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Statistical Analysis on Areal Concentration (I)

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Abstract

The present paper describes a few methods for deriving η curve suggested by Professor Hirozo Ogawa and applications were made on actual data for the analysis of areal concentration.

The author has proposed two new methods using η curve:

- (1) one method is founded on the degree of curvature of η curve with the intent of determining the location of boundaries between the concentrated and unconcentrated area.
- (2) the second method indicates the change of the distribution percentages of the function of concentration in a given area.

The author attempted to analyze the concentration of commercial function in the Hokkaido area.

1. Introduction

At the beginning of regional studies, the attempts were straight forward and resulted in tearing the problem down.

Nowadays, we know that regional problems are complex social mechanisms of institutions in which exist the rapid concentration of population in the metropolitan area and human resources intertwined with the processes of the metropolitan community.

Designs by governments turn on the state of such interdependent spatial systems as use of public facilities, transportation and communication networks, and the markets for land, housing and even labor, rather than the highly localized consequences directly elicited by political actions.

During the past ten years, the growing enthusiasm for the use of mathematical models as aids to regional planning and administration derives less from the proven adequacy of such than from the high speed and absolute mechanical accuracy with which mathematical models improve the planners ability to generate sound policy and effective programs.

The model thus constructed may fall into any of three classes depending on the thought of the model builder: there are descriptive models, predicative models and planning models.

The builder of a descriptive model has to replicate the relevant features of an existing regional environment or of an already observed process of regional change.

Good descriptive models are of scientific value because they reveal much about the structure of the regional environment reducing the apparent complexity of the observed world to the coherent and rigorous language of mathematical relationship.

The predicative model is to establish a logical framework for predication of the future.

The planning model necessarily incorporates the method of conditional predication but it goes further in the outcome of the planner's goals.

The model builder is concerned with the application of theories to a concrete case, with the aim of generating empirically relevant output from empirically based input. And he must be much more explicit in detailing the exact functional forms of his structural relations: he must also obtain his variables and parameters from empirical sources.

We prefer to deal with statistics of mass behavior and properties of regional development. And the macro analysis consists of a large part of descriptive generalizations based on empi-

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rical structure.

The author provides some orientation for the descriptive model and proposes a mathematical standard method for analysis of areal concentration and has applied the method to analyze the concentration of commercial functions.

2. Measurement of Areal Concentration

In the studies of regional science, various kinds of indices or coefficients have been used, so as to measure and describe the extent of areal concentration.

The present paper is related to such measures as location quotient of coefficient of localization curve as applied to the actual data for the analysis of areal concentration.

This direction of research also is connected with the basic problem of concentration and a new method of deriving the distribution from Lorenz curve.

Professor H. Ogawa referred to the localization curve as η curve. The localization will be referred to as η curve in the present paper. The author has run a comparison using η curve.

- (a) the degree of physical evenness of regional distribution of commercial functions which means the effect of the degree of the coefficient of η curve in the horizontal axis of cumulative ratios of distribution of population and in the vertical axis of cumulative ratios of the distribution of commercial indices.
- (b) the degree of curvature of η curve which means to determine the location of boundaries between the concentrated and unconcentrated area.

η curve is founded in the formula $Y = X^b$

The values X, Y are plotted graphically before starting the analysis in order to determine whether some curve other than the theoretical power function might fit the data better : so it becomes necessary to rectify the data by taking logarithms of X and Y before proceeding with the usual least-squares solution.

In short, the problem resolved itself into finding the value of the coefficient b in the following linear equation, which is a generalized version $\log Y = b \log X$.

The value of b determines the coefficients of the areal concentration.

If b is one, the distribution of index is not concentrated.

As b increases, η curve moves closer to the horizontal and vertical axis. It indicates that the distribution of index is better concentrated.

We must solve the curvature of η curve in order to determine the location of boundaries between the concentrated and unconcentrated area.

We can simply solve the curvature of η curve because η curve is denoted by X, Y axis.

We put,

$$d^2s = d^2x + d^2y \quad dy/dx = \tan \theta$$

The performance equations are as follows,

$$\frac{d}{d\theta} \left(\frac{dy}{dx} \right) = \frac{d}{d\theta} (\tan \theta) = \sec^2 \theta$$

$$\frac{d}{d\theta} \left(\frac{dy}{dx} \right) = \frac{d}{dx} \left(\frac{dy}{dx} \right) \frac{dx}{d\theta} = \frac{d^2y}{dx^2} \left(\frac{dx}{d\theta} \right) = \sec^2 \theta = 1 + \tan^2 \theta = 1 + \left(\frac{dy}{dx} \right)^2$$

Therefore,

$$\frac{dx}{d\theta} = \frac{1}{y''} (1 + y'^2) \quad \frac{ds}{dx} = \sqrt{1 + (dy/dx)^2} = \sqrt{1 + y'^2}$$

$$dy/dx = y' \quad dy/dx = y''$$

Curvature $d\theta/ds$ is as follows

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

We can determine the breaking point where the maximum value of the curvature are represented. We call this breaking point the concentrated point.

We define the concentrated area as the area that lies to the right of the concentrated point, and the unconcentrated area as the area that lies to the left of the concentrated point.

In addition, the author explains the method that indicates the change of the distribution percentages of a function as the function is concentrated in a area; in the horizontal axis of coefficients of concentration by function and in the vertical axis of the distribution percentages.

We call this method the distribution analysis.

3. Areal Concentration of Commercial Function

Human occupancy is a geographic unity consisting of various human activities.

The hierarchy of settlement has been observed and analyzed, since Walter Christaller, by many geographers in different countries to be essential to the understanding of regional characteristics.

In recent years, many new cities have come into existence and old ones have expanded their city areas absorbing their surrounding rural villages.

In such a new city area, consumers change their living conditions and consumer habits.

As for commercial activities, many arguments have been presented from the point of view that many economists are much more likely to think in terms of marketing.

They work from a theory of individual choice and have their own version of the market models.

Among these, the microanalytic approach has its problems, in that a model based on the theory of rational choice can be implemented only if the chooser's system of relative values can be specified in considerable detail.

It also is the implementation of a comprehensive market model embracing the entire range of transactions which substantially affects the patterns of urban development and land use.

In this paper, the author tries to clarify the correlations between the areal concentration of commercial functions and the regional development from the point of view of National Economy.

Reports of this type of research have apparently not been published to date.

First the author has attempted to contrast the geographic patterns of several commercial trades at a given point of time.

The basic magnitude is population and the nonbasic magnitude is the persons engaged. Cities and counties are taken as regions.

- (a) The experimental results of the concentration analysis for persons engaged in wholesale and retail trades (1964) by industry, city and county are shown in Fig. 1: the vertical axis is the cumulative number of persons engaged and the horizontal axis is the cumulative number of population.

The total number of persons engaged is slightly more concentrated in the central city Sapporo and local cities Asahikawa, Otaru, Hakodate, Kushiro, Muroran, Obihiro and Takikawa.

As for the areal concentration of persons engaged by industry, the persons engaged in wholesale and general merchandise are apparently concentrated in the cities with populations of 100,000 and over.

The central city of Sapporo, especially, has a high concentration of persons engaged in wholesale (42%) and in general merchandise (40%).

However, except for the food store trade which is in satisfactory agreement with the concentration of the total, the food and beverages retail trade which sell the household

commodities has no areal difference, and other industries do not show higher concentrations than that of the total.

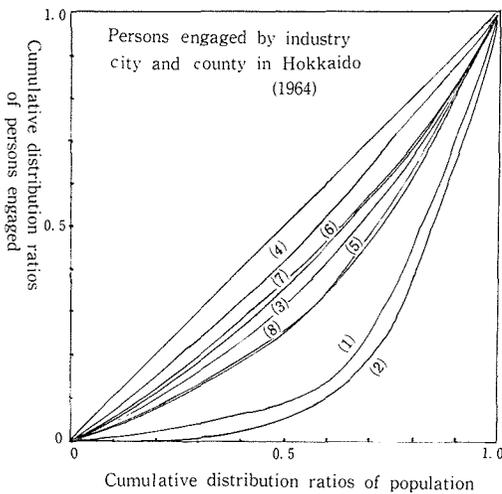
Next, the author explains the change of the distribution percentages by city and county as the coefficients of industries have higher values.

The changes of distribution percentages are shown from Fig. 2 to Fig. 5.

The changes of coefficients of η curve by industries are shown in table 1.

The set of cities and counties are divided into four groups.

The first group is the central and main local cities where the distribution percentages show higher values as the coefficients of concentration increase in values. The names of



- (1) Wholesale
- (2) General merchandise
- (3) Textiles, apparel and accessories
- (4) Food and beverages
- (5) Eating-house
- (6) Bicycles and Carts
- (7) Furniture and house furnishing
- (8) Total

Fig. 1

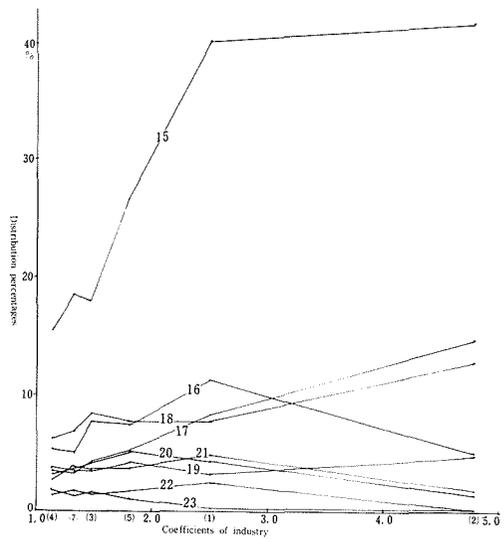


Fig. 2

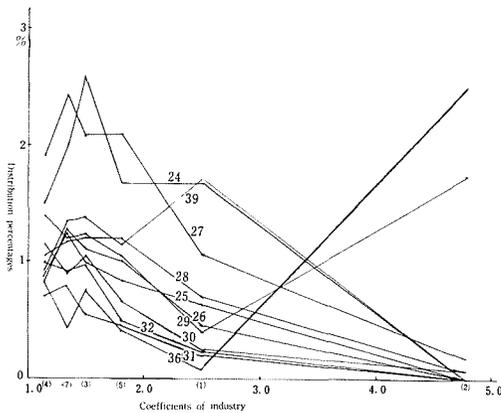


Fig. 3

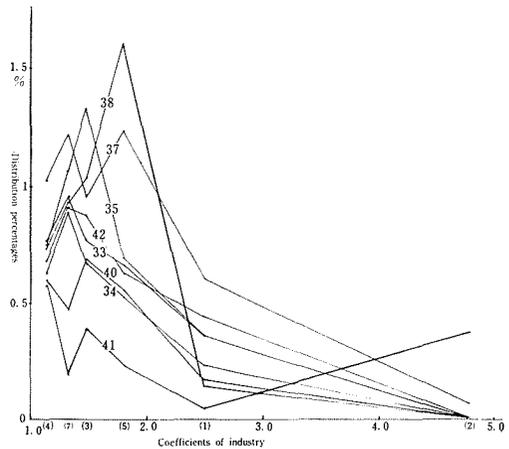


Fig. 4

these cities are Sapporo, Otaru, Hakodate and Muroran.

The second group show the local cities where the distribution percentages are almost unchanging. The names of these cities are Asahikawa, Kushiro and Obihiro.

The third group show the local cities where the distribution percentages present especially high value in wholesale or general merchandise concentration. The names of these cities are Kitami, Takikawa and Mikasa.

The fourth group show the local cities and counties where the distribution percentages

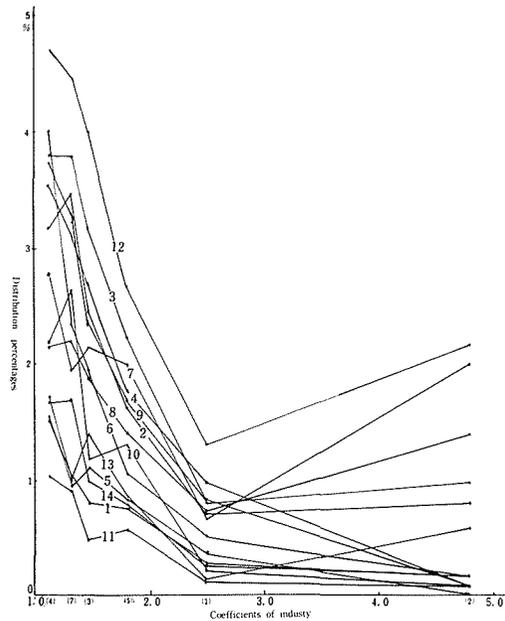


Fig. 5

Table 1

Number	Industry	η curve	Correlation coefficient
(1)	Wholesale	$y = x^{2.49784}$	0.96701
(2)	General merchandise	$y = x^{1.77909}$	0.97541
(3)	Textiles, apparel and accessories	$y = x^{1.47869}$	0.99560
(4)	Food and beverages	$y = x^{1.14695}$	0.99959
(5)	Eating house	$y = x^{1.81043}$	0.99195
(6)	Bicycles and Carts	$y = x^{1.49567}$	0.99704
(7)	Furniture and house furnishing	$y = x^{1.33207}$	0.99888
(8)	Total	$y = x^{1.70692}$	0.99500

Table 2

Number	Stores by scale	η curve	Correlation coefficient
(1)	1~4 persons engaged	$y = x^{1.68831}$	0.99570
(2)	5~9 persons engaged	$y = x^{2.00671}$	0.98900
(3)	10~29 persons engaged	$y = x^{2.52384}$	0.97699
(4)	30~49 persons engaged	$y = x^{1.90054}$	0.97033
(5)	50 and over persons engaged	$y = x^{0.25967}$	0.75401
(6)	Total	$y = x^{2.06163}$	0.98140

are slightly lower as the coefficients of concentration increase in values.

This group includes all other cities and counties except for those mentioned above.

(b) In addition, the experimental results of the concentration analysis for shops and stores by industry, city and county are shown from Fig. 6 to Fig. 8.

As for the total number of persons engaged, shops and stores with 1-29 persons are distributed equally, but these with 30-49 persons, and these with 50 persons and over are concentrated in the cities with populations of 100,000 and over, and these with 150,000 and over.

The distribution percentages of Sapporo increases from 31% to 44% as the scales of persons engaged expand from 30-49 persons to 50 persons and over.

As for wholesale, shops and stores with 10-29 persons, with 30-49 persons, and with 50 persons and over are remarkably concentrated in the cities with populations of 100,000 and over, and with populations of 200,000 and over.

As for general merchandise, it appears clear that shops and stores with 1-49 persons are concentrated in the cities with populations from 50,000 to 100,000, and these with 50 persons and over are concentrated in the cities with populations of 100,000 and over.

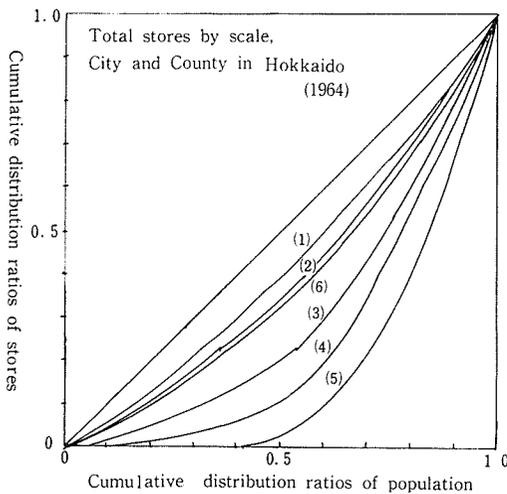
As for food and beverages, shops and stores with 1-29 persons are distributed almost equally, and these with 30-49 persons and 50 persons and over are concentrated in the cities with populations of 150,000 and over.

As for textiles, apparel and accessories, shops and stores with 30-49 persons and these with 50 persons and over are concentrated in the cities with populations 100,000 and over.

As for bicycles and carts, shops and stores are concentrated in the cities with populations of 50,000 and under and in the counties. The distribution percentages of persons engaged is only 0.8%.

Next, the author explains the change of the distribution percentages by city and county as the coefficients of wholesale store scales show higher values.

The changes of distribution percentages are shown from Fig. 9 to Fig. 11.



- | | |
|-------------------|-------------------------|
| (1) 1-4 persons | (4) 30-49 persons |
| (2) 5-9 persons | (5) 50 persons and over |
| (3) 10-29 persons | (6) total |

Fig. 6

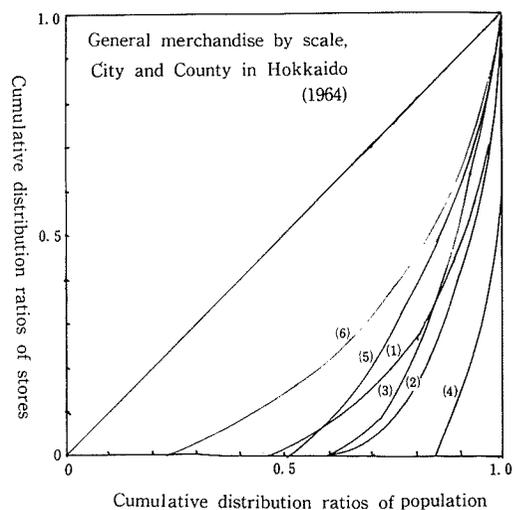


Fig. 7

The changes of coefficients of γ curve by wholesale store scales are shown in Table 2. Here, the cities and counties are divided into three groups.

The first group represents central and main local cities where the distribution percentages show higher values as the coefficients of concentration increases. The names of these cities are Sapporo, Otaru, Kushiro, Obihiro, Kitami and Takikawa.

The second group show the local cities where the distribution percentages is almost unchanging. The names of these cities are Asahikawa, Hakodate, Muroran, Tomakomai and Iwamisawa.

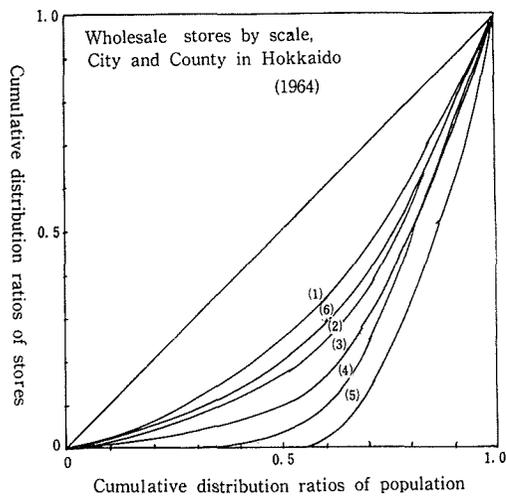


Fig. 8

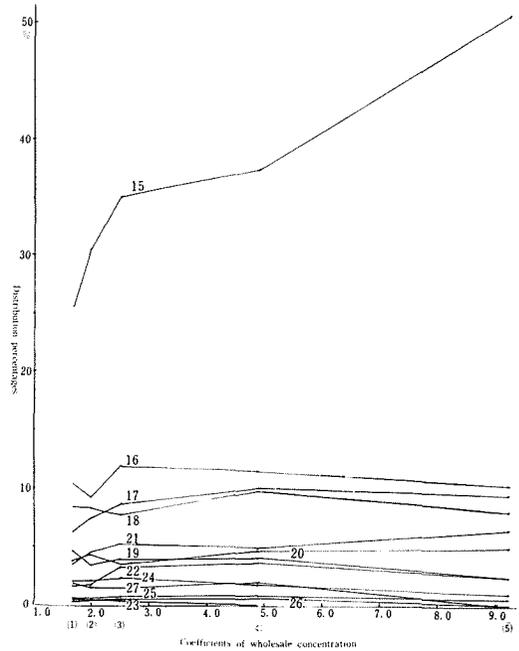


Fig. 9

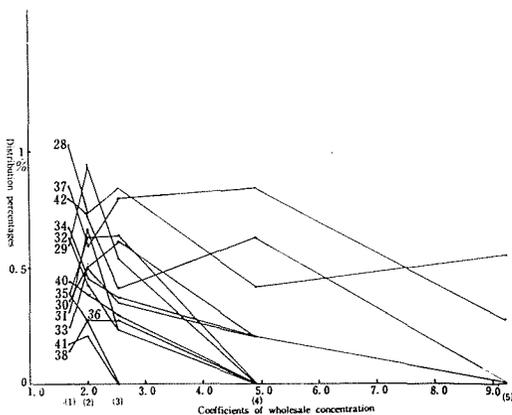


Fig. 10

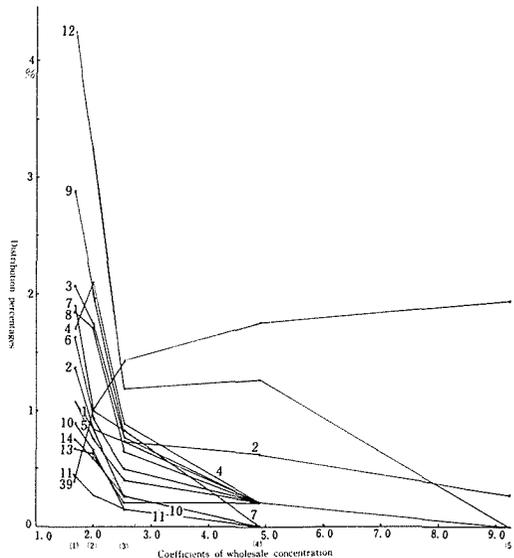


Fig. 11

The third group show the local cities and counties where the distribution percentages are slightly lower as the coefficient of concentration show higher values. This group includes all other cities and counties except for those mentioned above.

Table 3

Number	County (Gun)	Number	City
1	Ishikari-shicho	15	Sapporo
2	Sorachi-shicho	16	Asahikawa
3	Kamikawa-shicho	17	Otaru
4	Shiribeshi-shicho	18	Hakodate
5	Hiyama-shicho	19	Muroran
6	Oshima-shicho	20	Kushiro
7	Iburi-shicho	21	Obihiro
8	Hidaka-shicho	22	Kitami
9	Tokachi-shicho	23	Yubari
10	Kushiro-shicho	24	Iwamisawa
11	Nemuro-shicho	25	Abashiri
12	Abashiri-shicho	26	Rumoi
13	Soya-shicho	27	Tomakomai
14	Rumoi-sicho	28	Wakkanai
		29	Bibai
		30	Ashibetsu
		31	Ebetsu
		32	Akabira
		33	Mombetsu
		34	Shibetsu
		35	Nayoro
		36	Mikasa
		37	Nemuro
		38	Chitose
		39	Takikawa
		40	Sunagawa
		41	Utashinai
		42	Fukagawa

4. Conclusion

This preliminary report deals with a new approach for the analysis of areal concentration.

These methods involve a concentration analysis by the curvature of η curve and distribution analysis by the coefficient of areal concentration.

As a result of application to actual data of commercial functions in the Hokkaido area, it was found that the present methods are applicable for the analysis of areal concentration.

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