

## Progression of Functional, Differentiation of Cities with the Method of B-N Analysis

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### Introduction

Since J.W. Webb distinguished two types of urban society in 1959, a new concept has developed on analysis of the function of cities (J.W. Webb, 1959). It remarked that the function of a city in "Modern urban society" can not be isolated with other cities but integrated and differentiated in a cooperative frame work formed by a set of cities.

If it is approved, the changes of function of a city must also be interpreted as a transformation of differential relationship among cities. The purpose of this paper is to examine the functional differentiation of cities in Japan, and, with special concern, to analyze its recent change, using a methodic technique devised in basic-nonbasic analysis.

An index of employment constitution was adopted in this paper to measure the functions of cities using the information of the population census 1955 and 1960. The previous papers already discussed the imperfect availability of such index in analyzing urban functions (R.B. Andrews, 1954). These problems are, though important, not taken into account in this paper which intended to draw a draft of the subject.

### Integration of cities and B-N Analysis

Some popularized series of methodic formulas has been invented to measure the differentiation of urban areas, for instance, locational quotient by Gilles and others (R.C. Gilles, 1943) or specialization index by J.W. Webb (J.W. Webb, 1959). These predecessors have measured with common ideas the degrees of specialization of cities (as an indicator of urban differentiation) by means of calculating proportional values of employment constitution in comparison to the national average. But the writer infers that quantitative analysis of the integration and differentiation of cities can not be

accomplished through the relative comparison of specialization, but is far more desirably achieved by any means of estimation regarding the size of very part of activity which integrates to other cities, either practically or theoretically.

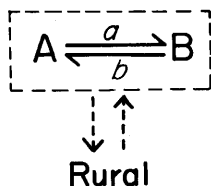


Fig. 1 : Differentiation and Integration of Urban Society.

See Fig. 1. The cities, A and B or some additional others, compose a set of city, and act, as a whole, a functional group to operate to rural ones. The way of analysing the mechanism of differentiation must be the examination of characters and sizes of parallel arrow lines, a and b, in the figure.

Here the writer conceives that the basic-nonbasic concept is closer akin than the specialization idea to the thought of analyzing the differentiation and integration of an urban society. The basic activity is a part of urban functions which is exported outside of the city. Those consequently contain more or less inter-urban exports which form a part of integration in urban society. Preceding to the practical application of the technique, however, another idea must necessarily be added. Namely, consumptive activities compose another section of integration with an "imports" nature in contrast to "export" nature of basic activities. The word, "integrated activity" in this paper, is used to express the sum total of both types of inter-urban integrations, basic (or productive) and consumptive activities.

Unfortunately, practical techniques have not been evolved sufficiently in the studies of basic-nonbasic analysis. But the formula by H. Hoyt can be used to calculate a value of production or number of employees which is equivalent to such integrated activity. The positive or negative values calculated by the formula, respectively estimate the excess or shortage of activity to the self-demanded quantity by the cities themselves. Then it is a reasonable assumption that these excess or shortage values must have conformity to the ideal integration of the city, when the formula works by a sufficiently detailed classification of industrial branches.

Having the intention to check the integration of inter-urban circuits exclusively, some modifications were appended to the original formula as follows. Some notes on the modification and its practical application by prefectural units were referred in the preceding paper. (Y. Watanabe, 1961)

Number of Employees (integrated activity)

$$= M \text{ branch employees in A city} - \left( \begin{array}{l} \text{Total employees in urban} \\ \text{industrial branches of A city} \end{array} \right) \\ \times \left( \frac{\text{M branch employees in the nation}}{\text{Total employees in the nation}} \right)$$

#### Areal differentiation of cities in Japan

A glance will be necessary on the static features, in provision for researching the recent changes of differentiation. Fig. 2 indicates the constitutional ratio of integrated manufacturing employees in the whole integrated employees of cities in 1960. The cities of positive values, generally of more than 10%, are broadly distributed in the area from Northern Kanto in the northeast to Northern Kyushu in the southwest. Within the area, special high values of over 50% are clustered in the narrow zone along the Pacific and the Setouchi Inland-sea coast. The area forms a so called "Manufacture belt in Japan" (J.H. Thompson, 1959) in which only one kind of activity, manufacturing, dominates the integrated activities so eminently as it veils down the total of other kinds of activities.

On the contrary, the cities of negative values disperse locally in such districts as Hokkaido, Tohoku, San-in, Southern Shikoku and Southern Kyushu.

These two types of the cities are so clearly differentiated by their location in the figure that they may seem quite complementary to one another in their integrated function in terms of areal differentiation. The cities in central Japan compose the productive ("exports") area of manufacture in Japan, while the northeastern and the southwestern peripheral parts of Japan form the consumptive ("import") area of manufacturing activity. In 1960, 7.0 millions manufacturing employees were in Japan, within which 2.76 millions operated in basic (productive) integration, and 0.17 million employees represented a consumptive nature. Those integrated employees clearly concentrate by their location: 86.9% of the basic type were concentrated to the 15 prefectures in the manufacture belt, while 82.0% of the consumptive one were in the remaining 31 prefectures, as shown in Table I.

But the mechanism of differentiation is a little more complicated with the interposition of rural activity. The cities in central Japan mainly act a role to produce some kinds of manufactured goods for most of the other cities as well as for the rural area in the nation. They are endowed with a

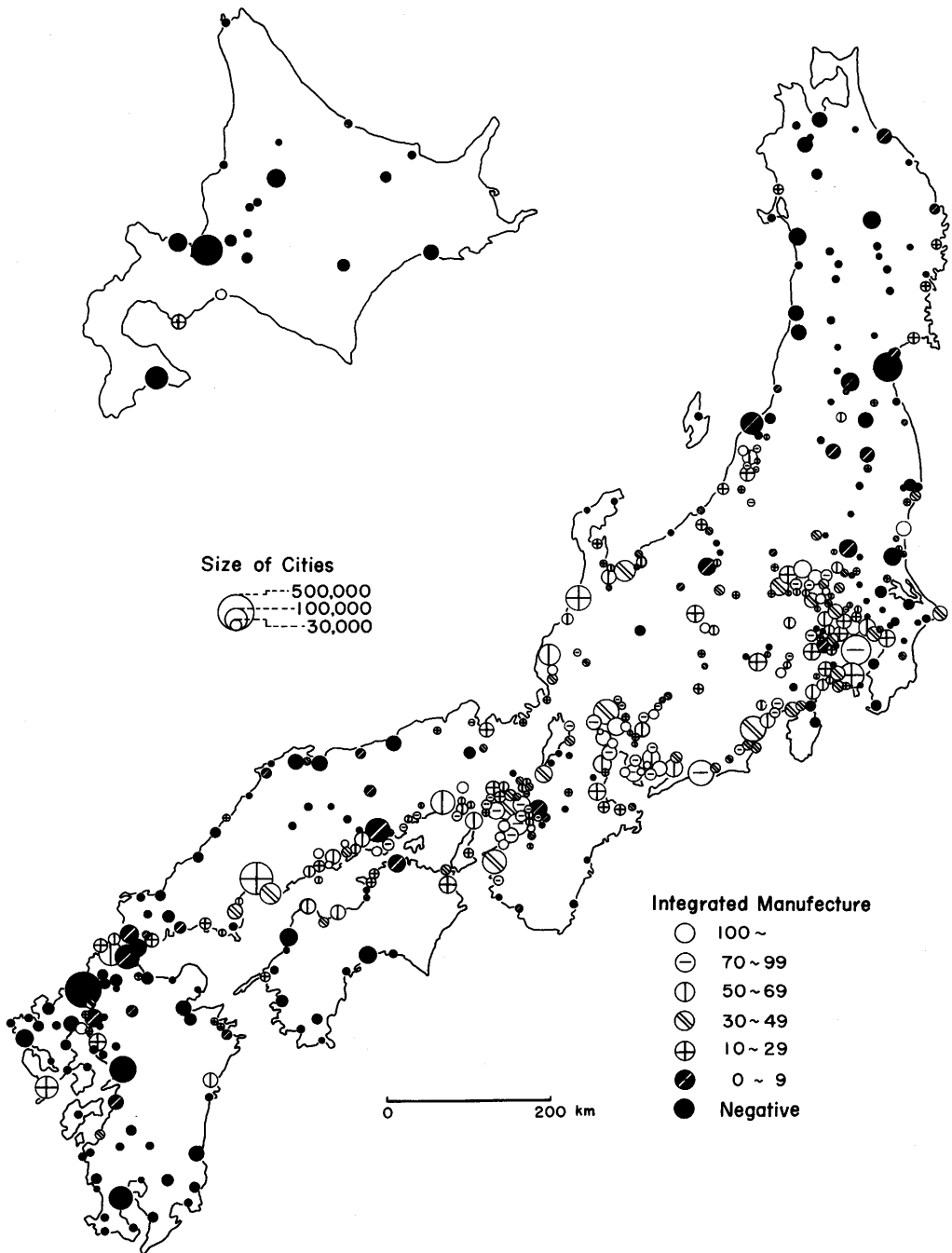


Fig. 2 : Constitutional Ratio of Integrated Manufacture and Size of cities. Size of city is expressed by number of employees in manufactural and service industries

small centrality function only for the local neighbourhood. On the other hand, the cities in the peripheral area principally operate to rural area with their basic integrated activities in various kinds of service industries. They are, in other words, the typical cities of centrality which trade the manufactured goods and manage the regionalism system. Further, counter activity of rural areas will return back to the city group with their peculiar basic integration, for instance, supply of foods. Even if these action might be distributed evenly to every city, its practical allotment must concentrates to the cities of central Japan in accordance with its intensive agglomeration of urban population. Quantitatively mentioned, 71% of Japanese urban population are concentrated in 15 prefectures in the manufacture belt, within which 31% are in five prefectures of metropolitan areas. This is a clear contrast to the fact that 68% of rural population are in the rest 31 prefectures. Thus the functional differentiation of Japanese cities seems triangular system which may be drawn in schema as in Fig. 3.

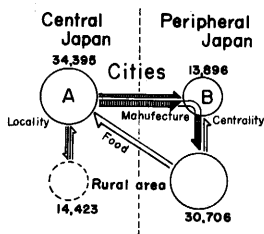


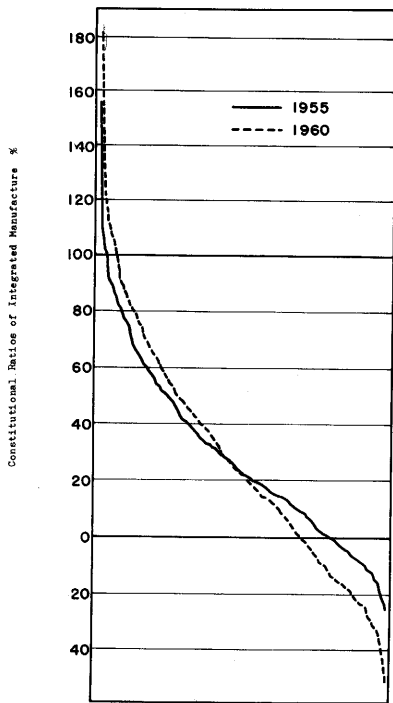
Fig. 3 : Integrating Model of Japanese Cities.

Finally, some cities in central Japan show an extremely high values (over 100%) of integration in manufacturing. This suggests the consumptive nature of centrality activities. As for the reason, the ratio of integrated service activity can be approximately estimated by the remaining value of 100% subtracted by the ratio of integrated manufacture. The larger cities must be complementary in service activities there to those cities and other highly specialized cities of manufacture. In the figure, they practically develop to considerable degree of integrated service activities, generally of more than 50 - 60 %, even in those industrialized areas. The cases are especially typical at the seat of the prefectural office.

Progression of the differentiation

The writer has already afforded a map corresponding to Fig. 2 for 1955. (Y. Watanabe, 1965). A comparison of the two maps obviously exposes some notable change of values for every city. However, the map representation of coropleth method does not favour the quantitative comparison of both years.

Fig. 4 exhibits the rank-size arrangement of the cities in Japan in respect to the percentage ratio of manufacture in integrated activity for 1955 and 1960. The lines form concave curves for both years, signifying the differentiation structure in which specialized cities of smaller number produce goods and the cities of large number consume it. But the most important notice should be made on the crossing of the lines of two years at the site near median rank.



Ranking of Cities

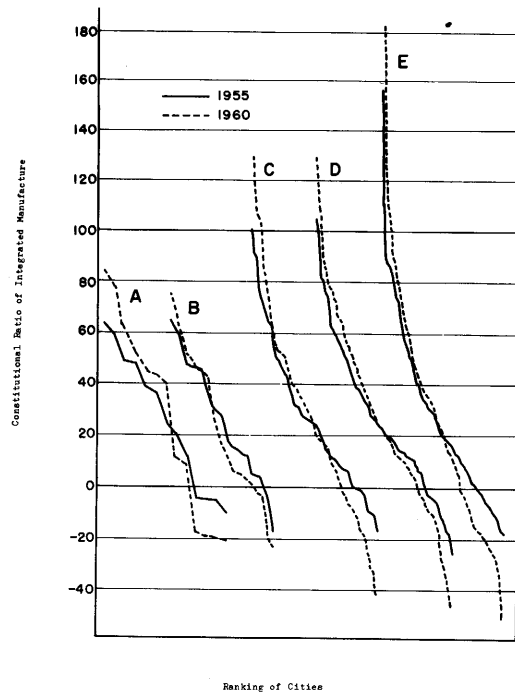


Fig. 5 : Rank-size Expression of Constitutional Ratio of Integrated Manufacture by City Size Groups.  
 A: More than 300,000, B: 200,000-300,000,  
 C: 100,000-200,000, D: 50,000-100,000,  
 E: Less than 50,000

Fig. 4 : Rank-size Expression of Constitutional Ratio of Integrated Manufacture.

This clearly reveals the progression of differentiation during the period. Different attitude of manufacturing integration has not been equalized among cities but elongated greatly. The changes in this five years mark about 20% for both the extremes of the positive and the negative, and over 15% for general cases. Only thirty or forty years will be sufficiently long (in calculation) to complete a perfect differentiation system starting from non-differential status. In 1955, there were only 13 cities which indicated an integrated manufacturing activity of over 100%. Such cities have increased to 36 in 1960, twice as many as 1955. Further, about 24% of the Japanese cities (36 cities) hold consumptive nature in integrated manufacturing in 1955. Such cities have increased to occupy 53% (164 cities) of all cities in 1960. The differentiation of cities into two extreme types has distinctly progressed in that period.

In order to examine the manner of progression, rank-size arrangement was classified into five groups by size of population in Fig. 5. In the figure, again, the rank-size lines of two years cross to one another commonly in all classes of city size. Moreover values of their crossing are unified in 20 -

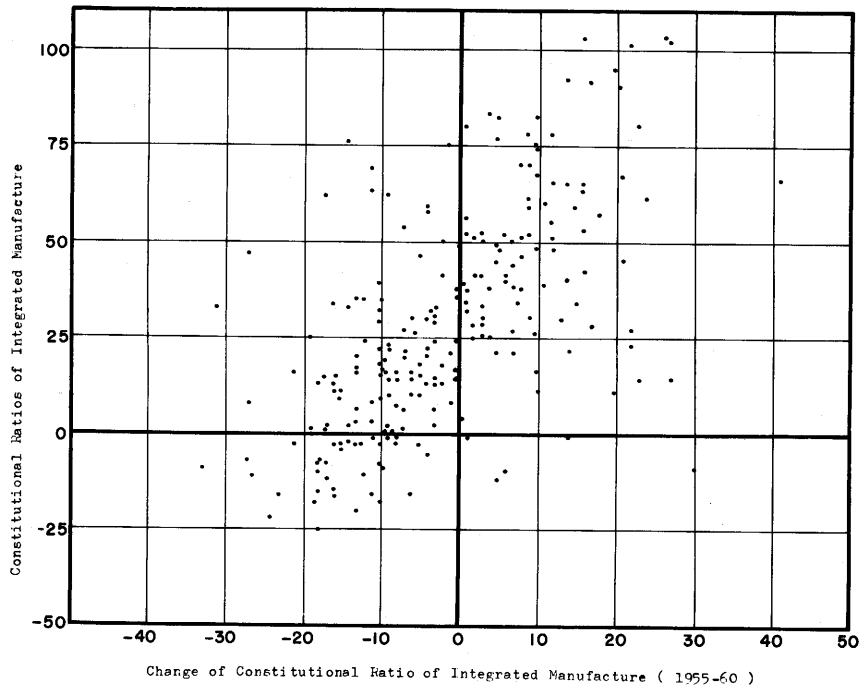


Fig. 6 : Constitutional Ratio (1955) and its Change (1955-60) of Integrated Manufacture

30 %, indicating the similar value to that of the whole cities. This will afford a clear evidence to conclude that the differentiation has progressed in Japan with no regard of the size of cities.

The course of progression seems simply to promote the established differential system of manufacturing which had been gradually consolidated before the beginning of the period. Fig. 6 shows that the cities of the higher ratio in 1955 have generally acquired the proportional elevation of the ratio and the cities of lower ones have almost lost the values during the period. This correlation seems to be quite linear, having the differential change of approximate 10 % for every 25 % in static differences in 1955. Meanwhile, the border point appear to separate increase and decrease at the value of about 30 % in 1955, as was already suggested by the line crossing of the rank-size system. Some exceptional cities, shown at the lower right corner in the figure, generally distribute to the surrounding area of the greater metropolises, where the local independent cities of properly low ratio have lately been embodied into metropolitan area and attracted a disproportional amount of manufacturing activities abruptly and arbitrarily.

#### Progression of areal differentiation

The tendency viewed in Fig. 6 may lead a succeeding presumption as to the differentiation, provided that the integrated activities of cities had been already differentiated to a remarkable degree by location at the beginning of the period.

Fig. 7 indicates increase and decrease of integrated manufacturing employees with circular symbols proportionated to the changes. During the period, the industrialized cities in central Japan have added a remarkable number of integrated manufacture, while those in peripheral area lost a comparable number of integrated manufacturing activities. In accordance with the general tendency in recent Japan, the absolute number of manufacturing employees has increased in almost every city even in the latter area. Nevertheless, integrated manufacturing activity contracts when activities other than manufacture have expanded far greater than manufacture, or when the increasing rate of manufacturing employees is distinctly below the national average and especially when the both causes combine. In such cases, faster enlargement of consumption of manufactured goods cancel out the effect of slight



Table I Distribution of Integrated  
Manufacturing employees (1960)

	Positive	Negative	Total	
Tokyo	667,166	0	667,166	5 prefectures of metropolitan area + 1,797,374
Kanagawa	208,213	481	207,732	
Aichi	309,491	0	309,491	
Osaka	479,404	0	479,404	
Hyogo	133,581	0	133,581	
Saitama	84,530	0	84,530	10 other prefec- tures in manufac- ture belt + 583,983
Chiba	38,393	3,004	35,389	
Shizuoka	105,571	8,095	97,476	
Gifu	72,024	0	72,024	
Mie	43,585	813	42,772	
Kyoto	95,985	588	95,397	
Okayama	48,611	92	48,519	
Hiroshima	57,375	1,139	56,236	
Yamaguchi	16,988	1,125	15,863	
Fukuoka	41,939	16,162	25,777	
Tochigi	34,036	491	33,545	14 prefectures in manufacturing "export" area + 285,769
Gumma	40,565	0	40,565	
Niigata	33,816	591	33,225	
Toyama	28,026	0	28,026	
Ishikawa	19,712	273	19,439	
Fukui	23,910	0	23,910	
Yamanashi	15,230	239	14,991	
Nagano	27,529	459	27,070	
Shiga	18,769	0	18,769	
Nara	5,185	0	5,185	
Wakayama	24,555	393	24,162	
Tokushima	4,372	0	4,372	
Kagawa	5,228	822	4,406	
Ehime	9,391	1,286	8,105	
Hokkaido	5,299	30,513	-25,214	17 prefectures in manufacturing import area - 73,580
Aomori	712	7,514	-6,802	
Iwate	5,088	8,076	-2,988	
Miyagi	1,749	10,763	-9,014	
Akita	2,011	7,427	-5,416	
Yamagata	9,172	2,249	6,923	
Fukushima	4,485	3,642	843	
Ibaragi	10,316	2,453	7,863	
Tottori	472	2,677	2,205	
Shimane	2,143	1,391	752	
Kochi	0	4,023	-4,023	
Saga	947	5,213	-4,266	
Nagasaki	5,560	10,309	-4,749	
Kumamoto	1,925	12,144	-10,219	
Oita	2,561	7,939	-5,378	
Miyazaki	8,233	7,256	977	
Kagoshima	1,307	11,971	-10,664	
Total	2,755,159	171,613	2,583,546	2,583,546

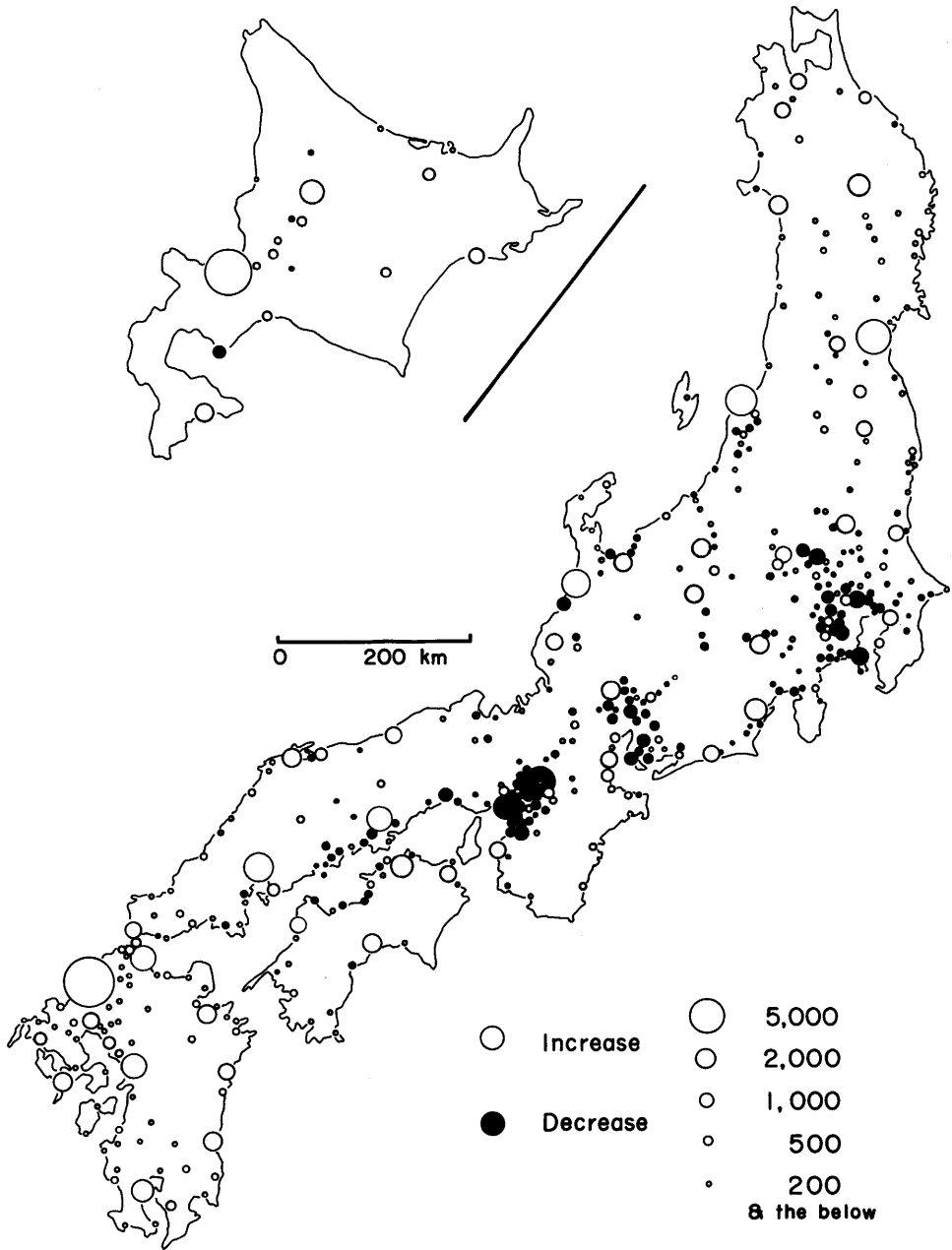


Fig. 7 : Changes of Number of Integrated Manufacturing Employees (1955-60).

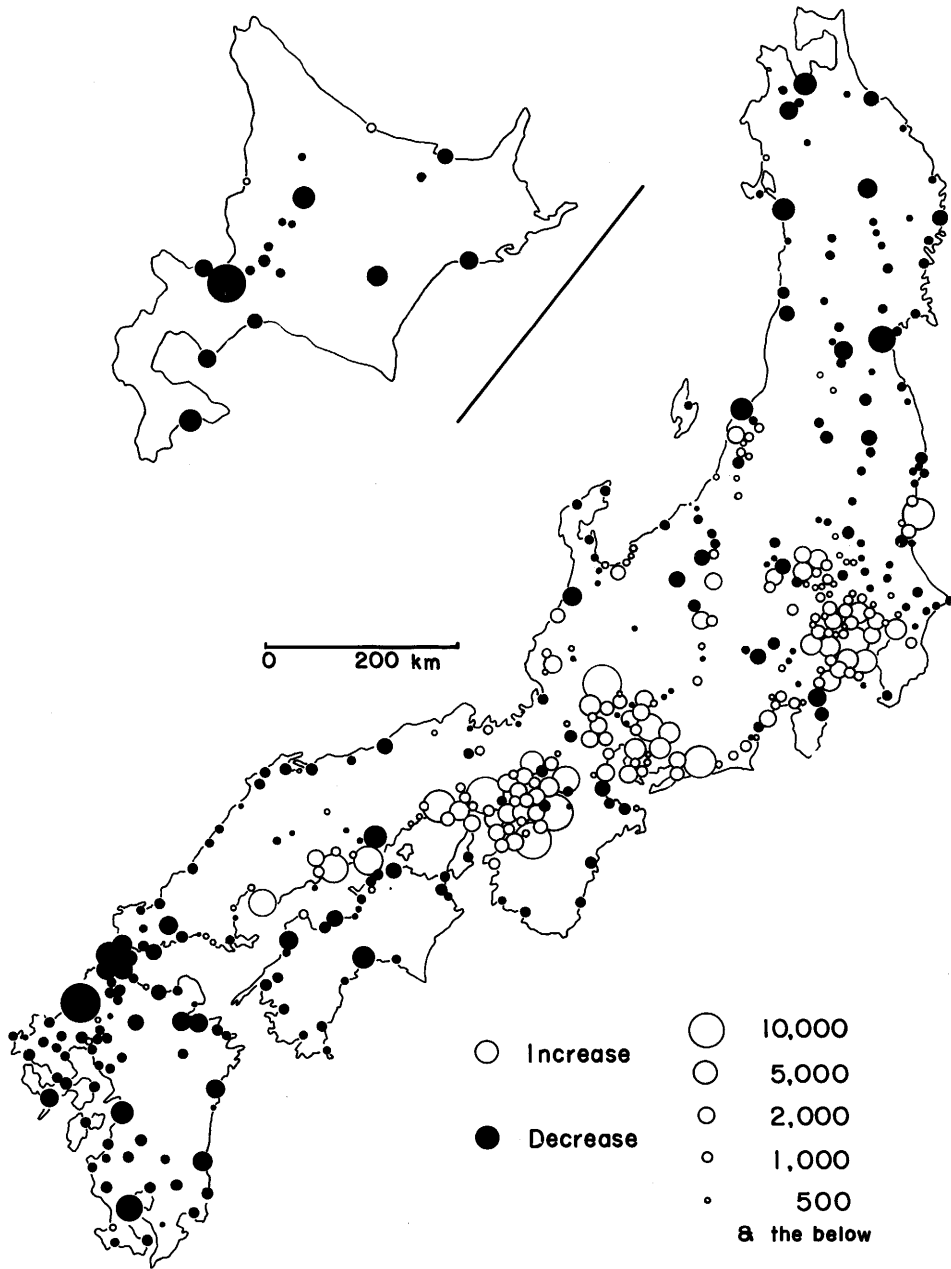


Fig. 8 : Changes of Number of Integrated Commercial Employees (1955-60).

Table II Increase and decrease of integrated manufactural employees (1955-1960)

Population class of Prefectures city		6 major cities	more than 300,000	300,000 200,000	200,000 150,000	150,000 100,000	100,000 50,000	50,000 30,000	Total
Saitama, Chiba Tokyo, Kanagawa	+	205,809	33,582	5,750	2,677	26,500	17,781	13,321	305,420
	-	0	0	0	0	0	1,674	970	2,644
	±	205,809	33,582	5,750	2,677	26,500	16,107	12,351	302,776
Osaka, Hyogo	+	77,451	13,348	21,269	9,665	8,468	25,671	14,975	170,847
	-	0	0	0	0	0	936	779	1,715
	±	77,451	13,348	21,269	9,665	8,468	24,735	14,196	169,132
Aichi	+	21,027		1,826	13,604		15,780	14,417	66,654
	-	0		0	0		0	11	11
	±	21,027		1,826	13,604		15,780	14,406	66,643
Shizuoka	+			8,177		3,147	3,759	1,594	16,677
	-			700		0	1,953	3,095	5,748
	±			7,477		3,147	1,806	1,501	10,929
Ibaragi	+					8,545	0	3,673	12,218
	-					1,393	359	1,544	3,296
	±					7,152	359	2,129	8,922
Toyama	+				1,545	0		2,252	3,797
	-				0	98		1	99
	±				1,545	98		2,251	3,698
Okayama, Hiroshima	+			0	6,536	137	8,123	17,203	32,612
	-			3,329	0	0	2,610	1,481	7,420
	±			3,329	6,536	137	5,513	15,722	25,192
The other 34 prefectures	+	6,201	0	2,795	227	55,529	91,512	99,828	256,092
	-	0	38,578	36,099	27,861	38,826	66,337	60,530	268,231
	±	6,201	38,578	33,304	27,634	16,703	25,175	39,298	12,139
Total	+	310,488	47,543	39,817	34,254	102,326	162,626	167,263	864,317
	-	0	38,578	40,128	27,861	40,317	71,259	68,411	286,554
	±	310,488	8,965	311	6,393	62,009	91,367	98,852	577,763

increase of manufacturing activity, and leads the city to depend the manufacturing production on other cities more strikingly than before. There prevails such status in many cities of peripheral Japan at present.

These two types of change, increase and decrease, are clearly differentiated in the figure by the location of cities, as if corresponding manufacturing workers moved from peripheral areas to central Japan. The area where integrated manufacturing have increased lies in the triangle connecting the three cities, Hitachi in Northern Kanto, Niigata in Northern Hokuriku and Hiroshima in Setouchi Inland-sea coast. It will be noticed that the cities of increasing tend to distribute within a part of manufacturing exports area, that is, "Japanese Manufacture Belt." Particularly a remarkable amount of integrated manufacturing employees have converged to the areas around the three greater metropolises, Keihin (Tokyo), Hanshin (Osaka) and Chukyo (Nagoya). About 860 thousands integrated manufacturing employees have increased in national total in the period and its 63 %, 542 thousands employees, have concentrated into only seven prefectures in and around the Metropolises, Saitama, Chiba, Tokyo, Kanagawa, Aichi, Osaka and Hyogo as in Table II. On contrary, increase of integrated manufacturing

employees, 270 thousands employees, is nearly balanced by decrease number of 290 thousands employees in remaining 39 prefectures, and the decrease of 140 thousands employees in peripheral 12 prefectures occupy 48 % of total decrease in the nation.

The changes of number of integrated service activities does not seem to be a simple opposite of manufacturing one. Fig. 7 shows the change of integrated commercial employees which are presumed as one of the best indicator of service branches of a centrality nature. Integrated commercial activity has expanded surely to a great extent where integrated manufacturing decreased. However its change is not exactly an alternative of manufacturing. It has sustained or increased in almost all cities of so extensive areas in Japan that integrated commercial activity seems to have "normally" developed for all types of cities during the period. The tendency has succeeded after the war, partly due to the rapid reformation of rural life into higher levels of a consumptive mode, and partly due to the contemporary rationalization of Japanese industries in which population moved from primary industry to urban industry. Only the areas surrounding greater metropolises display the exceptional case. Here, about a half of cities contracted their integrated commercial activity, though their absolute number generally increased similarly as the case of integrated manufacture in peripheral areas. The abrupt expansion of manufacture within the satellitic city may need a portion of time to be followed by service activity, and, in the same time, the vigorous development of commercial activity of the core city gradually invaded the surrounding suburban areas until the satellitic centers lost the activity of neighbourhood services. Thus the writer assumes that these decrease will be attributed to the affairs of metropolitanization and not be a result from the areal differentiation of urban function on a national scales.

Attention should be made on the uneven increase of integrated commercial activity by various city sizes in the peripheral area. The changes of integrated commerce surely suggest the promotion of the urban differentiation in Japan, even if it is not behaved with both types of changes, increase and decrease, That is, integrated commerce expanded "more" strikingly in the area of declining manufacture than the area of enlarging manufacture. Its expansion in the peripheral areas, however, owes its major part particularly to the larger cities, at least when it is compared to the uniform decrease of manufacture among various sizes of cities. There seems a result of the contest among the city classes in hierarchy of

central place. The larger cities have been exceedingly favoured in competition at all times after the war, with a reason of the continuous advances of rural consumptive life accompanying the improvement of traffic facilities. The typical cases are represented by the cities at the seat of prefectural office, where commerce acquired great advantages through the mental respects of governmental centers as regionalism ones. The law of primate city is still effective in Japan not only for Tokyo, but for these larger cities in non-industrialized areas.

This results that larger cities alone where the cities do not be equipped by manufacture, have acquired high ratio of population increase as comparable to industrialized cities in central Japan.

Thus the progression of areal differentiation seems finally to make the departure greater between the cities surrounding metropolises and the larger cities in the non-industrialized area in recent Japan. In such programing, most of smaller cities in the peripheral area have stagnated or declined, being excluded to out side of the program, while the metropolises expanded remarkably with a role of managing such differentiation.

#### Integration index of city

In the above analysis, manufactural or commercial activities bear a role to indicate functional differentiation. It is a difficult problem to make the analysis to synthesize up all branches of activity. Here the sum total of all negative value of integrated constitution is calculated for respective city, and is assumed to give a trial mean of integration index. The value equals to positive surplus values excess 100 % in sum of positive integrated value. The value 100 % means sum total of such constitution of integrated activities for each urban industrial branches as respectively matches to the standerlized status of integration in Japan. In this case, standerlized status is so estimated by the formula that the total of urban integrated activity of Japan just coincides to the rural ones. Therefore, diversification from such constitution, either positive or negative, must be integrated and complemented within an urban society.

Fig. 10 offers integration index of Japanese cities for 1955 and 1960. The mean value was 18.9 % in 1955, and it became 32.7 % in 1960. The value 100 % means only one branch of activity can compensate the whole import of rural industry. In 1955, only 1 city marked 50 % which denoted the mid way of such standardized integrating status. However it grew to 26

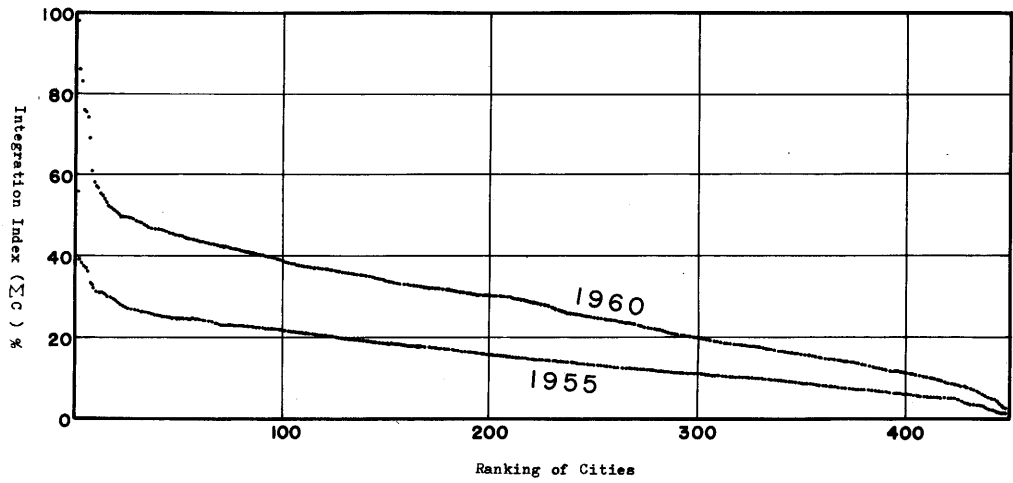
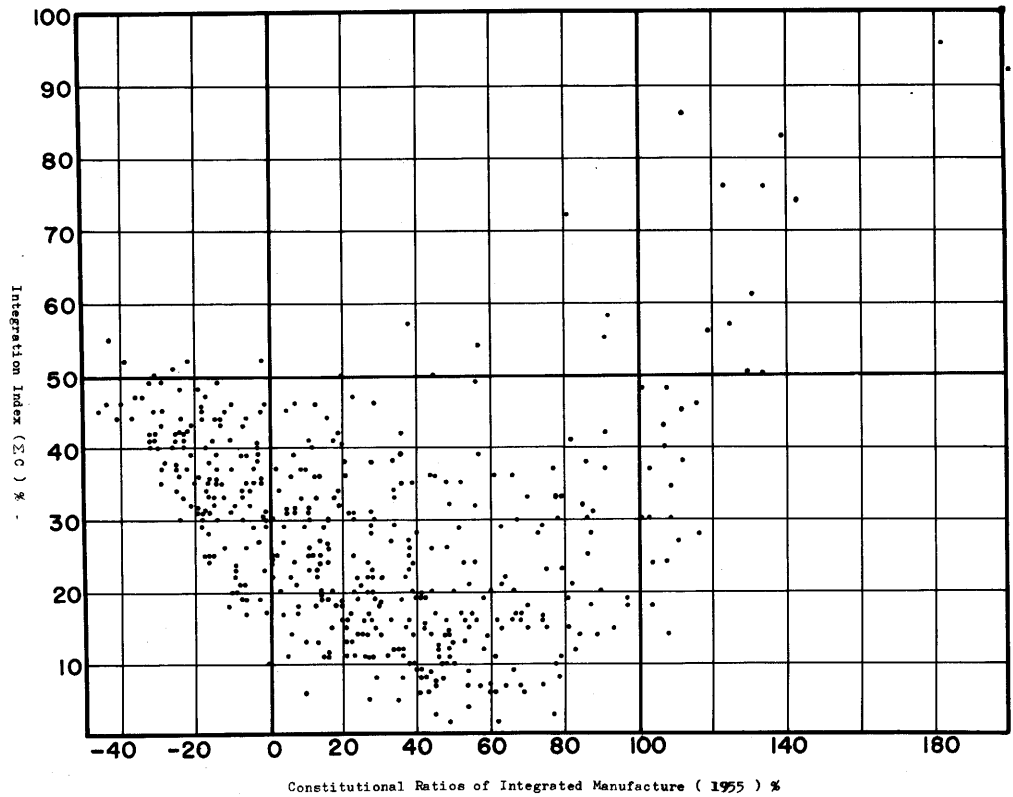


Fig. 9 : Rank-size Expression of Integration Index.



cities after only five years. As shown in Table III the dominant activity normally presents the same industrial branch for the both years, even in the case as integration index greatly changed. This suggest that a few kinds of typical integrated activities, already equipped, become more dominant in cities of recent Japan.

Table III Number of cities classified  
by B max branches

		B max branch		not changed	changes 1955-60
		1955	1960		
Construction		6	12	4	+6
Manufacturing	Food, kindred products	12	12	9	0
	Lumber, Wood products	4	4	3	0
	Furniture, Fixtures	3	3	2	0
	Textile mills	60	59	54	-1
	Apparel	5	7	5	+2
	Paper, Pulp	9	8	8	-1
	Rubber		2		+2
	Stone, cement, Glass	11	10	9	-1
	Chemical	19	17	15	-2
	Primary metal	11	14	11	+3
	Fabricated metal products	4	4	4	0
	Machinery	4	5	1	+1
	Electrical machinery	9	14	7	+5
	Transportation equipment	6	10	6	+4
Medical, Scientific, Optical	1	3	1	+2	
Miscellaneous Manufacture	5	5	4	0	
Services	Whole sale trade	9	15	9	+6
	Retail trade	227	206	188	-21
	Finance, Insurance		1		+1
	Transportation	22	18	15	-4
	Personal service	2	3	2	+1
	Miscellaneous service	7	2	2	-5
Government		10	12	6	+2
Total		446	446	365	



## Conclusion

More precise information will be left to another paper in future, including references to the status of local or individual cities, and quantitative enlightenment of various regional or chronological values, or the discussion on the more extended application of the integration index.

Above descriptions in this paper are summarized as follows. In Japan, areal differentiation of urban functions is clearly observed; the various types of manufacturing integration in central Japan and the local service integration in the rest of the area. These seem to manifest a type of concentric zoning; inner core ring of manufacture and outer peripheral zone of centrality services, embracing nodal metropolises with both.

Pre-modernized characters are often noted as remaining on Japanese cities in many aspects. Economical and social modernization of individual cities and the modernization of urban society by Webb seems to belong to somewhat of a different category of consideration. Especially it can be explicit as emergent policy of industrial development was executed on a pre-industrialized nation. The concentric zoning in Japan may suggest a general pattern of such course of differentiation. Certainly, the status of Japan seems properly to be a result of the extreme rapid development of industrialization after the Meiji era, in which national policy converged its investment into small areas to achieve the purpose of quick industrialization.

Based on the already established areal feature, the differentiation is still under progression even at present, or at least until 1960. Further it has particularly proceeded to large extent in accordance with the striking development of industry after 1955, though the Japanese Government pronounced a decentralization policy of manufacture in 1957.

As a result, Japanese cities seem diverging into two types of urban society. Cities of central Japan possess many characteristics of Webb's modern urban society. The cities bear quite different constitution of activities with respect to each other, or, in other words, they are heterogeneous. Their activities are importantly connected with remote areas, both terminals of the connection having the specialized function and its peculiar location. Finally, their integrated partners are also cities, being homogeneous to each other.

On the other hand, the cities in peripheral areas mainly perform a role of central place. They have a similar constitution of activities to each other. Their contacts are principally kept on the surrounding neighbourhood in their

productive integration. Further, their integration mainly operates to rural area, heterogeneous partners with the city group. These characters all belong to the nature of isolated urban society.

However, two types of urban societies form a perfect complement mutually on a national scale, being integrated closely to one another. Any city of the latter type is not "even relatively" isolated in Japan. This is also a reason of why integrated index does not reflect the grades of industrialized natures of cities, as is illustrated in Fig. 9. Symple contrast of two types of urban society can not be successful in this case, because both types are products of functional integration.

Here the writer proposes the concept of isolated and integrated urban society to be arranged with a distinction of local and national scales like hierarchy system. Its practical interpretation is a future problem. Further, there may remain a question whether the progression of differentiation can be a permanent tendency or not, or, whether the cities of centrality in modern urban societies intensify their nature forever or not.

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