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Changes in Regional Distribution of Population in Japan and Its Implications for Social Policy*

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CONTENTS

1. Introduction

Japan's rapid economic growth since the mid 1950's has brought about remarkable improvements in living conditions and reduction of wage differentials, but it has also been pointed out that it has caused imbalances such as excessive concentration of population, external diseconomies such as, pollution, traffic congestion, etc.

The purpose of the present paper is to focus attention on the mechanism of population movement in the context to the various socio-economic variables and to evaluate the effects of public policy in achieving regional development targets such as elimination of income differentials, restriction of excessive concentration, development of underdeveloped regions, etc.

Special emphasis is placed on an issue related to interregional population movement on an empirical basis from regional statistical data for 46 prefectures in Japan.

We first use a model of R. Stone [4] [5] [6] based on a multi-regional demographic account and then make an inter-temporal comparison of migration for 1954 to 1974. A regression analysis is made on the causes about changes in regional population pattern. Finally we evaluate policy implications of our empirical results.

2. Recent Changes in Regional Demographic Pattern

As indicated in Table 1, there have been gradual changes in regional population growth. In terms of net migration at prefectural level, the table clearly shows consistent trend of population concentration in three largest urban areas : a. Tokyo, Saitama, Chiba and Kanagawa in Kanto region, b. Aichi in Tokai region, c. Osaka, Hyogo and Nara in Kinki region.

Most of other prefectures indicate a negative trend in terms of net migration, especially in remote rural regions.

If looked at more carefully, there is an important change in the trend of concentration in recent years.

Table 1. Net Inflow (or Outflow) of Population in Percentage, 1955 - 1974 (%)

Prefecture	1955	1960	1965	1970	1974
1. Hokkaido	0	-0.3	-0.6	-1.4	-0.3
2. Aomori	-0.4	-0.9	-1.1	-1.2	-0.6
3. Iwate	-0.6	-1.0	-1.4	-1.5	-0.5
4. Miyagi	-0.4	-1.1	-0.5	-0.1	0.5
5. Akita	-0.8	-1.5	-1.7	-1.5	-0.7
6. Yamagata	-1.0	-1.3	-1.5	-1.2	-0.5
7. Fukushima	-1.1	-1.8	-1.4	-0.9	-0.4
8. Ibaraki	-0.9	-0.8	-0.8	0.7	0.8
9. Tochigi	-1.3	-1.2	-0.7	-0.4	0.3
10. Gunma	-0.8	-1.1	-0.5	0	0.1
11. Saitama	0	1.4	3.5	3.5	2.0
12. Chiba	-0.3	0.7	1.9	3.3	2.4
13. Tokyo	2.7	2.2	0.4	-0.9	-1.5
14. Kanagawa	1.3	2.7	2.9	2.3	0.8
15. Niigata	-1.1	-1.3	-1.0	-1.1	-0.4
16. Toyama	-0.9	-0.7	-0.8	-0.4	-0.2
17. Ishikawa	-0.6	-0.5	-0.4	-0.2	0.2
18. Fukui	-0.6	-0.8	-1.0	-0.6	-0.2
19. Yamanashi	-1.2	-1.4	-0.9	-0.7	-0.2
20. Nagano	-1.1	-1.1	-0.8	-0.5	-0.1
21. Gifu	-0.9	-0.1	-0.2	0.1	0
22. Shizuoka	-0.3	-0.1	0.1	0.3	-0
23. Aichi	0.9	1.6	1.0	0.9	0
24. Mie	-0.8	-0.5	-0.7	-0.2	0.1
25. Shiga	-0.9	-0.2	-0.4	0.9	1.1
26. Kyoto	0.2	-0.3	0.1	0.1	-0.1
27. Osaka	1.6	2.8	1.5	0.7	-0.4
28. Hyogo	0.4	0.9	0.4	0.4	-0.1
29. Nara	-1.1	-0.7	0.7	1.8	1.2
30. Wakayama	-0.3	-0.6	-0.2	-0.6	-0.4
31. Tottori	-0.8	-1.3	-1.1	-0.7	-0.2
32. Shimane	-0.8	-1.5	-2.0	-1.5	-0.5
33. Okayama	-0.6	-0.7	-0.4	0.4	0.2
34. Hiroshima	-0.4	-0.3	0.2	0.4	0.1
35. Yamaguchi	-0.4	-1.0	-1.1	-0.8	-0.3
36. Tokuyama	-1.1	-1.6	-1.3	-1.0	-0.4
37. Kagawa	-0.6	-1.3	-0.6	-0.2	0.3
38. Ehime	-0.7	-1.5	-1.2	-0.9	-0.2
39. Kohchi	-0.4	-1.5	-1.3	-1.0	-0.3
40. Fukuoka	0	-0.8	-0.6	-0.8	0.1
41. Saga	-1.0	-2.2	-1.6	-1.5	-0.6
42. Nagasaki	-0.9	-1.8	-1.7	-2.5	-0.5
43. Kumamoto	-0.3	-1.6	-1.3	-2.0	-0.2
44. Ohita	-0.6	-1.4	-1.4	-0.7	-0.2
45. Miyazaki	-0.4	-1.4	-1.4	-1.7	0.1
46. Kagoshima	-0.9	-2.1	-1.9	-2.2	-0.6

Source : Statistics Bureau : Annual Report on Population Movement based on Residence Registers

Tokyo, for instance, indicates remarkable decline in net migration, thus being negative in recent periods. A similar tendency is also observed for Aichi and Osaka, and these declining rates of concentration correspond in a consistent way to the gradually falling trend of emigration from other less developed prefectures. These recent changes, called "U-turn phenomenon", and usually attributed to such factors as a) growing dis-economy of scale and externality in large metropolitan areas, b) deceleration of economic growth which requires smaller portion of labor force from rural prefectures, c) narrowing down of wage and income differentials between urban and urral prefectures. Additional factors could be mentioned such as change in value system shifting to "Quality of Life" and growing shortage in mobile and young labour force in rural areas accompanied by increase in higher education oppotunities.

The declining tendency of migration to the largest urban areas, however, is somewhat cancelled by rising trend in neighbouring prefectures such as Saitama and Chiba in Southern Kanto region, and Nara in Kinki region. This implies that overflowing population tends to spill over toward those neighbouring areas because of relative advantage in housing and improvement in transportation and communication. Thus the trend of concentration and "U-turn" becomes more modest when observed at a more aggregative level of "region".

If we look at these post-war patterns in a longer historical perspective as in Table 2, we note that the post-war patterns are consistent with pre-war patterns until mid 1960's. According to T. Kuroda's estimation [3], there are only two metropolitan regions, namely Southern Kanto and Southern Kinki, which kept absorbing large amounts of emigrants from all the other regions. It was not until the mid 1950's that Tokai region started growing as one of the large metropolitan regions.

Thus it can be said that the historical pattern of interregional migration is closely related to the rural population outflow to three metropolitan regions, especially Kanto and Kinki, and that it tends to be accelerated after the War until the mid 1960's when a new trend of what Kuroda calls "muli-channel" migration emerged. The new trend is not confined to "U-turn" movement based to the home region but includes also migrations to other metropolitan regions and newly developing local areas.

In the following section we shall be more specific about this problem in an analytical framework by using a Stone-type demographic account of interregional population flows and related socio-econometric model.

Table 2. Historical Series of Interregional Migration

(thousand persons)

Prefecture	1920/25	1925/30	1930/35	1935/40	1947/50	1950/55	1955/60	1960/65
1. Hokkaido	-110	49	-24	-56	116	44	-56	-177
2. Tohoku	-145	-190	-238	-404	-167	-474	-584	-677
3. Kanto, North	-93	-109	-137	-142	-246	-336	-344	-178
4. Kanto, South	605	619	619	751	902	1,473	1,580	1,917
5. Tokai	31	-28	8	-17	-54	36	109	252
6. Hokuriku	-192	-182	-300	-281	-317	-496	-421	-397
7. Kinki, North	-50	-41	-35	-94	-121	-107	-109	-21
8. Kinki, South	456	434	778	453	395	618	732	950
9. Sanin	-32	-26	-55	-61	-54	-62	-117	-128
10. Sanyo	-47	-68	-18	-0	-106	-136	-212	-184
11. Shikoku	-91	-92	-177	-197	-111	-237	-297	-278
12. Kyushu, North	-89	0	-35	104	30	-130	-347	-642
13. Kyushu, South	-76	-59	-150	-249	-129	-254	-431	-460

Source : T. Kuroda, Jinkohido to Chiikishakai
(Migration and Regional Society)
(Ginkohsohsho No. 158, 1971.)

3. Frame Work of the Model[1/]

As shown in Table 3, regional population movement can be formulated in an accounting identity for each region as:

(1) $N_{-1} + M_I + F_I + B = N + M_E + F_E + D.$

where N_{-1} and N = number of population in certain region at the beginning and the end of period, M_I and M_E = interregional immigrants and emigrants, F_I and F_E = international immigrants and emigrants, B = number of births, D = number of deaths.

Next we define the population survived and stayed in the same region as

(2) $M_S = N_{-1} - D - F_E - M_E = N - B - F_I - M_I.$

From these two equations we obtain the following population identity.

(3) $N_{-1} = D + F_E + M_E + M_S$

(4) $N = B + F_I + M_I + M_S$

More generally, the M_E, M_I and M_S can be shown in the form of a square matrix (M_{ij}) and if we assume ratios of the regional emigrants to the population of j th region, the square matrix is represented as

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1/ A pioneering study in Japan was initiated by Prof. R. Stone by using inter-regional data of "Employment Status Survey". [7]

Table 3. Interregional Demographic Account

	Region I	Region II	Births	International Immigrants	Total
Region I	M_{S1}	M_{I1} $(=M_{E2})$	B_1	F_{I1}	N_1
Region II	M_{E1} $(=M_{I2})$	M_{S2}	B_2	F_{I2}	N_2
Deaths	D_1	D_2			D
International emigrants	F_{E1}	F_{E2}			F_E
Total	N_{1-1}	N_{2-1}	B	F_I	$N+D+F_E$ $(=N_{-1}+B+F_I)$

Table 3-1 Demographic Account, by Regions, 1974

Region	1	2	3	4	5	6	7	8	9	10
1	5093054	12757	4110	44413	9867	1758	0	5012	265	1698
2	13260	11055467	17453	142904	17710	4513	2742	7185	448	3023
3	5276	20676	8119035	140317	14936	1879	2179	7279	519	2420
4	53428	175882	127135	24908326	85648	16772	18430	72313	6193	32839
5	11140	20671	14615	77841	11986772	9871	14616	37136	2638	10285
6	2067	4897	1718	15560	10064	2756996	5579	10187	275	1488
7	2247	3277	2381	14926	14391	6160	4103654	74806	3381	7608
8	5459	7055	5408	60045	34405	10356	53946	13252781	12573	37783
9	279	310	291	5142	2697	278	2886	11930	1279550	9167
10	1715	2499	2003	28291	9714	1400	7642	41282	10925	5628510
11	981	1156	1104	16196	7242	996	5730	36451	742	12804
12	3517	2364	2542	50815	24765	1256	8559	44776	1420	23562
13	1333	1106	1445	28684	17619	739	5601	34254	528	7030
Deaths	30944	85414	64389	126262	77333	22366	30733	81448	12085	44156
International Emigrants	11706	26700	25649	231022	54295	8485	23797	79461	2241	18924
TOTAL	5236406	11420231	8389278	25890744	12367458	2843825	4286094	13796301	1333783	5841297

Region	11	12	13	Births	International Immigrants	ERROR	TOTAL
1	868	2967	22818	94356	9762	-19385	5284320
2	1191	2434	1345	189159	24524	1288	11484646
3	1221	3068	1419	151913	27590	-4603	8495124
4	19371	58273	34101	522704	220440	-1027	26350828
5	7579	27154	17900	242846	57323	-2218	12536169
6	763	1522	685	51321	10179	-1488	2871813
7	6316	9833	6217	81264	25973	-3125	4359309
8	37435	45914	35445	276803	82671	-4779	13953300
9	662	1380	428	20439	2488	-120	1337807
10	13149	23956	7890	106797	18606	-1258	5903121
11	3811569	4063	1930	65387	9953	-1457	3974847
12	3960	7855469	33690	140632	23386	2196	8222909
13	2040	31772	3702106	62674	6986	21252	3925169
Deaths	34265	60386	33136	0	0		702917
International Emigrants	9406	27772	7741	0	0		527199
TOTAL	3949795	8155963	3906851	2006295	519881		109929478

(5) $M_{ij(t)} = c_{ij(t)} N_{j(t-1)}$

The c_{ij} is also called transition coefficient matrix.

Thus, the regional population can be estimated as

(6) $N_{i(t)} = \sum_j c_{ij(t)} N_{j(t-1)} + B_{i(t)} + F_{Ii(t)}$.

Since, however, c_{ij} is assumed to change over time and B and F_I to be exogenous, we need more general approximation for forecasting purpose. If we assume (a) c_{ij} to remain constant since our base year 1954 and it is represented as $\bar{c}_{ij}$ and (b) B and F to be the functions of N, the equation (6) is modified as

(7) $N^*_{i(t)} = \sum_j \bar{c}_{ij} N^*_{j(t-1)} + b_{i(t)} N_{i(t-1)} + f_{i(t)} N_{i(t-1)}$ $[i = j]$

where N* is an estimated value obtained successively from the year 1954 through a familiar Markov-type estimation.

Now the rates of increase in population in the equations (6) and (7) are specified respectively as

(8) $\frac{\Delta N_{i(t)}}{N_{i(t-1)}} = \sum_j \lambda_{ij(t)} + b_{i(t)} + f_{i(t)}$

(9) $\frac{\Delta N^*_{i(t)}}{N^*_{i(t-1)}} = \sum_j \lambda^*_{ij(t)} + b^*_{i(t)} + f^*_{i(t)}$

where

(10) $\lambda_{ij(t)} = [c_{ij(t)} - I]\, \omega_{ij(t)}$

(11) $\lambda^*_{ij(t)} = [\bar{c}_{ij(t)} - I]\, \omega^*_{ij(t)}$

(12) $\omega_{ij(t)} = N_{j(t-1)}/N_{i(t-1)}$

(13) $\omega^*_{ij(t)} = N^*_{j(t-1)}/N^*_{i(t-1)}$

and I is an identity matrix. $\lambda_i (= \sum_j \lambda_{ij})$ is, therefore, a sum of the rate of mortality and the rate of net interregional immigration of i th region.

We can specify λ_i as a function of λ^*_i and other variables:

(14) $$\lambda_{i(t)} = \lambda^*_{i(t)} + \mathcal{E}_i \frac{\Delta N^*_{i(t)}}{N^*_{i(t-1)}} + \beta_i \frac{\Delta Q_{i(t)}}{Q_{i(t-1)}}$$

where $\mathcal{E}_i$ = adjustment parameter of c_{ij} and Q_i = additional explanatory variables as discussed later.

From equations (8) (9) and (14) we obtain the following relation which explains the deviation of N from N^*.

(15) $$\frac{\Delta N_{i(t)}}{N_{i(t-1)}} - \frac{\Delta N^*_{i(t)}}{N^*_{i(t-1)}} = \mathcal{E}_i \frac{\Delta N^*_{i(t)}}{N^*_{i(t-1)}} + \beta_i \frac{\Delta Q_{i(t)}}{Q_{i(t-1)}}$$

based on the approximation $b \doteqdot b^*$ and $f_i \doteqdot f^*_i$.

As discussed earlier, various accelerating and decelerating factors affecting regional mobility can be introduced as Q_i in (13). They are such factors as income motivation represented by relative per capita income, gravity-type distance factors related to transport efficiency, external costs and benefits in different regions, etc.[1/]

1/ For econometric studies in regional demographic pattern dealing with relative income difference, see T. Tukuchi and M. Nobukuni [1] and K. Mera [3].

In view of limited availability of data on Q especially in continuity as time series, we change the form of (15) into the form of loglinear equation as below.

$$(16) \quad \ln N_{i(t)} = \alpha_i + (1 + \varepsilon_i) \ln N^*_{i(t)} + \beta_i \ln Q_{i(t)} + \gamma_i Z_i$$

where Z_i denotes regional dummy variable.

As discussed later, we tried various alternative variables for Q_i, among which most important factors are listed as below.

1. relative per capita income (Y_i)
2. social cost (S_i)
3. scale effect (X_i)
4. fiscal and financial policy variable (P_i)
5. limiting factor variable ($L_i = f(\hat{N}_i - N_i)$)

The last variable needs some comment, as they are taken from our Markov-type multiplier matrix estimation which is defined as

$$(17) \quad \hat{N}_{i(t)} = \sum_j (I - c_{ij(t)})^{-1} (B_{i(t)} + F_{i(t)}).$$

Since we are particularly interested in growth limit of regional population, inverse matrices of 46 x 46 are computated for our five observation period and upper growth limits $\hat{N}_i$ are obtained by assuming $N_t = N_{t-1}$ under given B_t and F_t. Thus our limit factor variable is made a function of $\hat{N}_i - N_i$ as seen later.

4. Empirical Results

A. Statistical Data and Estimation of Regional Demographic Accounts

As a basis for our analysis, five tables for interregional demographic accounts (46 x 46) were constructed for the years, 1954, 1959, 1964, 1969 and 1974. The most important statistical sources are: (a) National Population Census (Statistics Bureau) (b) Vital Statistics (Ministry of Welfare) (c) Annual Report of Regional Demographic Movement based on Basic Resident Registers (Statistics Bureau) (d) International Migration Statistics (Ministry of Justice). The first source (a) provides a benchmark of prefectural population on which the annual time series of prefectural population are estimated by using the other three sources. For each prefecture the annual changes in population are estimated by adjusting net natural increase from source (b) and net social increase from sources (c) and (d). The population data are recorded as of October 1 of every year in view of consistency with source (a). Okinawa is excluded because of continuity of our analysis and international tourists are also excluded from international migration data. The prefectural estimates are regarded to be highly accurate, the errors being about 0.3 percent when checked against source (a) in every five years. For analytical point of view, source (c) is most important for compiling our demographic account, and it is also regarded as fairly reliable. Thus, theoretically we could compile our table for each year, but in this study only five tables were prepared in view of available time and resources.

B. Changes in Transition Coefficients

As stated earlier, a rapid process of urbanization since the War has been concentrated into three large metropolitan areas but this tendency has recently been levelling off. The migration coefficients c_{ij} obtained from our demographic account are related to this changing pattern of interregional migration as shown in Table 4. Here we have indicated only three prefectures because of space, but they indicate an interesting pattern of our regional population movement. All the three prefectures show declining tendency for their diagonal parameters during 1954 - 1964, while the trend levels off or even reverses during 1964 - 1974. Tokyo indicates the fastest declining trend, though somewhat decelerated for the later period.

Yamagata, the remotest prefecture among the three, tended to migrate to Kanto region, especially to Tokyo (13) for the earlier period but it has recently changed to migrate more to neighboring prefectures such as Miyagi (4) and Akita (5) or suburbanized prefecture such as Chiba (12). It should also be noted that its migration to Chugoku and Kyushu tends to keep increasing, though limited in percentage.

Saitama, one of the fastest increasing prefectures in Japan, still tends to increase its migration to other regions especially to Tokai and Kinki regions, while its migration to neighbouring Tokyo shows the highest rate for the earlier period but also declined recently.

Table 4. Changes in Transition Coefficients, Yamagata, Saitama and Tokyo

	6. Yamagata			11. Saitama			12. Tokyo		
Prefecture No.	1954	1964	1974	1954	1964	1974	1954	1964	1974
1.	.1720	.1255	.0666	.0255	.0672	.1216	.1112	.1443	.1947
2.	.0248	.0371	.0362	.0067	.0273	.0478	.0335	.0557	.0726
3.	.0299	.0364	.0480	.0093	.0290	.0502	.0375	.0537	.0726
4.	.1310	.2527	.3283	.0301	.0551	.0848	.0782	.1048	.1127
5.	.0779	.1121	.1156	.0152	.0287	.0406	.0564	.0553	.0641
6.	96.5255	95.8820	96.3343	.0187	.0275	.0392	.0818	.0662	.0595
7.	.0857	.1100	.1136	.0394	.0676	.0942	.1386	.1279	.1252
8.	.0280	.0381	.0373	.0574	.0954	.1598	.1957	.1978	.2302
9.	.0194	.0322	.0410	.0578	.0848	.1204	.1538	.1399	.1220
10.	.0191	.0221	.0176	.1182	.1842	.1557	.1192	.1254	.0936
11.	.0704	.2045	.2023	96.2431	95.1172	94.9439	.4127	1.1709	1.3188
12.	.0561	.1160	.1570	.0952	.2431	.4067	.4051	.9072	1.0703
13.	1.1662	1.2660	.7465	1.8895	2.1845	1.5241	-.3272	92.6480	91.8767
14.	.3135	.4894	.3623	.1721	.3370	.3416	.7542	1.3810	1.1386
15.	.0498	.0886	.0777	.0545	.0660	.0781	.2013	.1446	.1320
16.	.0050	.0099	.0106	.0048	.0101	.0151	.0329	.0328	.0321
17.	.0081	.0080	.0106	.0035	.0108	.0160	.0326	.0281	.0307
18.	.0046	.0055	.0027	.0018	.0029	.0064	.0185	.0144	.0162
19.	.0043	.0053	.0065	.0154	.0176	.0266	.0813	.0719	.0678
20.	.0062	.0118	.0105	.0376	.0449	.0617	.1378	.1101	.1106
21.	.0208	.0120	.0078	.0043	.0096	.0138	.0235	.0233	.0256
22.	.0736	.0907	.0486	.0396	.0805	.0930	.1633	.1495	.1562
23.	.0677	.0820	.0573	.0227	.0550	.0759	.1000	.1265	.1260
24.	.0086	.0132	.0079	.0052	.0097	.0151	.0240	.0249	.0244
25.	.0047	.0050	.0045	.0027	.0055	.0096	.0137	.0111	.0121
26.	.0134	.0126	.0150	.0086	.0120	.0207	.0398	.0367	.0386
27.	.0422	.0426	.0337	.0239	.0634	.0916	.1156	.1703	.1604
28.	.0171	.0147	.0148	.0167	.0335	.0493	.0902	.1044	.1018
29.	.0028	.0038	.0029	.0039	.0040	.0094	.0072	.0090	.0154
30.	.0044	.0038	.0021	.0029	.0043	.0057	.0137	.0140	.0127
31.	.0008	.0005	.0006	.0010	.0034	.0063	.0090	.0083	.0115
32.	.0010	.0004	.0013	.0019	.0038	.0064	.0129	.0117	.0141
33.	.0038	.0023	.0048	.0031	.0078	.0167	.0226	.0286	.0319
34.	.0047	.0031	.0053	.0057	.0142	.0273	.0457	.0523	.0610
35.	.0034	.0023	.0036	.0021	.0103	.0146	.0301	.0299	.0343
36.	.0002	.0009	.0011	.0008	.0034	.0046	.0091	.0089	.0127
37.	.0010	.0028	.0023	.0019	.0052	.0090	.0146	.0180	.0127
38.	.0017	.0016	.0030	.0033	.0077	.0132	.0226	.0266	.0303
39.	.0010	.0017	.0007	.0019	.0028	.0063	.0136	.0143	.0164
40.	.0065	.0051	.0067	.0129	.0571	.0764	.0788	.1000	.1180
41.	.0008	.0003	.0007	.0027	.0063	.0085	.0138	.0173	.0190
42.	.0019	.0015	.0027	.0038	.0085	.0166	.0270	.0306	.0385
43.	.0027	.0014	.0022	.0034	.0123	.0233	.0233	.0329	.0460
44.	.0018	.0017	.0022	.0017	.0057	.0135	.0177	.0208	.0308
45.	.0017	.0066	.0032	.0021	.0083	.0165	.0135	.0219	.0348
46.	.0010	.0019	.0025	.0042	.0130	.0294	.0347	.0433	.0650

The most dramatic change is observed for Tokyo where its diagonal coefficient falls rapidly for earlier period but continues to fall even later to 91.87 , the lowest in Japan as shown in Table 5. The fall is chiefly accounted for by the increase in absorbing capacity of neighboring prefectures such as Saitama, Chiba and Kanagawa, but the recent tendency is attributed to nation-wide decentralization in particular the reversed trend (or hitting the bottom) in formerly declining remote regions. The former is regarded as an overflow or extention of the Kanto metropolitan region, while the latter is related to the recent "U-turn phenomenon" of population movement. It is particularly note-worthy that the outflows are increasing in 1974 to less populated areas such as Tohoku, Sanin, Sanyo, Shikoku and Kyushu which used to serve as main regions for labor supply to large metropolitan areas since before the War.

The changes in transition coefficients in the above three prefectures represent three main factors in the past twenty years: a) increasing but, recently, leveling off tendency of demographic mobility as shown in changes in diagonals, b) suburbanizing tendency of metropolitan regions with central area already saturated and c) earlier rapid emigration and recent "U-turn phenomenon" in traditionally rural regions.

Therefore, a simple application of the transition coefficient to forecasting tend to be biased, i.e. a) overestimation of population for rural and underestimation for urban regions especially in earlier period and b) negligence of "U-turn" and level-off of migration process.

Table 5. Diagonal Coefficients (A) and the Rate of Population Increase (B)

Prefecture No.	(A)			(B)			
	1954	1964	1974	1954	1964	1974	(%)
1.	98.1	97.4	97.3	2.1	0.5	1.0	
2.	97.6	96.1	95.8	1.1	0.2	0.6	
3.	97.4	95.8	96.0	1.2	-0.6	0.6	
4.	97.1	95.9	96.0	2.0	0.5	1.5	
5.	96.9	95.8	96.1	0.7	-0.8	0.1	
6.	96.5	95.9	96.3	0.5	-0.7	0.3	
7.	96.3	95.8	96.0	0.8	-0.5	0.5	
8.	96.4	95.9	96.3	0.9	0.2	1.9	
9.	96.0	96.0	96.4	0.5	0.3	1.4	
10.	96.5	96.4	96.9	0.1	0.5	1.1	
11.	96.2	95.1	94.9	1.7	5.0	3.7	
12.	95.8	95.1	94.7	0.9	3.8	3.9	
13.	95.3	92.6	91.9	2.5	1.9	0.1	
14.	95.5	94.6	94.1	2.7	4.8	2.4	
15.	96.3	96.2	96.6	0.6	-0.3	0.7	
16.	97.0	96.7	96.7	0.7	0	0.7	
17.	96.7	96.5	96.4	0	0.4	1.3	
18.	96.6	96.3	96.5	0.4	0	0.8	
19.	96.1	95.8	96.0	1.0	-0.1	0.8	
20.	96.4	96.4	96.7	0.3	-0.1	0.7	
21.	96.5	95.9	96.3	0.6	0.9	0.9	
22.	97.0	96.5	96.3	1.3	1.3	1.2	
23.	97.3	96.3	96.0	1.9	3.0	1.4	
24.	96.7	96.0	96.1	0.2	0.5	1.1	
25.	96.0	95.5	95.7	0.3	0.4	2.2	
26.	96.3	95.6	95.0	1.0	1.1	1.2	
27.	95.9	95.0	94.7	2.4	3.7	1.2	
28.	96.3	94.5	95.2	1.6	1.8	1.2	
29.	95.6	95.0	94.9	0.7	1.1	2.4	
30.	96.6	95.9	96.2	1.4	0.8	0.4	
31.	96.3	95.4	95.7	0.7	-0.5	0.7	
32.	96.7	94.7	95.5	0.6	-1.6	0.4	
33.	96.8	95.8	95.9	0.8	0	1.2	
34.	96.9	96.2	95.6	1.1	1.1	1.3	
35.	96.5	94.7	95.3	1.1	-1.0	0.6	
36.	96.4	95.6	95.9	0.5	-0.8	0.5	
37.	96.4	95.5	95.6	0.3	-0.1	1.3	
38.	96.7	95.5	96.0	0.9	-0.7	0.8	
39.	97.0	95.5	95.9	2.8	-0.8	0.5	
40.	96.5	95.0	95.5	1.2	-0.2	1.6	
41.	95.3	93.8	94.9	0.7	-1.5	0.8	
42.	96.0	93.9	94.9	1.5	-1.7	0.7	
43.	96.8	94.7	95.2	1.9	-0.9	0.8	
44.	96.4	94.8	95.2	1.4	-1.0	1.0	
45.	96.5	94.4	95.1	1.7	-0.8	1.2	
46.	95.9	94.3	94.4	1.6	-1.1	0.2	
Average				1.4	1.1	1.3	

Note: For prefecture No. see Table 1 or Appendix 1.

C. Ex Post Forecast, 1955 - 1970

The results of our ex post forecast with our Markov model for our observation period, 1955 - 1970 are summarized in Table 6. Though the results are available for every year, we take up only five years for convenience. Here it is assumed that $\hat{c}_{ij}$ coefficients of 1954 are constant over time, as in equation (7), Section 3.

As expected, the results with our Markov model for earlier periods of 1955 and 1960 are fairly satisfactory, while those in later periods tend to be biased for rapidly changing prefectures such as three metropolitan areas or declining rural prefectures. Fairly accurate results are obtained during the first half of our period for such regions as Southern Kanto and Hokuriku regions, where the rates of increase in population are relatively slow or almost stable. Hiroshima and Shiga prefectures show a similar pattern and their predictive errors are quite small for this period.

For the second half of our period almost all the prefectures tend to have larger prediction errors. Taking examples, the errors for Tokyo are 15 and 30 percent for 1970 and 1975 respectively. This overestimation is obviously attributable to unexpectedly higher rate of outflow to neighbouring and other regions as stated before. Next to Tokyo in almost all the prefectures in Tohoku, Sanin, Sanyo, Shikoku and Kyushu regions our results are overbiased but their rates of divergence tend to level off for 1975. In contrast, underestimations are observed for growing regions such as Northern and Southern Kanto regions (except Tokyo), Tokai region (except Shizuoka and Mie), and Kinki regions (except Kyoto, Hyogo and Wakayama). The largest error of 40 percent is shown for Saitama, the most rapidly growing prefecture, in 1975.

D. Regression Analysis and Revised Version of Markov Model

As discussed in Section 3, the second step of our approach is to apply regression analysis to correct the above biased results by pooling both cross section and time series data for 13 aggregated regions and five years i.e. 1955, 1960, 1965, 1970 and 1975. The above population estimates with our Markov model, N^*, were used as a main explanatory variable and several additional variables were considered as candidates for estimating our equation (16) in Section 3. These additional factors Qs are expected to account for the causes of the divergence between N and N^*.

As regards the data, relative per capita income $Y_{i(t)}$ is readily available every year from the Prefectural Income Statistics of the Economic Planning Agency (EPA). But the data for social cost $S_{i(t)}$ is a rough approximation based on data on traffic congestion and density of industrial activity. The former data are approximated as number of registered cars per urbanized area, while the latter data are defined as amount of industrial shipment per urbanized area. Data on policy variables $P_{i(t)}$ are available from prefectural time series of public investment and public loans in EPA statistics. As the variable representing economies of scale we introduce real prefectural domestic products $X_{i(t)}$ which is also available from EPA time series data.

The last important variable, limiting factor $L_{i(t)}$, is taken directly from our Markov model estimation. Two alternative specifications are made as below.

$$L_{1i(t)} = \frac{\hat{N}_{i(t)}}{\sum_i \hat{N}_{i(t)}} - \frac{N_{i(t)}}{\sum_i N_{i(t)}}$$

$$L_{2i(t)} = \frac{\hat{N}_{i(t)} - N_{i(t)}}{\sum_i \hat{N}_{i(t)}}$$

Markov-type stationery state estimates $\hat{N}_{i(t)}$ as shown in equation (17) were obtained for five years in our observation period, and they are regarded as approximations to population growth limit for each region. The difference between $\hat{N}$ and N is thus considered as an idle capacity which is positively related to the population growth. Table 7 shows changing pattern of $L_{2i(t)}$, the rate of idle capacity for population growth which tends to decelerate (or accelerate) the growth if the rate becomes lower (or higher). The higher but levelling off tendency is observed for metropolitan regions such as Southern Kanto, Tokai, Southern Kinki regions, while the rates in other regions are lower but their declining tendency hits the bottom in 1969 and goes to reverse later on. The U shape trend is almost common to non-metropolitan areas especially in Tohoku, Shikoku and Kyushu. Since the population growth potencial $\hat{N}_{i(t)}$ depends on net inflow (or net outflow), the rate of mortality, and the absolute level of births and international immigrants, the recent increase is mostly accounted for by the increased international immigrants and gradual decline in mortality.

The results of our estimation are given in Table 8, among which equation 6 is the most satisfactory.

Table 6. Ex Post Forecast with Markov Model

Prefecture No.	1955 N	1955 N*	1955 N-N*	1960 N	1960 N*	1960 N-N*	1965 N	1965 N*	1965 N-N*	1970 N	1970 N*	1970 N-N*	1975 N	1975 N*	1975 N-N*
1.	4701	4690	11	5001	4977	24	5142	5238	-96	5197	5497	-301	5284	5772	-488
2.	1364	1364	1	1421	1435	-13	1416	1485	-69	1427	1529	-102	1445	1572	-128
3.	1412	1413	*	1447	1457	-10	1416	1478	-63	1378	1490	-112	1365	1504	-140
4.	1707	1708	-1	1742	1770	-29	1743	1811	-67	1803	1858	-55	1916	1936	-20
5.	1338	1338	*	1339	1358	-19	1287	1357	-70	1246	1351	-105	1222	1356	-135
6.	1350	1349	*	1326	1341	-15	1271	1322	-52	1231	1306	-75	1213	1309	-96
7.	2083	2081	3	2062	2085	-23	1990	2062	-72	1947	2039	-89	1955	2048	-93
8.	2055	2053	2	2046	2066	-19	2051	2069	-18	2114	2099	15	2296	2189	107
9.	1542	1546	-3	1514	1528	-15	1518	1507	11	1563	1511	52	1678	1566	112
10.	1608	1607	1	1583	1601	-17	1596	1592	4	1644	1613	31	1743	1676	67
11.	2239	2240	-2	2387	2367	20	2896	2542	354	3711	2859	853	4687	3318	1369
12.	2182	2181	1	2278	2241	37	2625	2353	272	3230	2571	659	4018	2918	1110
13.	7779	7810	-32	9360	9382	-22	10639	11128	-489	11294	13016	-1722	11418	14800	-3382
14.	2840	2843	-4	3311	3246	64	4229	3756	473	5265	4443	822	6228	5228	1000
15.	2463	2458	5	2446	2450	-4	2400	2436	-36	2364	2449	-85	2370	2499	-129
16.	1017	1016	1	1029	1012	17	1024	1009	15	1024	1017	7	1062	1046	16
17.	959	958	1	968	966	2	976	975	*	994	996	-2	1049	1042	6
18.	744	742	2	747	743	4	747	743	4	739	747	-8	761	766	-5
19.	803	801	2	783	789	-6	763	781	-18	760	785	-25	774	805	-31
20.	2016	2013	3	1982	1977	5	1955	1952	3	1949	1955	-6	2003	2003	*
21.	1571	1573	-3	1617	1588	28	1680	1615	65	1735	1661	74	1837	1741	96
22.	2619	2611	7	2731	2771	-40	2878	2929	-51	3052	3127	-75	3276	3387	-110
23.	3687	3693	-6	4087	4036	50	4667	4443	224	5245	4950	295	5817	5563	255
24.	1474	1475	-1	1476	1500	-25	1505	1533	-28	1528	1579	-51	1605	1653	-48
25.	845	845	*	834	844	-10	844	847	-3	872	861	11	964	903	61
26.	1881	1881	*	1950	1963	-13	2045	2075	-29	2186	2233	-47	2340	2435	-95
27.	4425	4438	-13	5214	5053	160	6351	5807	543	7319	6704	615	8018	7647	371
28.	3532	3542	-10	3795	3819	-24	4191	4157	35	4537	4580	-43	4875	5070	-197
29.	770	764	6	775	752	23	810	753	57	904	780	124	1056	837	218
30.	994	990	3	997	1013	-16	1016	1041	-25	1036	1084	-48	1061	1143	-83
31.	609	607	2	600	611	-11	581	610	-29	568	608	-40	575	617	-43
32.	920	917	3	892	925	-33	831	924	-93	779	920	-141	763	924	-161
33.	1675	1676	-1	1664	1695	-31	1636	1706	-70	1684	1736	-51	1786	1807	-21
34.	2121	2119	3	2166	2183	-16	2248	2248	*	2397	2353	45	2598	2512	86
35.	1574	1573	1	1591	1614	-23	1534	1645	-111	1499	1683	-184	1520	1737	-218
36.	876	873	2	853	867	-14	819	852	-33	793	842	-49	792	846	-54
37.	939	938	1	925	944	-19	901	944	-43	903	955	-52	948	988	-40
38.	1530	1529	1	1510	1544	-35	1448	1547	-99	1419	1555	-137	1441	1586	-145
39.	878	878	*	862	895	-33	818	906	-88	789	919	-130	793	945	-151
40.	3801	3814	-13	3983	4016	-33	3933	4186	-253	3999	4381	-382	4165	4595	-430
41.	967	964	3	950	969	-19	877	960	-83	841	951	-110	825	950	-125
42.	1730	1737	-7	1763	1798	-35	1650	1827	-177	1587	1843	-256	1548	1860	-312
43.	1873	1869	4	1869	1943	-74	1777	1985	-207	1716	2017	-300	1684	2046	-362
44.	1262	1259	3	1243	1284	-41	1191	1293	-102	1154	1300	-146	1168	1321	-153
45.	1127	1126	*	1137	1173	-36	1086	1198	-113	1058	1214	-156	1065	1236	-171
46.	2026	2018	8	1980	2053	-74	1869	2059	-190	1753	2052	-299	1692	2044	-352
TOTAL	87909	87924	-15	92235	92645	-410	96868	97685	-816	102233	104013	-1780	108698	111751	-3052

Note: For prefecture No., See Appendix 1.

Table 7. The Rate of Idle Capacity for Population Growth (L_2)

	1954	1959	1964	1969	1974
1. Hokkaido	0.624	0.599	0.449	0.329	0.500
2. Tohoku	0.512	0.390	0.356	0.336	0.460
3. Kanto, North	0.486	0.394	0.482	0.504	0.553
4. Kanto, South	0.727	0.700	0.680	0.583	0.460
5. Hokuriku	0.622	0.578	0.592	0.536	0.524
6. Tokai	0.446	0.377	0.407	0.401	0.500
7. Kinki, North	0.452	0.481	0.523	0.538	0.540
8. Kinki, South	0.671	0.647	0.582	0.539	0.479
9. Sanin	0.467	0.269	0.231	0.311	0.426
10. Sanyo	0.511	0.410	0.415	0.462	0.496
11. Shikoku	0.472	0.328	0.317	0.342	0.457
12. Kyushu, North	0.529	0.406	0.245	0.273	0.475
13. Kyushu, South	0.518	0.317	0.243	0.215	0.458

All the factors except scale variable X and policy variable P turn out to be fairly significant. Among them Markov estimate N^* is naturally most significant with the coefficients slightly higher than unity. Per capita income differencial Y is also significant next to N^*, and its elastisity is 0.118 which explains general U-shape trend in interregional migration, especially in regions 2, 9, 11, 12 and 13, as shown in Table -9. Per capita income advantage in metropolitan regions such as regions 4 and 8 gradually keep falling and there is a noticeable tendency of income equalization among regions.

Social cost variable $S_{i(t)}$ is also significant. Though its elasticity is small, its contribution as negative pressure to population inflow to metropolitan regions can not be ignored. Besides, the effects becomes important, if the rapid rate of increase in road traffic and industrial concentration are considered.

Policy variable $P_{i(t)}$ turns out to be insignificant and negative. This probably implies that the effects of $P_{i(t)}$ is already reflected in income differencial $Y_{i(t)}$ and our regional development policy has not been strong enough to shift the pattern of demographic movement independently of the relative per capita income factor. It might be that direct measures to equalize income differencials through tax policy is sometimes more effective than Keynsian type public investment policy whose effects tend to leak substantially in less developed regions.

Economies of scale factor X_i is not significant probably because of similar reason to P_i. It is also likely that the effect of S_i overshadows the scale factor especially in recent decade.

Our last variable L_2, the rate of idle capacity for population growth, is fairly significant, while L_1, difference in relative share turns out to be less significant. Decelerating rate of increase in Southern Kanto and Southern Kinki regions is well attributable to this limiting factor. Since the population growth limit defined by Markov multiplier matrix can not be raised in a short term, decline in idle space in metropolitan regions tend to automatically check their further growth of population independently of $Y_{i(t)}$ and $S_{i(t)}$.

In regard to regional dummy variable Z_i, our empirical result indicates the significance for Northern Kanto, Tokai and Northern Kinki. Tokai is featured by its fast economic growth as a new metropolitan area, with a higher potential, while the other two regions are noted as neighbours of metropolitan regions which give strong spill-overs to these two regions.

5. Concluding Remarks - Implications for Social Policy

As discussed earlier, a rapid industrialization and relative delay in regional development policy by the government has brought about imbalanced distribution of population, especially an excessive concentration in metropolitan areas since the mid 1950's. Although there are many indications of level off and even U-turn phenomenon in recent years, the imbalance of distribution still seems to continue. This imbalance has its own momentum: because of significant changes in age structure rural regions with high rate of emigration tend to decelerate its rate of natural increase, whereas reverse trend takes place in large metropolitan areas where the natural rate tends to be accelerated. The rate of natural increase in Shimane and Kohchi prefectures declined from 0.9 to 0.5 percent during 1955 to 1965, while the national average rate slightly rose from 1.0 to 1.1 percent during that period. In 1970 the rates of natural increase in the above two prefectures are 0.5 and 0.4 respectively, whereas those in Tokyo, Aichi and Osaka are 1.5, 1.6 and 1.8 percent respectively. This fact implies that once the momentum starts accelerating through migration the rate of change in population becomes harder for the government to control even by restricting or encouraging migration. In other words, highly traditional forces of "habit formation" tend to act in the field of demographic movement. Nevertheless, the recent trend or some indications of decentralization seems to be encouraging from the point of regional development as well as social policy.

Our analysis with the revised Markov model suggests several interesting points with regard to social and regional development policies which are summarized as below.

First, decentralization policy must be encouraged more through measures to narrow per income differentials among regions rather than through direct public investment which sometimes leaks its multipliers impact upon local employment. Tax incentives to persons needs to be more seriously considered instead of excessive reliance on investment policy.

Secondly, external costs of urban environment due to traffic congestion and industrial pollution tend to dominate the advantage in scale effect of metropolitan areas according to the present study. Decentralization policy, thus, need to be more concerned about its environmental assessment especially in non-metropolitan regions so as to encourage outflows from metropolitan areas.

Thirdly, in promoting regional and social development policies, emphasis must be placed on medium-sized prefectures neighbouring metropolitan areas as they have increasing population potentials as observed in the case of Northern Kanto, Northern Kinki and Tokai regions.

Fourthly, even after the equalization of per capita income is achieved, the present unbalanced structure of population is likely to continue because of the inertial nature of population movement. The importance of redeveloping of metropolitan areas should not be ignored in this context, though requiring much resources.

The strengthening of transportation and communication networks and the decentralization of educational facilities, though not explicitly analyzed in the present paper, seem to encourage migration to newly developing regions. Since these factors tend to work with accelerating impact on interregional migration, the present government policy needs more explicitly to take account of these external socio-economic influences.

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Appendix Regional Classification

Prefecture	Region	Prefecture	Region
1. Hokkaido	1. Hokkaido	24. Mie	6. Tokai
2. Aomori	2. Tohoku	25. Shiga	7. Kinki, North
3. Iwate	do.	26. Kyoto	do.
4. Miyagi	do.	27. Osaka	8. Kinki, South
5. Akita	do.	28. Hyogo	do.
6. Yamagata	do.	29. Nara	7. Kinki, North
7. Fukushima	do.	30. Wakayama	8. Kinki, South
8. Ibaragi	3. Kanto, North	31. Tottori	9. Sanin
9. Tochigi	do.	32. Shimane	do.
10. Gunma	do.	33. Okayama	do.
11. Saitama	4. Kanto, South	34. Hiroshima	10. Sanyo
12. Chiba	do.	35. Yamaguchi	do.
13. Tokyo	do.	36. Tokuyama	do.
14. Kanagawa	do.	37. Kagawa	11. Shikoku
15. Niigata	2. Tohoku	38. Ehime	do.
16. Toyama	5. Hokuriku	39. Kohchi	do.
17. Ishikawa	do.	40. Fukuoka	do.
18. Fukui	do.	41. Saga	12. Kyushu, North
19. Yamanashi	3. Kanto, North	42. Nagasaki	do.
20. Nagano	do.	43. Kumamoto	13. Kyushu, South
21. Gifu	6. Tokai	44. Ohita	12. Kyushu, North
22. Shizuoka	do.	45. Miyazaki	13. Kyushu, South
23. Aichi	do.	46. Kagoshima	do.

Note: Okinawa is not included in view of continuity in time series.