A Study on Areal Concentration of Population and Regional Income

Hirozo OGAWA and Etsuo YAMAMURA*

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Abstract

Theoretical concentration analyses were made, namely a time series analysis and a distribution analysis of areal concentration were conducted. The results were compared with the actual data of prefectural population and income.

According to the time series analysis of areal concentration of a prefectural population, a rapid areal concentration of population is apparent with an especially remarkable expansion of the commuting area of Tokyoto and Osakafu.

With respect to the prefectural income related to areal concentration, the correlations between the rates of changes of prefectural population and total engaged persons indicate high values and it was concluded that the main factor of areal concentration of population is the total engaged persons.

According to the time series analysis and weight vector and structure vector of areal concentration of prefectural income, it seems that the areal concentration of production incomes of secondary and tertiary industries increases gradually with the lapse of time and the main factor of the rate of changes of production income depend on these industries.

1. Introduction

At present, it is accepted that traffic problems are invariably involued as a strong influencing factor in our complex social and economical mechanisms of public facilities, transportation and communication networks with special regards to the rapid concentration of population in a metropolitan area.

In this paper, we have dealt with statistics of mass behaviors and properties of regional structures. And the direction of research is also connected with the basic problems of concentration by using the η curve methods; a time series analysis and a distribution analysis of areal concentration.

2. Measurements of Areal Concentration

In this chapter, the η curve methods are briefly reviewed. We define the notations of the η curve as follows.

$Y=\{y_i|(i=1, \cdots, n)\}$: the set of distribution ratios of nonbasic magnitude in the vertical axis.

$X=\{x_i|(i=1, \cdots, n)\}$: the set of distribution ratios of basic magnitude in the horizontal axis.

n : the number of subareas in the studied area.

* Department of Civil Engineering, Hokkaido University, Sapporo, Japan.

Where

$$\sum_{i}^{n} x_i = \sum_{i}^{n} y_i = 1$$

$D=\{D_i|D_i=y_i|x_i\,(i=1, \cdots, n)\}$: the location quotient. We rank $\{D_i\}$ in a smaller order and have designated $\{D_j\}$ with the new number order j.

$$Y' = \{y'_j|y'_j = y'_{j-1}+y_j, \quad y'_1 = y_1, \quad (j=1, \cdots, n)\}$$

$$X' = \{x'_j|x'_j = x'_{j-1}+x_j, \quad x'_1 = x_1, \quad (j=1, \cdots, n)\}$$

In the following, the points of $X' \times Y'$ were plotted against each j. The η curve is formula $Y=X^b$. The value of b designates the coefficient of concentration.

(1) Areal Concentration Analysis

This analysis is the method to determine the location of a boundary of a concentrated area. The curvature of the η curve must be determined to find the boundary.

The curvature $d\theta/ds$ is follows :

$$d\theta/ds = y''/(\sqrt{1+(y')^2})^3$$

We define the breaking point that takes a maximum value of curvature and represents this breaking point as the concentrated point. We define the concentrated area as the area that lies to the right of the concentrated point.

(2) Time Series Analysis of Areal Concentration

This analysis indicates in what manner the distributions of areal concentration change with the lapse of time.

$Y=\{y_i|(i=1, \cdots, n)\}$: the set of distribution ratios of nonbasic magnitude of the next census year.

$X=\{x_i|(i=1, \cdots, n)$: the set of distribution ratios of basic magnitude of basic time.

$S=\{s_i|s_i=y_i|x_i, \ (i=1, \cdots, n)\}$: the set of shift ratios of areal concentration between basic year and the next census year.

We rank $\{s_i\}$ in a smaller number order and have designated $\{s_j\}$ with new number order j.

Where

$$\sum_{j}^{n} x_j = \sum_{j}^{n} y_j = 1$$

$$Y' = \{y'_j|y'_j = y'_{j-1}+y_j, \quad y'_1 = y_1, \quad (j=1, \cdots, n)\}$$

$$X' = \{x'_j|x'_j = x'_{j-1}+x_j, \quad x'_1 = x_1, \quad (j=1, \cdots' n)\}$$

In this case, the ratios of the basic magnitude X are plotted on the horizontal axis and the ratios of the nonbasic magnitude Y on the vertical axis against j.

(3) Distribution Analysis of Areal Concentration

This analysis indicates in what manner the distribution percentages of function change as the degree of coefficients of concentration increase.

$Y=\{y_{ij}|(i=1, \cdots, m), \ (j=1, \cdots, n)\}$: the set of distribution ratios of nonbasic magnitude index j against the coefficients of concentration $\{b_i\}$.

$F=\{f_{i,j}(b_i)|f_{i,j}(b_i)=(y_{i,j}|\sum_{j}^{n} y_{i,j})\times 100,\ (i=1,\cdots,m),\ (j=1,\cdots,n)\}$: the set of distribution percentages of nonbasic magnitude index j against the coefficients of concentration $\{b_i\}$.

On the horizontal axis are plotted the coefficients of concentration $\{b_i\}$. And on the vertical axis are plotted the distribution percentages of nonbasic magnitude F. With respect to the detailed concept described above, the reader may refer to the author's papers[1),2)].

3. Areal Concentration of Prefectural Population

A regional analysis of a population begins with the study of areal concentration of population. Since it provides a fundamental basis of the activities of human beings.

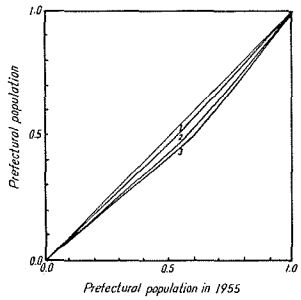
In this chapter, we shall discuss the empirical laws of the areal concentration of prefectural population.

First, for the time series analysis of areal concentration of prefectural population, we plotted the cumulative ratios of prefectural population in 1955 as the basic magnitude on the horizontal axis and the cumulative ratios of prefectural population in 1960, 1965 and 1970 as the nonbasic magnitude on the vertical axis. And the graph of the time series analysis is shown in Fig. 1.

It appears that the concentration of population increases gradually with the lapse of time.

In addition, we shall analyze the changes of the distribution percentages of population. Then, we plotted the distribution percentages of prefectural population on the vertical axis and the coefficients of areal concentration on the horizontal axis against the past census years. And these graphs are shown in Fig. 2 to Fig. 3.

From the graphs described above, the most remarkable feature from 1955 to 1960 is the heavy concentration of population in the Tokyoto, Osakafu, Aichi and Kanagawa prefectures. And the outstanding features from 1960 to 1965 are the



Number	Year	Coefficient of Concentration	Correlation Ratio
1	1960	1.04846	0.99930
2	1965	1.11075	0.99711
3	1970	1.16903	0.99510

Fig. 1. Time Series Analysis of Prefectural Population.

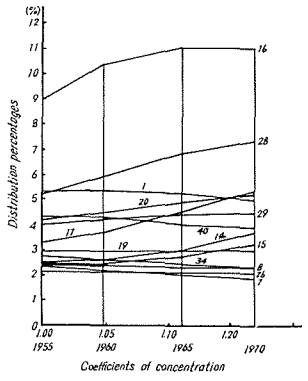


Fig. 2. Distribution Analysis of Prefectural Population (I).

expansion of concentrations around the prefectures mentioned above, that is Saitama, Chiba and Hyogo prefectures and the decreasing of population of Tohoku, Shikoku and South Kyushu regions. And the special features from 1965 to 1970 are the wide expansion of concentration around the prefectures mentioned above, namely in the Nara prefecture and North Kanto region and the temporary decrease of concentration of Tokyoto.

Next, the features mentioned above will be clarified by habitable area analysis. Here, the cumulative ratios of prefectural population per habitable area in 1960 are

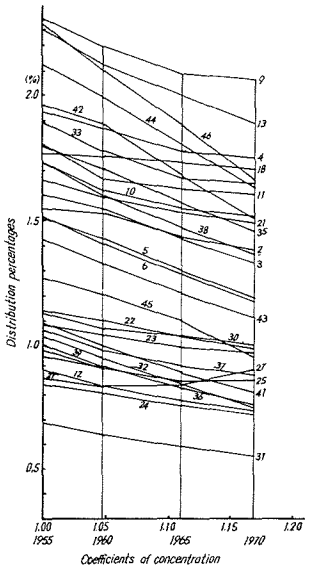
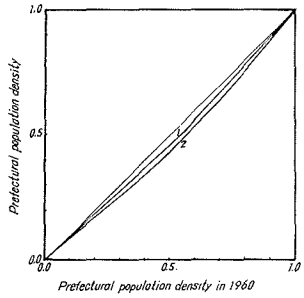


Fig. 3. Distribution Analysis of Prefectural Population (II).



Number	Year	Coefficient of Concentration	Correlation Ratio
1	1965	1.07074	0.99928
2	1970	1.13126	0.99865

Fig. 4. Time Series Analysis of Prefectural Population Density.

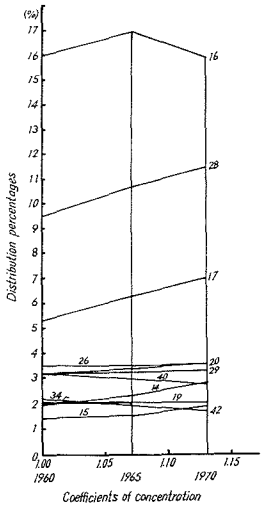


Fig. 5. Distribution Analysis of Prefectural Population Density (I).

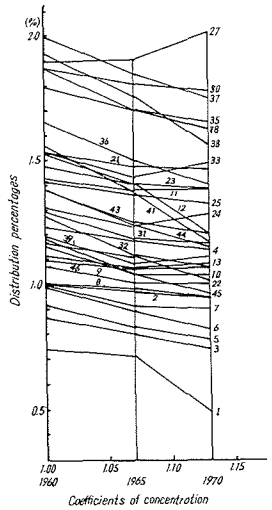


Fig. 6. Distribution Analysis of Prefectural Population Density (II).

plotted as the basic magnitude on the horizontal axis and those of 1965 and 1970 are plotted as the nonbasic magnitude on the vertical axis. And the graph is shown in Fig. 4.

It appears that the concentration of prefecural populotion per habitable area increases gradually with the lapse of time. In addition, we shall analyze the changes of the distribution percentages of population per habitable area from distribution analysis. The graphs are shown in Fig. 5 to Fig. 6. These graphs provide evidence of the features mentioned above.

The names of prefectures of distribution analysis are shown in Table 1.

Table 1. The Names of Prefectures

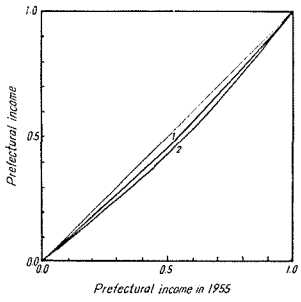
number	Prefectures	number	Prefectures	number	Prefectures
1	Hokkaido	17	Kanagawa	33	Okayama
2	Aomori	18	Gifu	34	Hirosima
3	Iwate	19	Shizuoka	35	Yamaguchi
4	Miyagi	20	Aichi	36	Tokushima
5	Akita	21	Mie	37	Kagawa
6	Yamagata	22	Toyama	38	Ehime
7	Fukushima	23	Ishikawa	39	Kochi
8	Niigata	24	Fukui	40	Fukuoka
9	Ibaraki	25	Shiga	41	Saga
10	Tochigi	26	Kyoto	42	Nagasaki
11	Gumma	27	Nara	43	Oita
12	Yamanashi	28	Osaka	44	Kumamoto
13	Nagano	29	Hyogo	45	Miyazaki
14	Saitama	30	Wakayama	46	Kagoshima
15	Chiba	31	Tottori		
16	Tokyo	32	Shimane		

4. Areal Concentration of Prefectural Income

As for the prefectural income, many arguments have been presented in as much as workers in the field of economics tend to think in terms of National Income Accounts.

In this chapter, we shall attempt to clarify the correlations between the areal concentration of prefectural population and income from a point of view of regional analysis.

First, we shall analyze the correlation between the rates of changes of



Number	Year	Coefficient of Concentration	Correlation Ratio
1	1960	1.09187	0.99905
2	1965	1.13905	0.99704

Fig. 7. Time Series Analysis of Prefectural Income.

prefectural population and total engaged persons. The correlations give high values of 0.97767 from 1960 to 1965 and 0.98691 from 1965 to 1970. These high correlations indicate that the main factor of areal concentration of population is the areal concentration of total engaged persons.

Next, we shall analyze the correlations between the prefectural income and total engaged persons.

For the time series analysis of areal concentration of prefetural income, we plotted the cumulatve ratios of prefectural income in 1955 as the basic magnitude and the ones in 1960 and 1965 as the nonbasic magnitude.

The graphs are shown in Fig. 7. These graphs indicate that the areal concentration of production income increases gradually with the lapse of time.

In addition, to clarify the cause of those changes, we shall caluculate the standard weight vector and structure vector. The results are shown in Table. 2. From Table 2, it is clear that the dominant factors of the rates of changes of production income are the secondary and tertiary industries.

Table 2. Standard Weight Vector and Structure Vector of Production Income

Standard Weight Vector

Criterion Composite	Predictor Composite		
Production Income	Primary	Secondary	Tertiary
1960/1955	0.14538	0.75495	0.40671
1965/1955	0.01301	0.54055	0.55221

Structur Vector

Criterion Composite	Predictor Composite			multiple Correlation Coefficient
Production Income	Primary	Secondary	Tertiary	
1960/1955	0.07699	0.91949	0.72445	0.90757
1965/1955	0.06415	0.91338	0.91832	0.88981

5. Conclusion

In summary, the areal concentration analyses was conducted and compared with the actual data of prefectural population and income. As a result, two points became clear.

First, according to the time series analysis of areal concentration of prefectural population, it appears that a remarkable expansion of commuting area around Tokyo to and Osakafu has resulted in a rapid areal concentration of population. Thus, the inflow trips to these prefectures have increased remarkably causing a persistent delay of traffic flow resulting in an aggravation of the urban enviroment.

Second, with respect to the areal concentration of prefectural income, the correlations between the rates of changes of prefectural population and total engaged persons indicate high values and the main influencing factor of areal concentration

of population is considered to be the total engaged persons.

According to the time series analysis and weight vector and structure vector of areal concentration of prefectural income, it seems that the areal concentration of production incomes of secondary and tertiary industries increases gradually with the lapse of time and the main influencing factor of rates of changes of production income depends on these industries.

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