-year periods, the growth rate of Ushiku-shi which has the longest CBD distance (48.0km) in the Joban-line region, was always significantly higher than that of Ryugasaki-shi (with CBD distance 45.6km), which is the second farthest locality in this region. That is, the right-hand tail of the growth-rate curve turns up for each of the six periods. (ii) For the 1985-90 period, there exists a shallow midpoint valley, in the growth-rate curve, with an altitude of nearly zero. This valley corresponds to Toride-shi (with CBD distance 36.5km) with a five-year growth rate of 3.89%.

(4) Tokaido-line region; (i) For the 1960-65 and 65-70 periods, there exists a deep midpoint valley and a relatively deep outlying vally in the growth-rate curve. The midpoint valley corresponds to Nishi-

ku (with CBD distance 27.6km) of Yokohama city, with a five-year growth rates of 0.17% for the former period and −6.18% for the latter period. The outlying valley corresponds to Kamakura-shi (with CBD distance 44.3km) with a five-year growth rates of 19.99% for the former period and 17.68% for the latter period. (ii) The 1985-90 period shows, in the growth-rate curve, a shallow midpoint valley and a shallow outlying valley whose bottoms both have a negative altitude. They correspond respectively to Nishi-ku with a five-year growth rate of −2.38%, and Kamakura-shi with a five-year growth rate of −0.68%.

(5) Sobu-line region; For the 1985-90 period, the five-year growth rate of Yachimata-shi (33.32%), which has the longest CBD distance (49.8km) in the Sobu-line region, is distinctly higher than any five-year growth rate shown by those localities with the largest CBD distance in each of the railway-line regions (5.33% for Fujinomachi with CBD distance 55.5km in the Chuo-line region, 4.82% for Gyoda-shi with CBD distance 58.0km in the Takasaki-line region, 16.88% for Ushiku-shi with CBD distance 48.0km in the Joban-line region, and 9.00% for Chigasaki-shi with CBD distance 50.1km in the Tokaido-line region).

Taking into consideration the nature of this investigation and Klaassen's spatial-cycle framework[13] together, it can be tentatively pointed out that the aforementioned three general characteristics of the growth-rate curves (i.e., the outward-movement tendency, the reductive-tendency, and the flattening tendency) would suggest the following possibilities as to the development of centralization and suburbanization processes of population in the five railway-line regions of the Tokyo FUR during the 1960-90 period:

(1) A movement from the stage of centralization to that of suburbanization seems to have taken place for all the railway-line regions.
(2) A movement from the stage of accelerating suburbanization to that of decelerating suburbanization seems to have taken place for most of the railway-line regions.
(3) A movement from the stage of suburbanization to that of recentralization may not have taken place yet for any of the railway-line regions.

Now we want to ascertain whether or not these possibilities would, to a reasonable degree, reflect real phenomena. Therefore let us examine in the next section the changes in the values of the ROXY index for the five railway-line regions; doing so will facilitate a clearer understanding of the spatial redistribution processes of population in the five railway-line regions.

3. Changes in Values of ROXY Index for Five Railway-line Regions: Spatial-cycle Race for 1960-90

From Table 3, we obtain the annual growth ratios[14] of population for localities of the five railway-line regions in the Tokyo FUR as shown by Table A-2 in the appendix. Based on Table A-2 which also furnishes us with the data on the CBD distance for each locality of the five

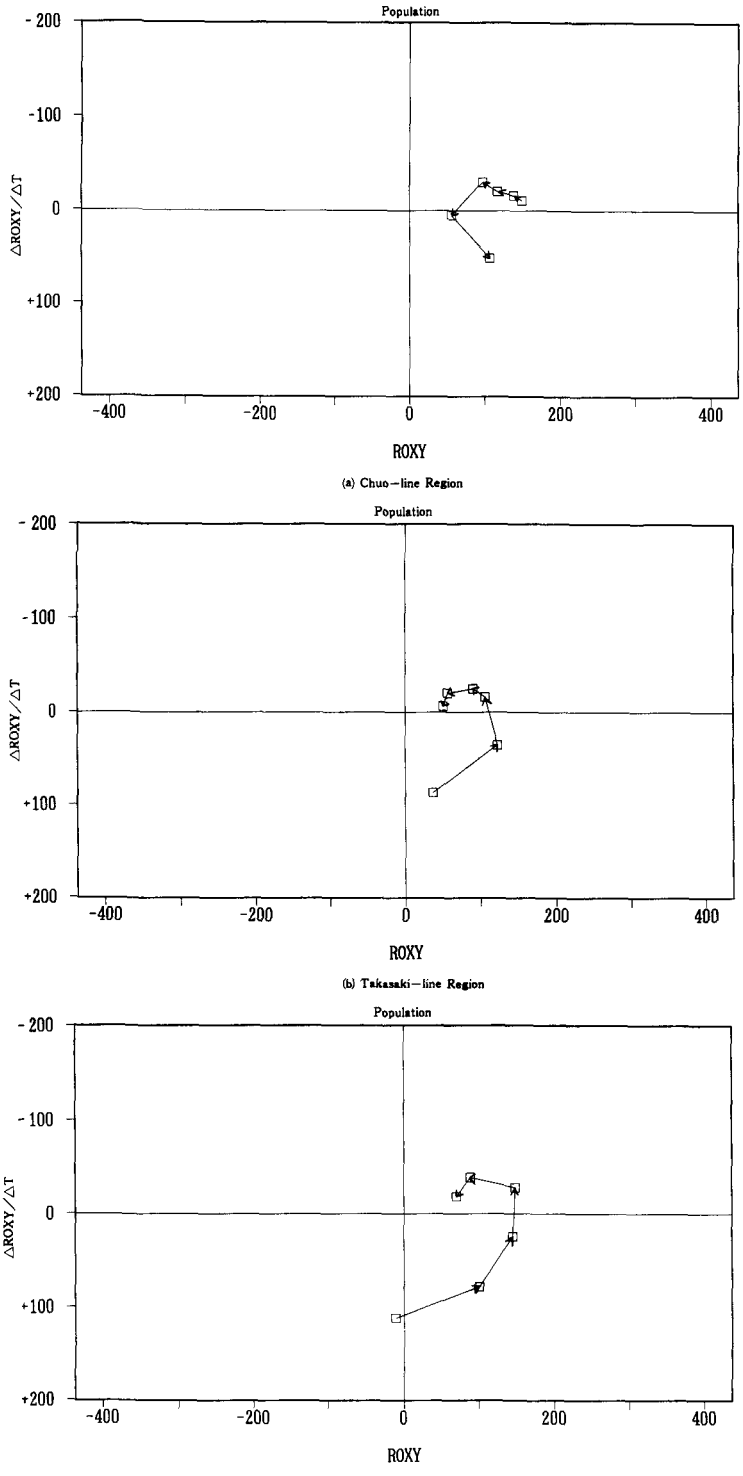


Figure 2 Locus of Spatial-cycle Path for Five Railway-line Regions in Tokyo FUR

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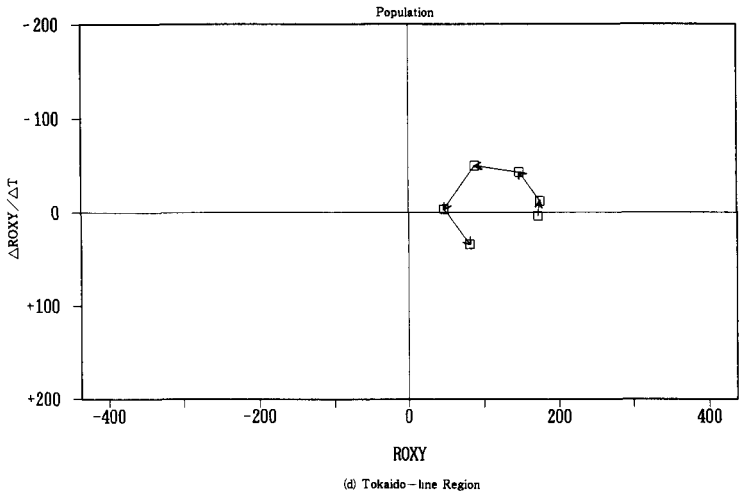
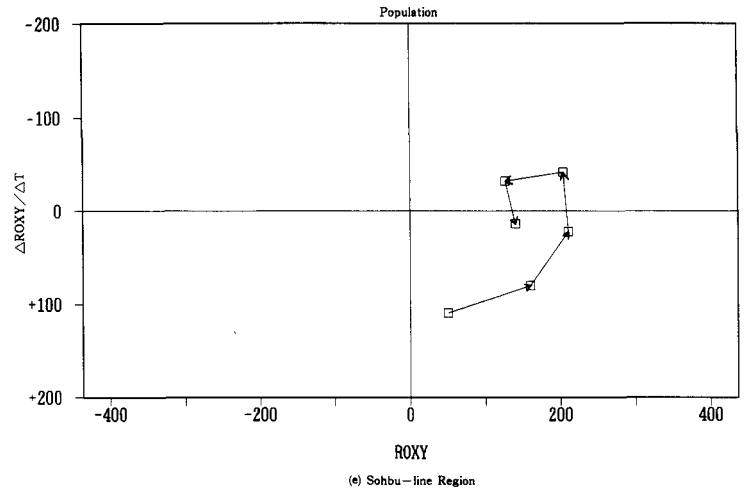


(d) Tokaido-line Region



(e) Sohbu-line Region

Figure 2 (Continued)

regions, we obtain the values of the ROXY index[15] for each of the five railway-line regions and for each of the six five-year periods as shown in Table 4. This table enables us to produce Figure 2 which diagrammatically illustrates the locus of the spatial-cycle path for the five railway-line regions for the thirty-year period between 1960 and 1990. In Figure 2, we have (i) the value of the ROXY index along the abscissa axis and (ii) the marginal value[16] of the ROXY index along the ordinate axis which extends its positive direction downward. In this figure, suppose we cut the two-dimensional space into eight equal parts revolving around the origin. Then, each eighth segment of the whole two-dimensional space, would roughly corre-

Table 4 ROXY Index for Five Railway-line Regions in Tokyo FUC

Railway-line Region	Number of Localities	Period					
		1960-65	1965-70	1970-75	1975-80	1980-85	1985-90
Chuo	16	150.12	139.02	117.34	97.51	55.90	107.03
Takasaki	14	36.20	122.95	106.86	90.51	56.55	50.25
Joban	12	-11.27	100.44	145.55	148.81	89.28	70.71
Tokaido	14	171.39	175.08	147.06	88.43	47.36	81.38
Sobu	14	50.51	160.06	210.90	204.64	126.75	140.41

[Note] The values of the ROXY index in this table were calculated based on the annual growth ratios and the weighting factor of the CBD distance.

spond to each of the basic component stages conceived in the spatial-cycle paradigm, as follows:

(1) North-northwestern segment;
First-half stage of accelerating centralization
(2) West-northwestern segment;
Second-half stage of accelerating centralization
(3) West-southwestern segment;
First-half stage of decelerating centralization
(4) South-southwestern segment;
Second-half stage of decelerating centralization
(5) South-southeastern segment;
First-half stage of accelerating suburbanization
(6) East-southeastern segment;
Second-half stage of accelerating suburbanization
(7) East-northeastern segment;
First-half stage of decelerating suburbanization
(8) North-northeastern segment;
Second-half stage of decelerating suburbanization

Taking this scheme as our guide, we can perhaps comment, based on Figure 2, on the stages of the spatial cycles for each railway-line region. In doing so, it should be kept in mind that the above paradigm has been arranged under the ideal assumption that the stages of accelerating central-

ization, decelerating centralization, accelerating suburbanization and decelerating suburbanization would take place cyclically. The actual situation may be deviated from this assumption to some extent. It is therefore suggested that the above scheme should not be applied rigidly but instead interpreted flexibly when employed in the analyses of the spatial cycles. Be that as it may, we can point out the following factors based on Figure 2 and Table 4.

The ROXY index for the Chuo-line region decreases continuously from 150.12 for the 1960-65 period to 55.90 for the 1980-85 period. It then begins to increase to 107.03 for the 1985-90 period. This would imply that, in the early 1960's, the Chuo-line region was already beginning its first half-stage of decelerating suburbanization, and that the region was thereafter deceleratingly suburbanized until around 1980. This region seems to have entered into the stage of accelerating re-suburbanization[17] in the early 1980's, and afterwards was continuously at the stage of accelerating re-suburbanization.

The ROXY index for the Takasaki-line region increases from 36.20 for the 1960-65 period to 122.95 for the 1965-70 period. It then begins to decrease continuously to 50.25 for the 1985-90 period. This would imply that the Takasaki-line region was acceleratingly suburbanized until around 1970, and that from the beginning of the 1970's onward, the speed of suburbanization decereased continuously. This region approached the end of the second-half stage of its decelerating suburbanization around 1990.

The ROXY index for the Joban-line region increases from −11.27 for the 1960-65 period to 148.81 for the 1975-80 period, with the negative sign turning positive in the middle of the 1960's. It then begins to decrease to 70.71 for the 1985-90 period. This would imply that the Jobanline region was near the end of the second-half stage of decelerating centralization around 1960, and that the region got into the stage of accelerating suburbanization in the early 1960's. The speed of suburbanization began to decelerate in the middle of the 1970's and continued to decelerate afterwards, resulting in that the region was at the second-half stage of decelerating suburbanization towards 1990.

The ROXY index for the Tokaido-line region increases from 171.39 for the 1960-65 period to 175.08 for the 1965-70 period. It then begins to decrease to 47.36 for the 1980-85 period. After that it turns up again to 81.38 for the 1985-90 period. This would imply that the Tokaido-line region was near the end of the second-half stage of accelerating suburbanization around 1960, and that the region began its first-half stage of decelerating suburbanization in the early 1960's. The speed of suburbanization continued to decelerate until the early 1980's, when the region seems to have entered into the stage of accelerating re-suburbanization. The region was acceleratingly suburbanized toward the end of the 1980's.

The ROXY index for the Sobu-line region increases from 50.51 for the 1960-65 period to 210.90 for the 1970-75 period. It then begins to decrease to 126.75 for the 1980-85 period. After that it increases again to 140.41 for the 1985-90 period.

This would imply that the Sobu-line region was acceleratingly suburbanized until the middle of the 1970's. The speed of suburbanization continuously decreased until the middle of the 1980's when the region seems to have entered into the stage of accelerating re-suburbanization.

Comparing spatial-cycle stages among the five railway-line regions, the following points can be made in conjunction with the development of the 'race along the spatial cycle path (i.e., spatial-cycle race).'

(1) In the early 1960's, the Chuo-line region was at the stage of decelerating suburbanization, and was taking the lead in the race.
(2) In the spatial-cycle race of the early 1960's, the Tokaido-line region (whose position was then at the stage of accelerating suburbanization), the Takasaki-line region (at the stage of accelerating suburbanization), the Sobu-line region (at the stage of accelerating suburbanization), and the Joban-line region (at the stage of decelerating concentration), in this order, followed behind the Chuo-line region.
(3) In the spatial-cycle race of the late 1980's, the Chuo-line region (whose position was then at the stage of accelerating re-suburbanization) was leading the race, followed by the Tokaido-line region (at the stage of accelerating re-suburbanization), the Sobu-line region (at the stage of accelerating resuburbanization), Takasaki-line region (at the stage of decelerating suburbanization), and the Joban-line region (at the stage of decelerating suburbanization), respectively.
(4) The relative order in the spatial-cycle race between the Takasaki-line region and the Sobu-line region was reversed around 1980.

4. Conclusion: New Possible Interpretations of Klaassen's Spatial-cycle Hypothesis

As mentioned in Section 3 and in a note to Section 1, Klaassen's original hypothesis argues that the spatial-cycle path of a large metropolitan area cyclically follows four stages: urbanization (decelerating centralization when the ROXY index method is applied), suburbanization (accelerating suburbanization), counter-urbanization (decelerating suburbanization), and re-urbanization (accelerating centralization). The investigation of this paper, however, partly suggests that the spatial-cycle path can circulate even within only the two stages of accelerating suburbanization and decelerating suburbanization for a period of, say, a half century. This suggestive interpretation consequently implies another conceptually possible general tendency that the spatial-cycle path can circulate within only the two stages of accelerating centralization and decelerating centralization for a period of, say, a half century. In sum, it would be possible for us to conceptualize practically the following three sub-schemes for Klaassen's spatial-cycle framework; (i) spatially cyclical path along the four stages of accelerating centralization, decelerating centralization, accelerationg suburbanization and decelerating suburbanization, (ii) spatially cyclical path within only the two stages of accelerating suburbanization and decelerating

本論文目次

suburbanization, (iii) spatially cyclical path within only the two stages of accelerating centralization and decelerating centralization. Furthermore, the combination of the above three types of paths would perhaps also be able to hold as the fourth sub-scheme; spatially cyclical path along the route generated by combining several feasible loops within the framework of the first sub-scheme[18]. This fourth sub-scheme (i.e., combined sub-scheme) seems to add a new conceptual dynamism to Klaassen's traditional framework to make urban and regional studies somewhat more useful for the conduct and development of urban and regional studies and policies.

It is to be born here in mind that the aforementioned conclusions have been tentatively drawn on the basis of our analytical method in which we have used the growth rate of population (instead of change in the absolute level of population). In this sense, this paper can be said to have analyzed the centralization and suburbanization processes only in terms of relative changes in population over spatial units situated in the Tokyo metropolitan area.

Despite those drawbacks, we hope that the 'Spatial-cycle and ROXY-index' approach would still help us obtain a better insight into the intra- and inter-metropolitan spatial redistribution of specitic tyes of economic and social activities.

Notes

1) See Kawashima (1977, 1982) for an explanation of background scientific motivations to delineate eighty-five FURs and for the criteria adopted in delineating them. See also Glickman (1979) for the discussion on the delineation and application of the Japanese-version of SMSAs, which he refers to as the Regional Economic Clusters (RECs) in his study.
2) The SMSAs in the USA totalled 224 in 1965. The name of SMSA has been later changed to the Metropolitan Statistical Area (MSA).
3) Among these studies on FURs are Kawashima (1977, 1978, 1982, 1986a, 1986b, 1986c, 1987a, 1987b). Most of his works employed the ROXY index approach as the mothodological instrument. See Kawashima (1985, 1989) for the discussion on the fundamental characteristics of the ROXY index method.
4) In Klaassen (1979) and Klaassen *et al.* (1981), the discussion was focused on the spatial-cycle stages of urbanization, suburbanization, counter-urbanization (or disurbanization, or deurbanization) and reurbanization for the phenomena of spatial redistribution of population within large metropolitan areas.
5) See Note 3 for the method of ROXY index.
6) The present paper is a follow-up study to the previous two papers by Kawashima (1986b, 1986c) in the sense that the three papers all intend to investigate the phenomena of spatial cycles for railway-line regions in the Tokyo metropolitan area. In Kawashima (1986b, 1986c), the area of Tokyo city was not disaggregated into the twenty-three subareas which are referred to

as *ku* (ward). The present paper, however, does employ the data of those twenty-three disaggregated subareas, which has hopefully refined the results of this research as compared wiht the case in which we use the aggregated data for Tokyo city.

7) The phrase of 'Roxyian approach' is used here to imply the analytical approach employing the ROXY index method to investigate the spatial-cycle types of phenomena.

8) More precisely speaking, the CBD is the location point of the former Tokyo Metropolitan Government Office, and the center of each locality is the location point of the public office (i.e., city hall, ward office, or town hall) of that locality.

9) Note that the figures shown in this table for the 1960 and 1965 population of Saiwai-ku (14132) and Kawasaki-ku (14131) are actually those for Kawasaki-shi. Saiwai-ku and Kawasaki-ku were designated as *ku* (ward) in April 1972. Before that, each of them was simply a part of Kawasaki-shi, which makes population staistics unavailable from the national population census for the years 1960 and 1965. It should also be noted, however, this unavailability of the 1960 and 1965 population data for Saiwai-ku and Kawasaki-ku would not seem to cause serious distortions in the results of our analysis. The reason for this less-seriousness is that the values of the ROXY index are calculated, in the present paper, based on the annual growth rates of population (but not on the absolute level of population) as well as on the CBD distance for each locality.

10) Exceptions to the outward-movement tendency, are the 1980-85 and 85-90 periods for the Takasaki-line region and the 1985-90 period for the Joban-line region.

11) Exceptions to the reductive-tendency, are the 1960-65 and 85-90 periods for the Takasaki-line region and the 1975-80 period for the Sobu-line region.

12) The quantitative grounds on which this flattening tendency would be justified, are as follows: We first calculate, by railway-line region, the value of the difference between the maximum and minimum, among the five-year growth rates of localities for each of the six five-year periods. Then, we can recognize that the values of the difference would show a marked trend toward continuous decline over time as indicated by Table A-1 in the appendix. Exceptions to this flattening tendency are the 1960-65 period for the Takasaki-line region and the 1985-90 period for the Chuo-line, Takasaki-line, Tokaido-line and Sobu-line regions.

13) One of the conventional interpretations of the spatial-cycle framework is that the processes of the intra-metropolitan spatial redistribution of population would follow the stages of accelerating centralization (which corresponds to the stage of 'reurbanization,' as originally coined by Klaassen), decelerating centralization (urbanization), accelerating suburbanization (suburbanization), decelerating suburbanization (counter-urbanization), and then accelerating

本論文目次

recentralization (reurbanization).

14) Assume that x_t and x_{t+1} are the respective population levels for time t and t+1. The growth ratio of the population between time t and t+1 is defined then, as x_{t+1} divided by x_t. The annual growth ratio is the k-th root of the above growth ratio, when the length of the interval between time t and t+1 is k years.

15) The value of the ROXY index for each of the railway-line regions for a five-year period is calculated through the following mathematical formulation with the CBD distance for each locality used as the weighting factor.

$$\left(\frac{\text{weighted-average annual growth ratio}}{\text{simple-average annual growth ratio}}-1.0\right)\times 10{,}000$$

$$=\left[\frac{\sum_{i=1}^{n} d_i r_i^{t,t+1}}{\sum_{i=1}^{n} d_i}\times\frac{n}{\sum_{i=1}^{n} r_i^{t,t+1}}-1.0\right]\times 10^4$$

$$=\frac{n\sum_{i=1}^{n} d_i r_i^{t,t+1}-\sum_{i=1}^{n} d_i\times\sum_{i=1}^{n} r_i^{t,t+1}}{\sum_{i=1}^{n} d_i\times\sum_{i=1}^{n} r_i^{t,t+1}}\times 10^4$$

where d_i : CBD distance of locality i

$r_i^{t,t+1}$: annual growth ratio of population for locality i for the period between time t and $t+1$

n : number of localities.

16) The marginal value of the ROXY index defined here, is calculated as follows:
(i) For the periods 1960-65 and 85-90; the difference between the value of the ROXY index for the assigned period, and that for its adjacent period.
(ii) For other periods; the difference between the values of the ROXY index for the two periods adjacent to the assigned period.

17) We discuss, in this paper, the spatial processes of centralization and suburbanization in terms of the *relative magnitude* of the growth rates of localities. Consequently, the following possibility should be noted: If the growth rates of the inner localities tend to decrease continuously with negative signs, and if the population of outer localities tend to change little, then the patterns of the changes in the value of the ROXY index would indicate the existence of the stage of suburbanization or re-suburbanization.

18) One of the conceptually possible routes would be the path circulating along the stages of (1) through (8) → (5)+(6) → (7)+(8) → (1)+(2) → (3)+(4) → (1)

through (8), in case we use the eight basic component stages presented in Section 3.

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本論文目次

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本論文目次

Appendix

Table A－1　Five-year Growth Rates (%) of Localities: Values of Maximum, Minimum and Their Diffrence for Five Railway-line Regions

(a) Chuo-line Region

	1960-65	1965-70	1970-75	1975-80	1980-85	1985-90
Maximum	66.94	44.98	28.61	20.03	10.20	9.30
Minimum	-20.63	-20.27	-16.89	-11.12	-7.86	-21.83
Difference	87.57	65.25	45.50	31.15	18.06	31.13

(b) Takasaki-line Region

	1960-65	1965-70	1970-75	1975-80	1980-85	1985-90
Maximum	43.42	102.26	47.11	20.40	14.20	19.60
Minimum	-10.21	-15.91	-13.76	-10.40	-5.13	-7.83
Difference	53.63	118.17	60.87	30.80	19.33	27.43

(c) Joban-line Region

	1960-65	1965-70	1970-75	1975-80	1980-85	1985-90
Maximum	85.25	58.49	54.79	45.15	29.27	17.15
Minimum	-10.21	-15.91	-13.76	-10.40	-4.97	-7.83
Difference	92.46	74.40	68.55	55.55	34.24	24.98

本論文目次

Table A－1 (Continued)

(d) Tokaido-line Region

	1960-65	1965-70	1970-75	1975-80	1980-85	1985-90
Maximum	59.75	59.78	36.48	18.43	10.48	9.00
Minimum	-20.43	-20.27	-16.89	-11.12	-7.86	-21.83
Difference	80.18	80.05	53.37	29.55	18.34	30.83

(e) Sobu-line Region

	1960-65	1965-70	1970-75	1975-80	1980-85	1985-90
Maximum	65.87	54.01	41.80	58.38	36.36	33.32
Minimum	-20.43	-20.27	-16.89	-11.12	-7.86	-21.83
Difference	86.30	74.28	58.69	69.50	44.22	55.15

本論文目次

Table A−2 Annual Growth Ratios of Population for Localities of Five Railway-line Regions in Tokyo FUC

[a] Chuo-line Region

(unit of distance: km)

Code	Distance	1960-1965	1965-1970	1970-1975	1975-1980	1980-1985	1985-1990
13102	1.1	0.9548	0.9590	0.9720	0.9830	0.9933	0.9682
13101	2.1	0.9553	0.9557	0.9637	0.9767	0.9838	0.9519
13104	5.7	1.0001	0.9885	0.9877	0.9870	0.9934	0.9774
13113	6.1	1.0007	0.9934	0.9921	0.9869	0.9963	0.9676
13114	9.6	1.0140	1.0011	0.9970	0.9849	0.9943	0.9901
13115	11.7	1.0196	1.0060	1.0028	0.9934	0.9990	0.9961
13203	18.5	1.0210	1.0051	1.0037	0.9962	1.0027	1.0004
13204	18.5	1.0675	1.0276	1.0115	0.9995	1.0022	0.9992
13210	23.7	1.1079	1.0435	1.0169	0.9994	1.0043	1.0024
13206	25.8	1.0899	1.0527	1.0225	1.0103	1.0102	1.0072
13214	27.5	1.1067	1.0459	1.0164	1.0064	1.0096	1.0113
13215	29.2	1.0592	1.0655	1.0153	0.9992	1.0023	1.0029
13202	31.0	1.0421	1.0306	1.0336	1.0064	1.0054	1.0085
13212	33.2	1.0939	1.0771	1.0516	1.0279	1.0142	1.0124
13201	40.3	1.0476	1.0406	1.0493	1.0372	1.0196	1.0180
14424	55.5	0.9957	0.9958	1.0066	1.0201	1.0147	1.0104

[b] Takasaki-line Region

(unit of distance: km)

Code	Distance	1960-1965	1965-1970	1970-1975	1975-1980	1980-1985	1985-1990
13106	4.2	0.9787	0.9659	0.9708	0.9783	0.9899	0.9838
13118	6.7	0.9950	0.9764	0.9752	0.9811	0.9917	0.9944
13117	8.9	1.0155	0.9906	0.9947	0.9840	0.9895	0.9929
11203	14.8	1.0748	1.0419	1.0247	1.0188	1.0122	1.0171
11223	18.0	1.0647	1.0207	0.9976	0.9853	0.9987	1.0090
11204	23.2	1.0488	1.0401	1.0421	1.0158	1.0104	1.0209
11220	26.0	1.0485	1.0395	1.0250	1.0036	0.9952	1.0229
11205	28.0	1.0487	1.0450	1.0404	1.0156	1.0105	1.0160
11219	36.5	1.0709	1.1513	1.0573	1.0258	1.0144	1.0177
11231	40.2	1.0569	1.0661	1.0441	1.0302	1.0198	1.0234
11233	44.0	1.0585	1.0903	1.0803	1.0176	1.0269	1.0193
11217	48.0	1.0277	1.0283	1.0422	1.0203	1.0119	1.0364
11304	54.5	1.0367	1.0356	1.0171	1.0378	1.0203	1.0151
11206	58.0	1.0051	1.0138	1.0190	1.0207	1.0163	1.0095

本論文目次

Table A-2 (Continued)

[c] Joban-line Region

(unit of distance: km)

Code	Distance	1960-1965	1965-1970	1970-1975	1975-1980	1980-1985	1985-1990
13106	4.2	0.9787	0.9659	0.9708	0.9783	0.9899	0.9838
13118	6.7	0.9950	0.9764	0.9752	0.9811	0.9917	0.9944
13121	8.4	1.0472	1.0213	1.0127	1.0036	1.0009	1.0027
13122	10.5	1.0344	1.0075	0.9909	0.9898	0.9994	0.0027
12207	17.8	1.1312	1.0965	1.0632	1.0307	1.0129	1.0131
12220	23.3	1.0882	1.0760	1.0798	1.0516	1.0318	1.0235
12217	28.6	1.1137	1.0664	1.0616	1.0333	1.0269	1.0224
12222	31.7	1.0418	1.0819	1.0913	1.0580	1.0201	1.0156
8217	36.5	1.0300	1.0900	1.0557	1.0617	1.0199	1.0077
8563	41.4	1.0062	1.0464	1.0459	1.0534	1.0237	1.0193
8208	45.6	1.0078	1.0131	1.0171	1.0123	1.0252	1.0322
8219	48.0	1.0130	1.0240	1.0739	1.0774	1.0527	1.0317

[d] Tokaido-line Region

(unit of distance: km)

Code	Distance	1960-1965	1965-1970	1970-1975	1975-1980	1980-1985	1985-1990
13101	2.1	0.9553	0.9557	0.9637	0.9767	0.9838	0.9519
13103	2.4	0.9801	0.9850	0.9867	0.9920	0.9933	0.9598
13109	8.1	0.9977	0.9875	0.9838	0.9889	1.0065	0.9926
13111	11.6	1.0136	0.9945	0.9878	0.9911	1.0005	0.9955
14132	15.6	1.0619[1)]	1.0263[1)]	0.9911	0.9859	0.9981	1.0072
14131	16.9	1.0619[1)]	1.0263[1)]	0.9702	0.9834	0.9947	1.0062
14101	19.8	1.0211	1.0005	0.9892	0.9905	1.0048	1.0107
14102	24.9	1.0270	1.0107	1.0060	0.9886	0.9869	1.0058
14103	27.6	1.0003	0.9873	0.9811	0.9802	0.9958	0.9952
14106	28.0	1.0982	1.0738	1.0285	1.0070	1.0143	1.0062
14110	37.1	1.0652	1.0983	1.0642	1.0344	1.0201	1.0043
14204	44.3	1.0371	1.0331	1.0352	1.0084	1.0033	0.9986
14205	44.9	1.0705	1.0550	1.0304	1.0245	1.0181	1.0130
14207	50.1	1.0802	1.0531	1.0324	1.0238	1.0159	1.0174

[Note] 1) These figures are for the population of Kawasaki-shi. Saiwai-ku (14132) and Kawasaki-ku (14131) were designated as *ku* (ward) in April 1972. Before that, each of them was simply a part of Kawasaki-shi, and therefore their population statistics are not available from the national population census for the years 1960 an 1965.

本論文目次

Table A－2 (Continued)

[e] Sobu-line Region

(unit of distance: km)

Code	Distance	1960-1965	1965-1970	1970-1975	1975-1980	1980-1985	1985-1990
13101	2.1	0.9553	0.9557	0.9637	0.9767	0.9838	0.9519
13107	3.8	0.9914	0.9758	0.9773	0.9853	0.9976	0.9938
13106	4.2	0.9787	0.9659	0.9708	0.9783	0.9899	0.9838
13108	4.9	1.0049	0.9979	0.9997	1.0038	1.0143	0.9981
13123	10.0	1.0506	1.0197	1.0118	1.0089	1.0078	1.0191
13122	10.5	1.0344	1.0075	0.9909	0.9898	0.9994	1.0027
12203	15.7	1.0575	1.0465	1.0411	1.0267	1.0178	1.0188
12204	19.5	1.1065	1.0776	1.0539	1.0253	1.0112	1.0102
12216	23.5	1.0901	1.0902	1.0335	1.0121	1.0173	1.0212
12201	31.7	1.0657	1.0773	1.0646	1.0251	1.0111	1.0101
12228	36.5	1.0354	1.0593	1.0724	1.0963	1.0250	1.0149
12212	41.7	1.0212	1.0810	1.0598	1.0460	1.0368	1.0360
12322	45.8	0.9983	1.0071	1.0622	1.0863	1.0640	1.0202
12323	49.8	0.9983	1.0015	1.0237	1.0230	1.0328	1.0592

本論文目次