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AN EMPIRICAL ANALYSIS OF BASIC-NONBASIC EMPLOYMENT SPLIT OF EACH ZONE COMPRISING AN URBAN REGION

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The aim of this study is to find a new approach to measure the basic employment of each zone comprising an urban region. The technique proposed here is conceptionally similar to the usual minimum requirements technique but differs in operational procedure and subject area. The most important feature about this study is that special regard is paid to the zone area. In this paper, the empirical results of the employment serving ratio and the population serving ratio are given. And it is found that the employment serving ratio shows a tendency to grow as the zone area increases, but the ratio of local employment to employed residents is scarcely affected by the zone area. From these results, it may be given as a conclusion that the regional total basic employment varies with the zone area which is divided into.

Keywords: *basic employment, population distribution, multipier and zone area*

1. INTRODUCTION

The aim of this study is to find an approach to measure the basic employment of each zone comprising an urban region, that is available for understanding and forecasting the population distribution in the urban region. The definitions of the basic and nonbasic employment in this study are based on the economic base theory developed by Homer Hoyt[1] ; nonbasic (local) employment is directed to the production of goods and services for the residents in the study area and basic employment is directed to the production of goods and services for elsewhere.

There are a number of studies on economic base theory[2)~10)]. And, several moot points have been raised. They are related to the assumptions of the economic base theory and the ways to measure the economic base of an urban region. It is conceivable that their central subject is caused basically by difficulty in identifying the economic base of the urban economic system. It is really a task of great difficulty to distinguish between the basic sector and the nonbasic (local) sector, since there are many firms which supply their goods and services not only to the people in the region but to the people outside the region.

There are four ways to measure the economic base of an urban region which have been proposed and used. They are as follows[11] :

The Direct Measurement of the Base. This way requires that a survey be undertaken of the firms and institutions in the urban region to ascertain the proportion of their output sold outside the urban area.

The Assumption Approach. This approach proceeds by classifying activities into local and basic by assumption only, with no empirical foundation necessary.

The Location Quotient Approach. This approach proceeds by seeking to solve for N_k in the following

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simple equation,

$$\frac{N_k}{\text{total local employment}}=\frac{\text{national employment in industry } k}{\text{total national employment}}$$

Where N_k is local employment in a given industry k.

The Minimum Requirements Technique. The principal notion of this technique is that one can determine the exportbound output from a region by comparing a region, industry by industry, with other urban regions of the same size and general structure.

These four ways do not entirely give any relevant relationship between the basic and local employment to the estimation of the population distribution in an urban region, because the economic base theory still has a large problem. It is that the theory has taken no thought of the region area or the zone area. The basic sector of employment is usually defined as export-oriented employment, embracing industries and production processes in which the final product is exported out of the particular system of interest. Therefore, as the region area or the zone area increases, the basic sector must gradually convert to the local sector, and on the contrary as the region area or zone area decreases, the local sector must gradually convert to the basic sector.

The Garin-Lowry model is a typical one which is widely applied as a general model which combines through the economic base mechanism, a residential location model and a service location model[12]. It is supposed that one of the weak points of the Garin-Lowry model is to make the division between basic and nonbasic employment, whithout due regard to the zone area.

Under the above critical mind, this study will develop a new approach to measure the basic employment of each zone comprising the urban region and examine about how the zone area influences the division between basic and nonbasic employment.

2. THEORETICAL FRAMEWORK OF BASIC-NONBASIC EMPLOYMENT

The theoretical framework developed in this study depends in the main principle on economic base theory[4], but there is a difference. The difference is that, in this study, a distinction is made between employment at the work place (hereafter called employment) and employed persons at usual place of residence (hereafter called employed residents).

It is rarely the case that an urban region is economically closed. Therefore, we consider any unclosed system of urban regions. It is realistic to disaggregate the service sector in the economic base theory into service employment S_1 to employment and service employment S_2 to population. And also, it is possible and desirable to classify the basic employment into mobile employment B_1 and immobile employment B_2 where, the immobile basic employment means the one belonging to the industries, such as agriculture and mining, which can't move their locations. And the mobile basic employment means the one belonging to other industries. The theory can now be succinctly stated in six equations

$$\boldsymbol{P}={}_R\boldsymbol{E}/\rho \qquad 0<\rho<1 \cdots\cdots (1)$$

$$S_1=\alpha\cdot{}_w\boldsymbol{E} \qquad 0<\alpha<1 \cdots\cdots (2)$$

$$S_2=\beta\cdot\boldsymbol{P} \qquad 0<\beta<1 \cdots\cdots (3)$$

$$B_1={}_w\boldsymbol{E}^{b1} \cdots\cdots (4)$$

$$B_2={}_w\boldsymbol{E}^{b2} \cdots\cdots (5)$$

$${}_w\boldsymbol{E}=B_1+B_2+S_1+S_2 \cdots\cdots (6)$$

Where,

$\boldsymbol{P}$ is the regional total population.

${}_R\boldsymbol{E}$ is the regional total employed residents.

${}_w\boldsymbol{E}$ is the regional total employment.

${}_w\boldsymbol{E}^{b1}$ is the regional total of mobile basic employment.

${}_w\boldsymbol{E}^{b2}$ is the regional total of immobile basic employment

ρ is an activity rate.

α is an employment serving ratio.

β is a population serving ratio.

Equations (1)～(6) are the fundamental indentities of the theory which must hold in any urban economic system. But, as stated above, no urban regions are completely selfsufficient, and each region must trade with other regions. And, in many cases, some people living in a region go to work to other regions around the region, and some people working in a region live in other regions around the region. Then, the total employment in the region, ${}_{W}E$, can be expressed as

$${}_{W}E={}_{R}E+\varepsilon \quad \cdots\cdots (7)$$

Where, ε stands for the remainder between the regional total employment and the regional total employed residents.

From the above identities, the regional total employment ${}_{W}E$ can be expressed in terms of both basic employments as

$${}_{W}E=({}_{W}E^{b1}+{}_{W}E^{b2}-\beta\varepsilon/\rho)/(1-\alpha-\beta/\rho) \quad \cdots\cdots (8)$$

In the same way, from equations(1), (7) and (9), the regional total population P can be gotten

$$P=\{{}_{W}E^{b1}+{}_{W}E^{b2}-(1-\alpha)\,\varepsilon\}/\rho(1-\alpha-\beta/\rho) \quad \cdots\cdots (9)$$

Equations (8) and (9) are the reduced forms of equations (6) and (1) respectively. From an initial input of basic employments (${}_{W}E^{b1}$ and ${}_{W}E^{b2}$), given the regional multipliers; activity rate ρ, employment serving ratio α and population serving ratio β, and given the remainder ε between the regional total employment and the regional total employed residents, then the levels of regional total employment ${}_{W}E$ and population P can be determined. From these values, the levels of both service employments (S_1 and S_2) are derived.

The theory stated above may be applied to each zone and each industry, even when an urban region is divided into zones and the region's economy is classified into industries. Assuming that the multipliers α and β by industry can be determined, a theory by zone by industry will be developed in the following.

Now, consider an urban region which is divided into n zones and holds m industries. Then, after the manner of equation (6), the employment in industry k in zone j, ${}_{kW}E_j$, can be stated by the following equation

$${}_{kW}E_j={}_{kW}E_j^{b}+{}_{k}\alpha\cdot{}_{W}E_j+({}_{k}\beta/\rho_j)\cdot{}_{R}E_j \quad \cdots\cdots (10)$$

Where

${}_{kW}E_j^{b}$ is the basic employment in industry k in zone j.

${}_{W}E_j$ is the total employment in zone j.

${}_{R}E_j$ is the employed residents in zone j.

ρ_j is the activity rate in zone j.

${}_{k}\alpha$ is an employment serving ratio in industry k.

${}_{k}\beta$ is a population serving ratio in industry k.

The total employment in zone j, ${}_{W}E_j$, can be found by summing equation (10) over k, that is

$${}_{W}E_j=\sum_{k=1}^{m}{}_{kW}E_j={}_{W}E_j^{b1}+{}_{W}E_j^{b2}+\alpha\cdot{}_{W}E_j+\beta'{}_{R}E_j \quad \cdots\cdots (11)$$

Where,

${}_{W}E_j^{b1}$ is the total of mobile basic employment in zone j.

${}_{W}E_j^{b2}$ is the total of immobile basic employment in zone j.

$${}_{W}E_j^{b1}+{}_{W}E_j^{b2}=\sum_{k=1}^{m}{}_{kW}E_j^{b} \quad \cdots\cdots (12)$$

$$\alpha=\sum_{k=1}^{m}{}_{k}\alpha \quad \cdots\cdots (13)$$

$$\beta'_j=\sum_{k=1}^{m}({}_{k}\beta/\rho_j) \quad \cdots\cdots (14)$$

This β'_j means a ratio of service employment to employed residents in zone j.

3. TECHNIQUE TO MEASURE THE BASIC AND NON-BASIC SECTOR

In this chapter, first, some controversial points on usual measurement techniques will be given and, second, a new approach to measure the basic employment of each zone in the urban region will be developed.

(1) Some Controversial Points on Usual Techniques

Some comments on usual techniques by Michael Goldberg and Peter Chinloy are as follows[11] ; the direct measurement of the base is most reliable, but most expensive. The assumption approach is not useful when one is making assumptions based on experience in other urban regions whose underlying structural and historical characteristics might differ considerably from the subject region. The location quotient approach assumes that a nation is self-sufficient. This assumption is unreasonable for the countries in today's world. The most frequent criticism of the minimum requirements approach is that, given the usual sample size of 50~100 comparison urban areas, there are bound to be some outliers with observed minimum requirements below their own actual minimum requirements.

And, as stated in the introduction, there is a serious problem in the usual economic base theory. It is that the theory takes no thought of the region area or the zone area. So that, a new technique must be one that can seek to identify basic employment by zone area and to establish the relationship between basic and nonbasic employment.

(2) New Minimum Requirements Technique

The new technique developed here is conceptionally related to the minimum requirements technique but differs in operational procedure and subject area. The differences in operational procedure are that, in this technique, a distinction is made between employment and employed residents, and the local employment is divided into service employment to employment and service employment to employed residents. The difference in subject area is that, in this study, the area is not regional one but zonal one. The principal notion is that one can determine the basic employment in a zone by comparing a zone, industry by industry, with other zones of the same area in the same region. This new technique shall be called "New Minimum Requirements Technique"

By dividing equation (10) by ${}_RE_j$, an employment in industry k to employed residents ratio in zone j can be generated as

$$\frac{{}_{kW}E_j}{{}_RE_j}=\frac{{}_{kW}E_j^b}{{}_RE_j}+{}_k\alpha\cdot\frac{{}_WE_j}{{}_RE_j}+{}_k\beta' \quad \cdots\cdots (15)$$

Where,

$${}_k\beta'={}_k\beta/\rho_j \quad \cdots\cdots (16)$$

The relationships among the terms in equation (15) can be made in Fig 1.

Referring to Fig. 1, we note that the straight line AB is just the level of ${}_{kW}E_j/{}_RE_j$ when the basic employment in industry k, in zone j, ${}_{kW}E_j^b$, is zero, the slope of the straight line is equal to the employment serving ratio in industry k, ${}_k\alpha$, the segment OA on the axis of ordinates is equal to the level of ${}_k\beta'$ and the segment CD is the level of ${}_{kW}E_j^b/{}_RE_j$ when the basic employment in industry k in zone j is ${}_{kW}E_j^b$ and the employed residents in the same zone is ${}_RE_j$.

There must be no zones where the basic employment in a given industry is just zero. So that, it is almost impossible to draw the correct lines such as the straight line AB in Figure 1, by using some real data. But there must be some zones where the basic employment in a given industry, ${}_{kW}E_j$, is nearly equal to zero. Then, we can draw a suitable line corresponding to the straight line AB, and estimate the approximate values of the multipliers ${}_k\alpha$ and ${}_k\beta'$ by industry by zone area. Then, by using equations (13) and (14), the suitable multipliers α and β' can be estimated. We finally can disaggregate the total employment at each work zone into basic employment ${}_WE_j^b$, services to employment $\alpha\cdot{}_WE_j$ and consumer services $\beta'\cdot{}_RE_j$.

In this study, we dare to adopt the employed residents instead of the population, for the reason that the zonal income is supposed to be proportional not to the population but to the employed residents.

4. DATA AND EMPIRICAL RESULTS

The identity represented by equation (10) or (15) specifies that, when the employment ${}_{w}E_j$, the employment in industry k, ${}_{kw}E_j$, and the employed residents ${}_{R}E_j$ in zone j are given, the basic employment in industry k, ${}_{kw}E_j^b$, in the same zone is calculated by two multipliers: the emoployment serving ratio in industry k, ${}_{k}\alpha$, and the employed resident serving ratio in industry k, ${}_{k}\beta$. To obtain estimates of these two multipliers, we use data on the distributions of population, employed residents, employment by industry and total employment in the Tokyo Metropolitan Region (including the Metropolis of Tokyo and the following three prefectures : Saitama, Chiba and Kanagawa) in 1980[13]. This region is split into 282 zones which are units of cities, towns and villages, and their areas are different. Most of them (90.78 %) are in the range from 10 km^2 to 120 km^2, but there are some zones which are outside this range.

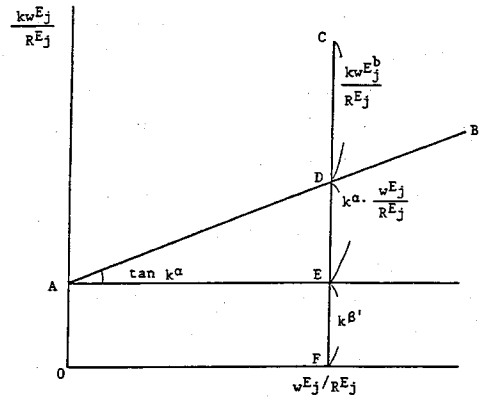

Fig. 1 Graphical expression of equation 15.

In this analysis, zones in which the number of employed residents is ten thousand or less are excluded, for the communities in those zones can be supposed as incomplete which must import even daily services from other zones. To certify this supposition, we use data on financing and insurance which are typical service industries, and examine the relationship between the employment in these industries and the employed residents by zone. The result is shown in Fig. 2.

In the domain in this figure where the number of employed residents is over around ten thousand, a straight line of the least required employment in the industries for the employed residents can easily be drawn, but in the other domain, such a straight line can not be drawn. From this fact, in this analysis, the communities in which the number of employed residents is ten thousand or less are assumed to be incomplete. The straight line of the required employment in the Fig. 2 can be drawn from the origin. Therefore, the multiplier ${}_{k}\alpha$ in financing and insurance can be concluded to be nearly equal to zero.

And also, zones in which an increasing rate in population for five years from 1975 to 1980 is over 20 per cent are excluded, for an increase of service employment, as a general rule, lags behind a swift increase in population.

As mentioned in chapter 3, if we can draw a suitable line corresponding to the straight line AB, the approximate values of the multipliers ${}_{k}\alpha$ and ${}_{k}\beta'$ can be estimated. However, it is not always easy to draw a suitable line by industry by zone area. That is because there are some classes of zone area which does not have enough number of zones to

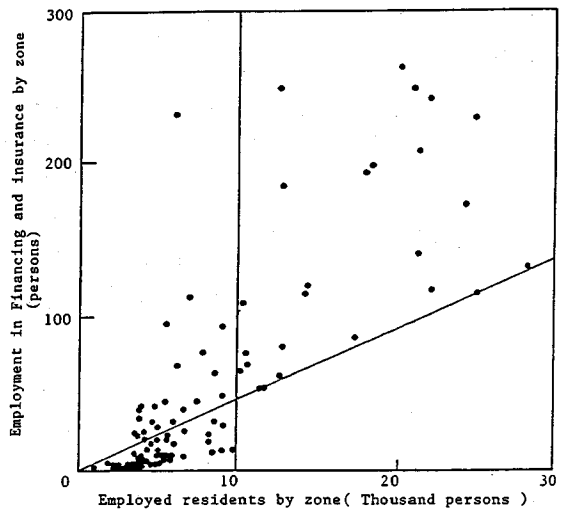

Fig. 2 Relationship between employment in financing and insurance and employed residents. The range of zone areas is from 15 km^2 to 50 km^2.

draw the straight line. But there is a solution to this problem. That is, if we can find at least a suitable straight line by industry in any class of zone area, that pattern by industry might be applicable to the other classes of zone area. In this analysis, some multipliers ${}_k\alpha$ and ${}_k\beta'$ will be estimated in this way.

We divide the mobile industries into ten groups and the zone areas into nine classes as shown in Table 1, and try to get the lines by industrial group by zone area class corresponding to the straight line AB in Fig. 1. Three typical examples of the relationship between the ratios of employment in industry k to employed residents and employment to employed residents are represented in Fig. 3 (a), (b) and (c).

These figures occur when both ${}_k\alpha$ and ${}_k\beta'$ assume to be certain values, only ${}_k\alpha$ assumes to be nearly equal to zero and only ${}_k\beta'$ assume to be nearly equal to zero respectively.

The estimated values of multipliers ${}_k\alpha$ and ${}_k\beta'$ by industrial group by zone area class are given in Table 1. But the multipliers ${}_k\alpha$ and ${}_k\beta'$ in agriculture, forestry and hunting, fisheries and aquiculture and mining are assumed to be zero, because they are regarded as immobile basic industries. There are many industries in which either the multipliers ${}_k\alpha$ or the multipliers ${}_k\beta'$ is equal to zero. This is considered to be entirely the result of the use of the data on major industrial groups. Using a far more refined definition than the one used here, these multipliers may not always equal to zero. But they must be nearly equal to zero.

Table 1 Shows a fact that the multipliers ${}_k\beta'$ in (1) construction, (2) manufacturing, (3) transport and communication, (4) supply of electricity, gas, water and heat and (5) services are zero or nearly equal to zero regardless of the zone area. This fact means that the nonbasic sectors in these industries are generally directed to the production of goods and services for the employment in each zone. Table 1 also shows a fact that the multipliers ${}_k\alpha$ in financing and insurance and real estate are zero or nearly equal to zero regardless of the zone area. This fact means that the nonbasic sectors in these industries are mainly directed to the production of goods and services for the population in each zone. Furthermore, both of the

Table 1 Multipliers (${}_k\alpha$ and ${}_k\beta'$) by major industrial group by zone area class.

Industry \ Zone area (Km2)		10.0-14.9	15.0-19.9	20.0-29.9	30.0-39.9	40.0-49.9	50.0-59.9	60.0-79.9	80.0-99.9	100.0-119.9
Construction	$k\alpha$	0.04874	0.07289	0.06560	0.06965	0.06731	0.06214	0.06272	0.07313	0.07508
	$k\beta'$	0.00000	0.00000	0.00000	0.00000	0.00856	0.00000	0.00000	0.00000	0.00000
Manufacturing	$k\alpha$	0.10317	0.06168	0.07551	0.10249	0.06258	0.11898	0.11789	0.10714	0.11839
	$k\beta'$	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Wholesale and retail trade	$k\alpha$	0.03154	0.03531	0.03006	0.01782	0.03789	0.05067	0.03452	0.07162	0.04918
	$k\beta'$	0.09055	0.09864	0.07921	0.10498	0.09373	0.10153	0.09500	0.10530	0.08179
Financing and insurance	$k\alpha$	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	$k\beta'$	0.00393	0.00460	0.00389	0.00469	0.00635	0.01040	0.01261	0.01587	0.01268
Real estate	$k\alpha$	0.00000	0.00003	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	$k\beta'$	0.00346	0.00462	0.00321	0.00285	0.00176	0.00161	0.00279	0.00272	0.00493
Transport and communication	$k\alpha$	0.03946	0.02710	0.01932	0.02780	0.03897	0.02524	0.03173	0.03971	0.03456
	$k\beta'$	0.00000	0.00108	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Electricity,gas,water and heat supply	$k\alpha$	0.00154	0.00207	0.00086	0.00113	0.00055	0.00139	0.00202	0.00271	0.00613
	$k\beta'$	0.00024	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Services	$k\alpha$	0.10644	0.09614	0.12976	0.12179	0.12738	0.11678	0.11691	0.13359	0.15525
	$k\beta'$	0.00000	0.00000	0.00910	0.00002	0.00000	0.00000	0.00000	0.00000	0.00000
Government	$k\alpha$	0.00794	0.00580	0.00757	0.00228	0.01058	0.00731	0.00630	0.00455	0.00770
	$k\beta'$	0.00609	0.01053	0.01250	0.01324	0.01266	0.01254	0.01122	0.01761	0.01930
Establishments not adequately described	$k\alpha$	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	$k\beta'$	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Total	α	0.33883	0.30102	0.32868	0.34296	0.34526	0.38251	0.37209	0.43245	0.44629
	β'	0.10427	0.11947	0.10791	0.12578	0.12306	0.12608	0.12162	0.14150	0.11870
The sum of α and β' ($\alpha + \beta'$)		0.44310	0.42049	0.43659	0.46874	0.46832	0.50859	0.49371	0.57395	0.56499
Number of zones used for study		20	23	19	16	8	12	14	12	5

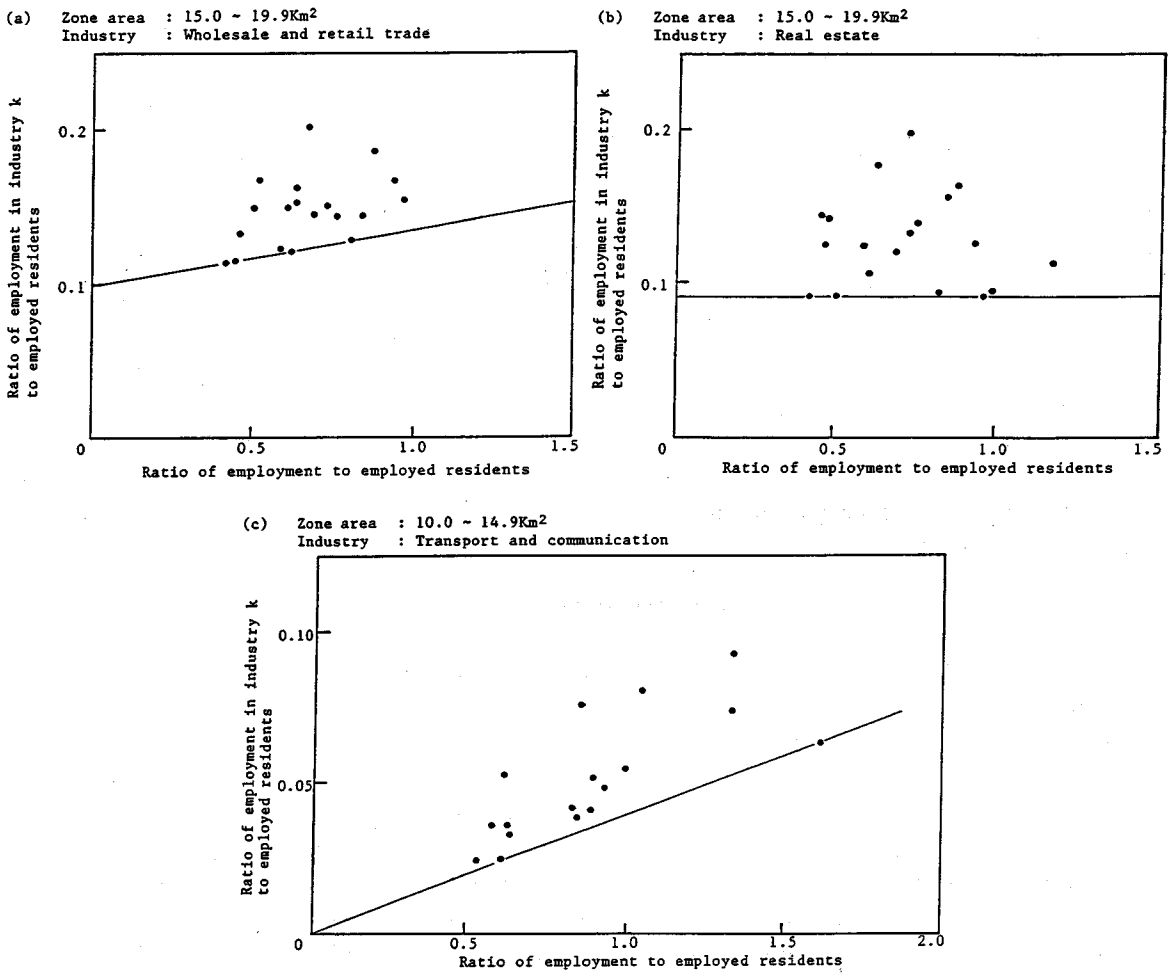

Fig. 3 The relationships between the ratios of employment in industry k to employed residents and employment to employed residents.

multipliers ${}_k\alpha$ and ${}_N\beta'$ in wholesale and retail trade and government are not equal to zero. This fact means that the nonbasic sectors in these industries are directed to the production of goods and services for the employment and the population in each zone.

The multipliers α and β' calculated by summing ${}_k\alpha$ and ${}_N\beta'$ over k are also given in Table 1. As mentioned in the introduction, it is conceivable that these multipliers α and β' have to change as the zone area changes. Therefore, we should examine how the zone area affects these multipliers. The result is given in Fig. 4. As can be seen, the level of multiplier α shows a tendency to grow as zone area increases. This tendency clearly shows the fact that the basic sector gradually converts to the local sector as the zone area increases. This fact means that the multiplier α may be called a psedo-multiplier. So that, when we use this α for an estimation of population distribution in an urban area, the multipliers α must be given to each zone which area is different from others. As for the other multiplier β', the zone area scarcely affects the multiplier. So that, this β' is considered to be a real multiplier, because we can use this multiplier β' for an estimation of population distribution, on the assumption that this β' is nearly constant independently of the zone area. But, when the zone area does not exceed 10 km², the zone area must affect the multiplier β'.

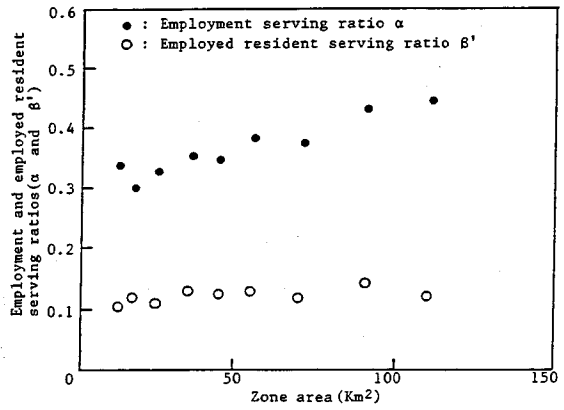

Fig. 4 Effects of the zone area on the multipliers α and β'.

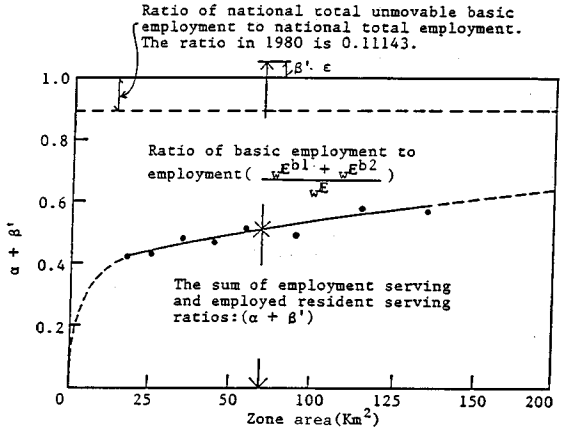

Fig. 5 The effects of the zone area on the multiplier $(\alpha+\beta')$.

5. ON THE RELATIONSHIP BETWEEN REGIONAL TOTAL BASIC EMPLOYMENT AND ZONE AREA

In this chapter, first, we will examine the effects of the zone area on the regional total basic employment.

The ratio of regional total basic employment to regional total employment, $({}_wE^{b1}+{}_wE^{b2})/{}_wE$, can be obtained by rewriting equation (8):

$$\frac{{}_wE^{b1}+{}_wE^{b2}}{{}_wE}=1-(\alpha+\beta')+\frac{\beta'\cdot\varepsilon}{{}_wE} \quad \cdots\cdots (17)$$

In this equation, the term $(\alpha+\beta')$ is supposed to be the multiplier which increases with the zone area. This supposition can be substantiated by a fact shown in Fig. 5 which is gotten by using the multipliers α and β' given in Table 1. From this result, when an urban region is divided into zones of equal area and the remainder between the regional total employment and the regional total employed residents, ε, is fixed, the ratio of the regional total basic employment to the regional total employment is found to decline as the zone area increases. So that, when the regional total employment ${}_wE$ is fixed, the regional total basic employment, ${}_wE^{b1}+{}_wE^{b2}$, must decline as the zone area increases, and the converse must also be true. From this consideration, it may be concluded that the regional total basic employment varies with the zone area.

As shown in Fig. 5, the multiplier $(\alpha+\beta')$ increases with the zone area. A least upper bond of the multiplier's growth must be equal to the remainder between unity and the ratio of national total immobile basic employment to nationl total employment. And then, the total of mobil basic employment ${}_wE^{b1}$ is nearly equal to zero.

6. CONCLUSION

In this study, under a critical mind that the basic employment of each zone comprising an urban region must vary with the zone area, a new technique to measure the basic employment by zone is deveploed. This technique is conceptionally similar to the minimum requirements techinque developed by Edward Ullman and Michael Dacey of the University of Washington[14], but, as stated in chapter 3, it differs in operational procedure and subject area.

The usual minimum requirement technique has often used the population as a regional size or a zonal size. But the usual technique is not always adequate to measure the economic base of a region or a zone, because as stated in the introduction, as the region area or the zone area increases, its basic sector must gradually convert to the local sector regardless of the level of population.

The technique proposed here is a way to disaggregate employment into four groups (: mobile and immobile basic employments, service employment to employment and service employment to employed residents) by using the data on the distributions of employed residents and employment by industry in an urban region. In this paper, the empirical results of the employment serving ration and the population serving ratio are given. And it is found that the employment serving ratio shows a tendency to grow as the zone area increases, but the ratio of local employment to employed residents is scarcely affected by the zone area. From these results, it may be concluded that the zonal basic employment and the regional total basic employment vary with the zone area.

It is supposed that this technique may be cheap and good for the estimations of zonal basic employment and population distribution in an urban region, because the technique uses just the data on employment by industry by zone and employed residents by zone.

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