INNOVATION DIFFUSION AND URBAN SYSTEM IN JAPAN DURING THE MEIJI AND TAISHO ERA, 1868~1926

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INTRODUCTION

The discussion about diffusion process of entrepreneurial innovation has recently begun to refer to its specific relation with the urban system (Berry, 1972; Cohen, 1972; Sheppard, 1976; Webber & Joseph, 1977). Such advance of the study seems to result from development of the idea that the adoption of innovations is conditioned by the urban system in the following two manners. First, the adoption is decided by entrepreneur or propagator ultimately through his estimation of sufficient market potential (Moseley, 1974), and, second, the adoption of innovations provides the foundation of urban growth, directly or indirectly (Pedersen, 1970; Pred, 1973; Robson, 1973). Whichever the concern in the study is, the emergent problem to be clarified will be the structural relationship of actual diffusion process to urban system. Though Hudson (1969) and Pedersen (1970) have already suggested theoretically that innovation diffusion in the idealized region is affected, to some extent, by size-arrangement mode and spatial distribution manner of urban system, there perhaps exists no study examining the relationship between spatial diffusion of innovation and urban system in the actual region except Pred (1973). He proposed a conceptual model on development of urban system with his finding that innovation diffusions produced apparent influence on the growth of U.S. urban system in pretelegraphic period.

So, the author thinks it necessary for our better understanding of Japanese urban system to investigate its development in the Meiji and Taisho era (1868~1926) in terms of the point as mentioned above. The present Japanese urban system was fundamentally grown in this period under peculiar environment of so-called the Meiji Evolution. That may be comprehended as follows: In the Meiji era (1868~1912) falling in the turning epoch from the feudal state to the modern one, the new government decided to introduce the Western Civilization – that is, new organization and technology, namely, innovation – in order to expand the national production; and, on this course, the industrialization became vigorous from the late Meiji era to the early Taisho era and the frame of Japanese urban system was coarsely accomplished at the end of Taisho era or the early Showa era (Watanabe, 1968; Takahashi, 1975). Therefore, it may be reasonably conceived that the developing process of Japanese urban system can not be fully explained only by the studies on the industrialization process of Japan but also by the analysis of the diffusion process of various innovations in those days.

URBAN SYSTEM IN THE MEIJI AND TAISHO ERA

The transformation of Japanese urban system in the investigated period will be outlined in this section. At first, functional regions are figured to manifest the spatial pattern of Japanese urban system in the early Meiji era. The indicator data used to signify functional regions are inter-prefectural flows of the national bank draft for private business in 1882. R-mode factor analysis (the extracted principle components with eigenvalues of 1.0 or more being subjected to varimax rotation) by Goddard's method (1970) was applied to delimitate functional regions. The division of the prefectures in those days was somewhat different from the present system; that is, Ishikawa in those days unified the present Toyama, Osaka unified Nara, Ehime unified Kagawa, Nagasaki unified Saga and Kagoshima unified Miyazaki, respectively. The present Hokkaido was divided into three prefectures of Hakodate, Sapporo and Nemuro. So the areal units in analysis consist of forty-two prefectures excluding Nemuro Prefecture with which no transaction was performed by the other prefectures.

Five factors with eigenvalues of 1.0 or more, accounting for 86.7% of the total variance, were extracted from the 42 (the number of origin prefectures) x 42 (the number of

Table 1 Dominant factor loadings and dominant factor scores

Factor	Prefecture	Factor loading	Factor score
I (21.2789, 50.7%)	Chiba	0.9896	–
	Ibaragi	0.9810	–
	Yamanashi	0.9781	–
	Hakodate	0.9695	–
	Yamagata	0.9675	–
	Tokushima	0.9579	–
	Aomori	0.9445	–
	Fukushima	0.9356	–
	Osaka	0.9353	–
	Tochigi	0.9327	–
	Nagano	0.9180	–
	Mie	0.8959	–
	Hyogo	0.8499	–
	Iwate	0.8032	–
	Miyagi	0.8015	–
	Gifu	0.7934	–
	Niigata	0.7883	–
	Aichi	0.7598	–
	Wakayama	0.6864	–
	Shiga	0.5158	–
	Kyoto	0.5149	–
	Tokyo	–	6.2606
II (9.6989, 23.1%)	Okayama	0.9795	–
	Shimane	0.9767	–
	Kagoshima	0.9668	–
	Fukuoka	0.9619	–
	Yamaguchi	0.9600	–
	Kochi	0.9080	–
	Oita	0.9015	–
II	Sapporo	0.9002	–
	Ishikawa	0.8946	–
	Ehime	0.8805	–
	Hiroshima	0.7906	–
	Tokyo	0.7760	–
	Tottori	0.7713	–
	Fukui	0.7527	–
	Kyoto	0.7132	–
	Kumamoto	0.6851	–
	Shiga	0.6255	–
	Wakayama	0.6153	–
	Osaka	–	6.2399
III (2.8070, 6.7%)	Gunma	0.9790	–
	Saitama	0.9583	–
	Shizuoka	0.8494	–
	Kanagawa	–	6.1810
IV (1.4704, 3.5%)	Nagasaki	0.9298	5.3182
	Kumamoto	0.6612	1.6463
	Fukuoka	–	1.5711
V (1.1378, 2.7%)	Kanagawa	0.5108	–
	Gunma	–	2.6167
	Aichi	–	1.3502
	Kyoto	–	1.2479
	Shizuoka	–	1.1718
	Akita	−0.7772	−3.8494
	Sapporo	–	−2.2557
	Hakodate	–	−1.7574

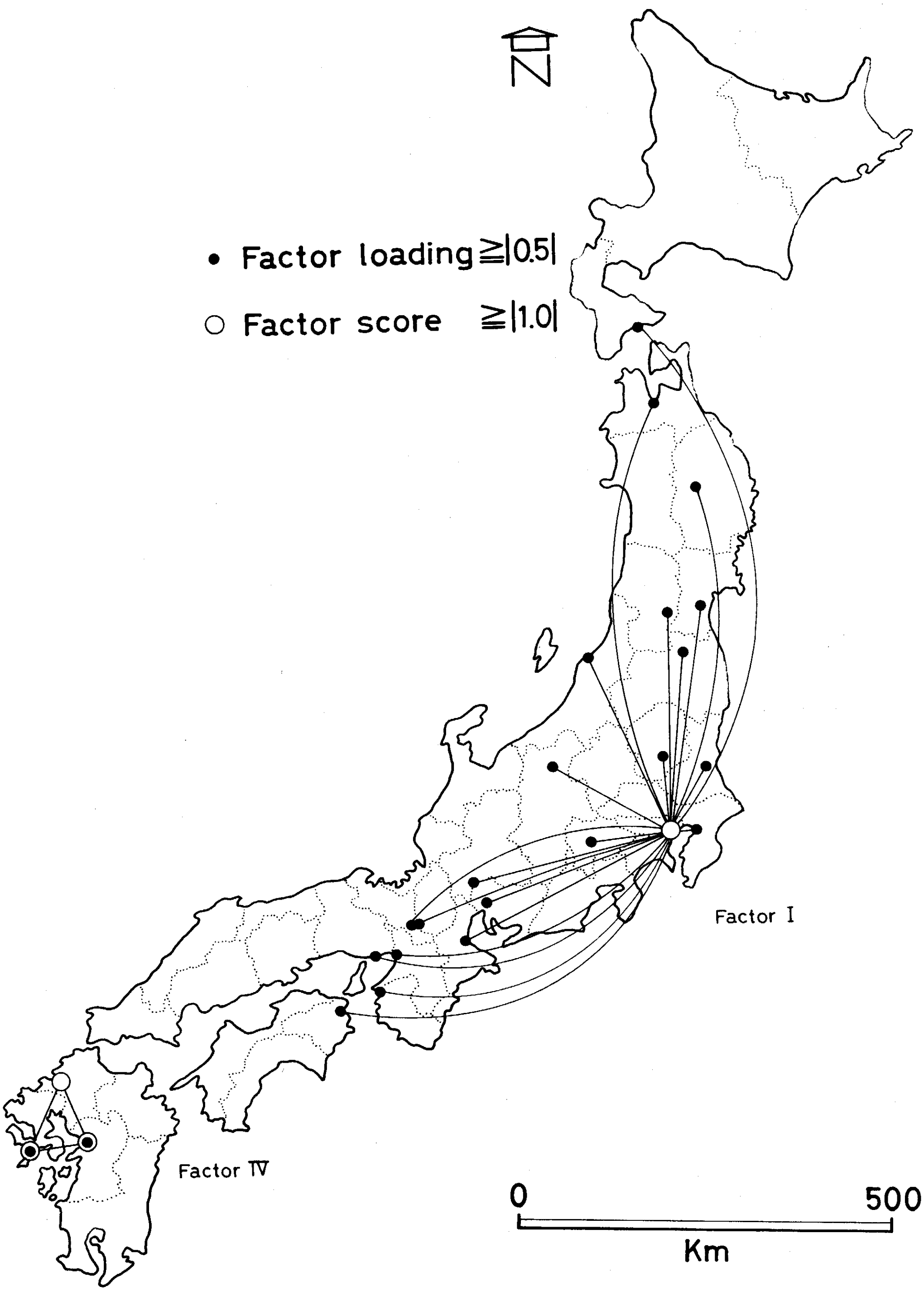

Fig. 1 Functional regions delimitated by factor analysis of the national bank draft (1)

destination prefectures) draft flow matrix (Table 1). Factor I with eigenvalue of 21.2789 accounts for 50.7% of the total variance. If the prefectures with factor loadings of 0.5 or more are determined as major destinations, most of these prefectures tend to be distributed in Eastern Japan delineated by the Niigata-Nagano-Shizuoka Prefectures line as its west boundary (Fig. 1). In Eastern Japan only six prefectures of Sapporo, Akita, Gunma, Saitama, Tokyo and Shizuoka have not high loadings on Factor I, while the prefectures in the Tokai District (Aichi, Mie and Gifu), those in the Kinki District (Shiga, Kyoto, Osaka, Hyogo and Wakayama) and Tokushima Prefecture constitute the major destinations in the western half of Japan bordered by the Ishikawa-Gifu-Aichi Prefectures line. With regard to origin prefecture, only one prefecture, Tokyo, manifests the factor score of 1.0 or more. Therefore, Factor I can be interpreted as distinguishing the sphere of influence of Tokyo, where Tokyo Prefecture is the origin, and the whole area of Eastern Japan and the Tokai and Kinki Districts in Western Japan are the destinations. Unfavorably, the content of contract for the draft is unknown in this source material. But, if it is admitted to assume that commodity flows were directed in the opposite course of draft flows, the contact of Tokyo to the Tohoku District in Eastern Japan seems to inherit a part of the regional relationship in the previous era (the Edo era, 1603~1867) when agricultural products such as rice etc. were supplied to Edo (Tokyo) from the Tohoku District by the eastward navigation route (Toyoda & Kodama, 1969). But, on the other hand, the origin prefecture of draft flows to most prefectures of the Tohoku District on the coast of the Japan Sea was assigned to Tokyo but not to Osaka, along which the contact to Osaka had been established by the westward navigation route in the Edo era. This shows a new style of Japanese urban system in the Meiji era, which Kurosaki (1961) has already reported in a paper on the trade areas of Tokyo and Osaka in the early Meiji era, using the data of commodity flows of rice, foreign textiles and foreign sugar. Besides, the connection of Tokyo to the Kinki District may also inherit the feudal regional relationship originally stemmed from commodity transportation by the *Higaki* cargo-vessel and the *Taru* cargo-vessel in the Edo era (Toyoda & Kodama, 1969).

Factor II with eigenvalue of 9.6989 accounts for 23.1% of the total variance. The destination prefectures with factor loadings of 0.5 or more are mostly distributed in Western Japan (Fig. 2). Only Gifu, Aichi, Mie, Osaka, Tokushima and Nagasaki Prefectures exceptionally do not show the destination nature in Western Japan. Contrariwise, Sapporo and Tokyo constitute the destination prefectures in Eastern Japan. On the other hand, the origin prefecture with factor score of 1.0 or more is only Osaka. Therefore, Factor II may virtually imply functional integration of Osaka Prefecture and represents the sphere of influence of Osaka, which was expanding over Western Japan. The special connection of Osaka to the prefectures on the coast of the Island Sea (Okayama, Hiroshima, Yamaguchi and Ehime) and the Hokuriku District (Fukui and Ishikawa) on the coast of the Japan Sea will suggest the inheriting regional relationship by the feudal transportation system of agricultural products for Osaka through the westward navigation route (Toyoda & Kodama, 1969).

Factor III with eigenvalue of 2.807 accounts for 6.7% of the total variance. The destination prefectures with factor loadings of 0.5 or more are Saitama, Gunma and Shizuoka in the Kanto and Chubu Districts, and the origin prefecture with factor score of 1.0 or more is Kanagawa (Fig. 2). Raw silk products in Gunma Prefecture and tea products

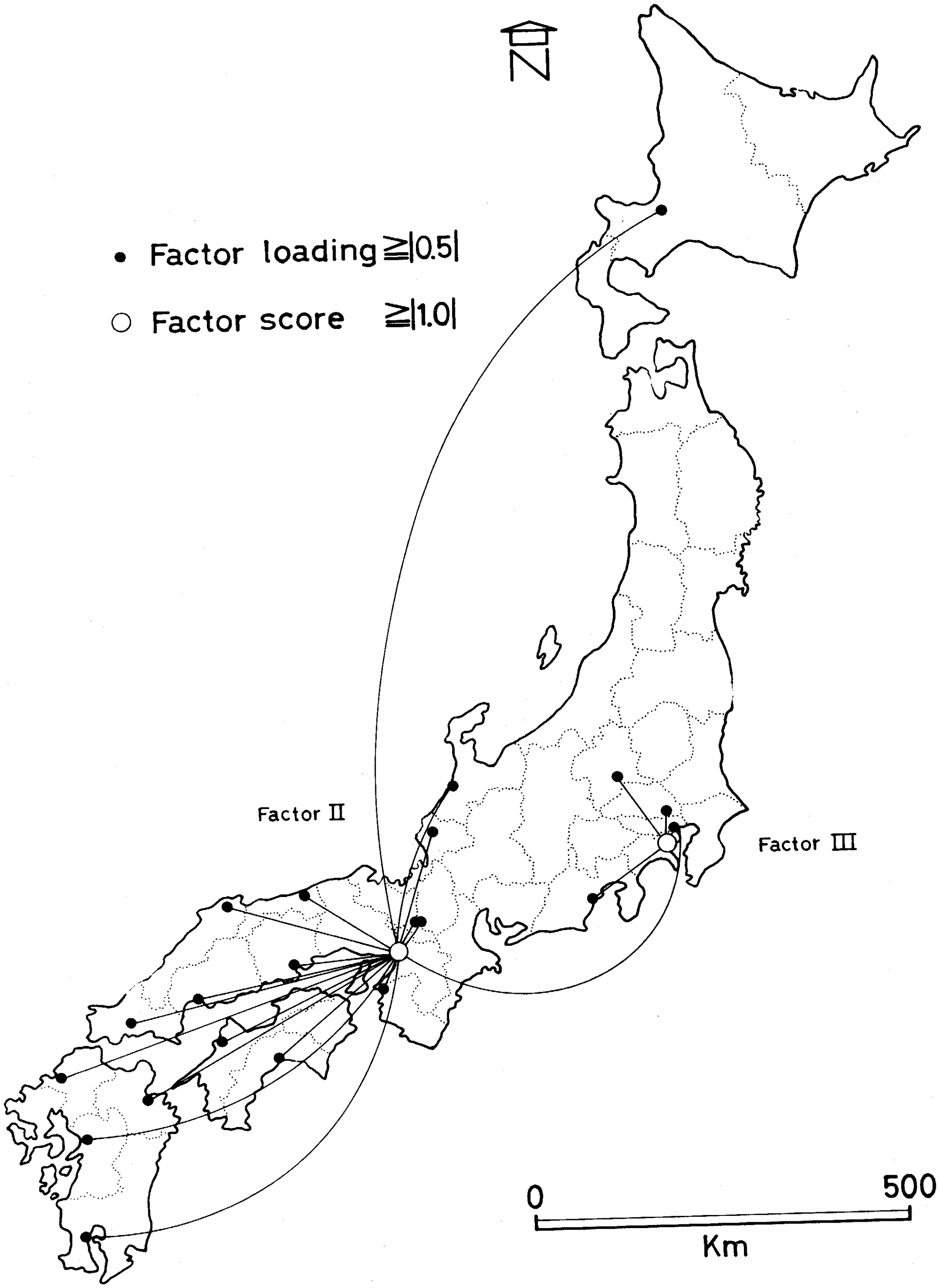

Fig. 2 Functional regions delimitated by factor analysis of the national bank draft (2)

in Shizuoka Prefecture began to be exported from Yokohama, a newly created foreign trade port in Kanagawa Prefecture (Furushima & Ando, 1975). The former prefecture amounted to 16.1% of the national total raw silk production in 1882, being the first in Japan, and the latter prefecture amounted to 12.0% of the national total tea production in 1882, also ranked the first in Japan. Further, raw silk products in Saitama Prefecture amounted to 11.4% of the national total raw silk production in 1882, being the third in Japan. On the other hand, export of raw silk and tea respectively amounted to 60.9% and 16.5% of the total export value (26,661,889 Yen) of Yokohama in 1882. Consequently, it is reasonable enough to assume Factor III to signify the hinterland of Yokohama.

Factor IV with eigenvalue of 1.4704 accounts for 3.5% of the total variance. The destination prefectures with factor loadings of 0.5 or more are Nagasaki and Kumamoto in the Kyushu District, and the origin prefectures with factor scores of 1.0 or more are Nagasaki, Kumamoto and Fukuoka (Fig. 1). Unlike Factor I~III, two out of three origin prefectures are also destinations. Factor IV seems to represent a relatively interdependent functional region on a local scale. The fact that both of factor loading and factor score of Nagasaki are the largest among the above three prefectures may lead us to a supposition that Factor IV distinguishes functional region bound up with foreign trade at Nagasaki. Main exports from Nagasaki in 1882 were coal for ship's use (715,900 Yen), rice (722,161 Yen), coal (434,946 Yen) and dried cuttlefish (398,043 Yen), and main imports were kerosene (257,038 Yen), brown sugar (145,526 Yen) and ginned cotton (128,473 Yen). Furthermore, coal production in Nagasaki and Fukuoka Prefectures amounted to 63.4% and 26.2%, respectively, of the national total coal production by private mines in 1882.

Factor V with eigenvalue of 1.1378 accounts for 2.7% of the total variance. The character of this factor is somewhat peculiar in its splitting structure into the positive and the negative parts, or bipolar structure. In the positive one, the destination prefecture with factor loading of 0.5 or more is only Kanagawa, and the origin prefectures with factor scores of 1.0 or more are Gunma, Shizuoka, Aichi, Shiga and Kyoto (Fig. 3). These facts may suggest us that, in contrast with Factor III, the positive part of Factor V distinguished functional region formed by import flows from Yokohama port. On the other hand, in the negative one the destination prefecture with factor loading of –0.5 and less is only Akita, and the origin prefectures with factor scores of –1.0 and less are Akita, Sapporo and Hakodate (Fig. 3). Formation of this functional region thus seems to be attributed to rice shipment from Akita Prefecture to the Hokkaido District in reclaiming stage (Furushima & Ando, 1975).

Because of the areal division in the source material, that is not city unit, the above delimitation of functional regions can not be accurately representative of the spatial pattern of urban system in the early Meiji era. But the following could be inferred from such prefectural pattern as described above. First, Factor I and Factor II suggest that the cities in Eastern Japan were under the sphere of influence of Tokyo and those in Western Japan belonged to the sphere of influence of Osaka. Next, the fact that Tokyo and Osaka mutually performed the destination of another in Factor II and Factor I reveals that the close interdependence of the two cities had been already established by the early Meiji era. These two observations may make us interpret that the urban system in the early Meiji era basically inherited the castle town system or feudal urban system under the *Bakuhan* policy, though the sphere of influence of Tokyo in the Meiji era considerably expanded in comparison with

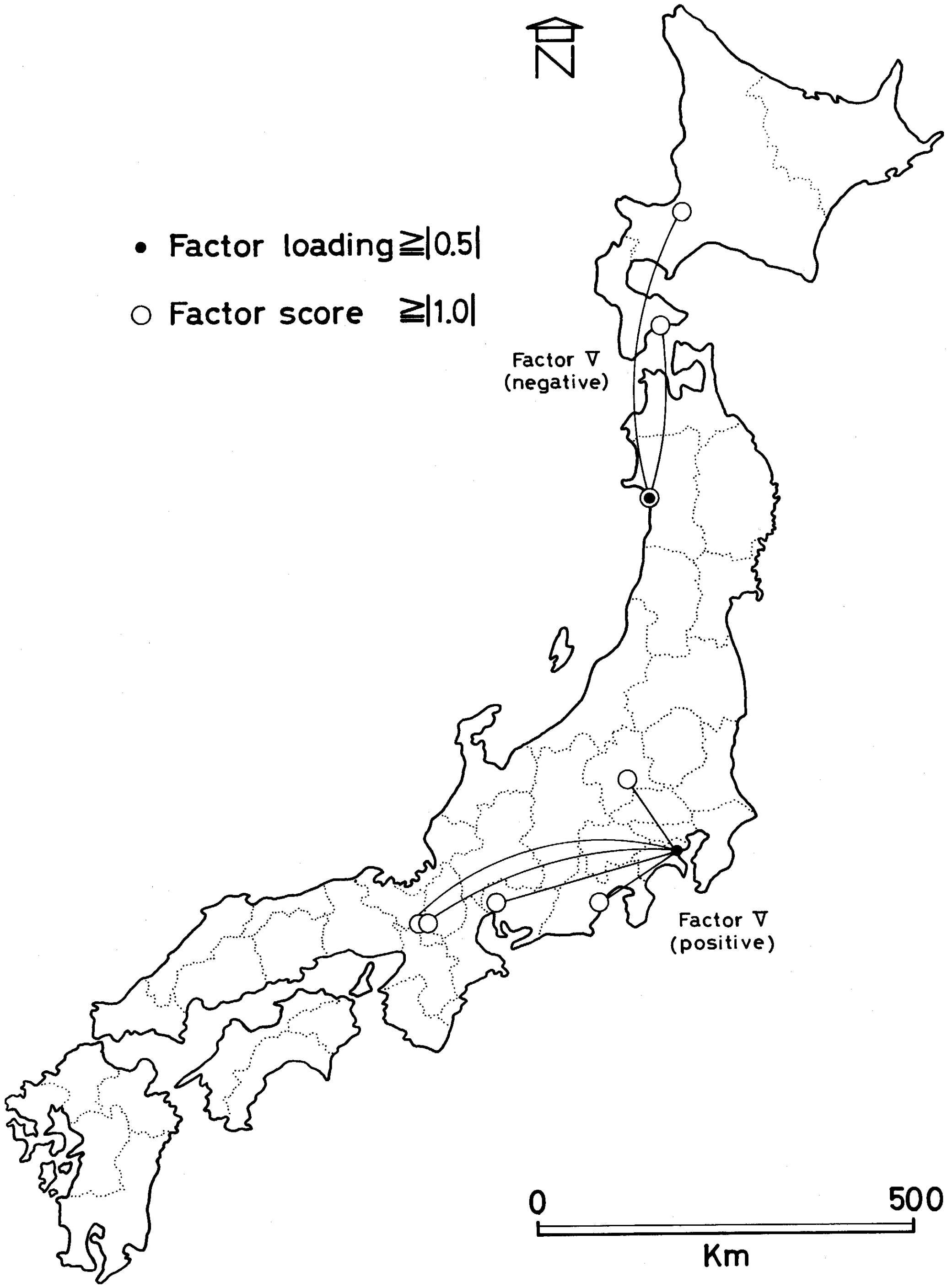

Fig. 3 Functional regions delimitated by factor analysis of the national bank draft (3)

that in the Edo era and inversely that of Osaka shrank (Kurosaki, 1961).

The *Bakuhan* policy is a kind of centralized government system that the Tokugawa government in Edo (Tokyo) divided the whole country into large or small fiefs measured by *kokudaka* or yields of rice, and then subordinated the *daimyo*s or feudal lords who managed the fiefs. About two hundreds and sixty *daimyo*s in this system were compelled to construct their own castle towns in their fiefs at regular spacings to collect products for the purpose of consumption by *daimyo* and his retainers, and for conversion into money to secure financial revenue for feudal clan. Thus, the castle towns were not only the centers of governing and military affairs, but also the places of consumption and the centers of commodity circulation. Therefore, every castle town was densely inhabited in proportion to yields of rice. On the other hand, a residual part of rice or domestic products in each fief was shipped to Osaka to be converted into money by concentrating urban merchants. Then commodities and money were further transported to Edo (Tokyo) to meet the demand of *daimyo*s and their retainers who were dwelling there under the alternative-year attendance system. So commodities and money in circulation finally centered to Edo (Tokyo) as the largest consuming place and Osaka as the commercial center. Through such circulation process, many minor port towns and post towns were formed in various districts of the country, too (Yazaki, 1962). Hereupon the Tokugawa's castle town system could be defined as an interdependent urban network in national market economy, which consists of (1) three national centers, Edo (Tokyo), Osaka and Kyoto (the capital in former days), with their population of about 1,000,000, 379,513 and 350,986 in 1711 respectively, (2) castle towns, and (3) port towns and post towns.

But the castle town system differs from the urban system of the early Meiji era in the following points. The former system was almost closed to foreign countries by the seclusion policy of the Tokugawa government, though foreign trades were limitedly permitted exceptionally via the port of Nagasaki. The latter system was open to foreign countries, with which trades were vividly transacted via plural ports, for example, Yokohama, Kobe, Niigata and Hakodate in addition to Nagasaki. The fact that there were signified functional regions whose nodes were the trade ports of Yokohama and Nagasaki in Factor III~V implies that the urban system in the early Meiji era did not only inherit the castle town system, but also newly posessed heterogeneous elements which had not existed in the latter system. Furthermore, the fact that the connection between Hokkaido and Akita was extracted by Factor V suggests that the city for reclamation of Hokkaido became a new constituent element of the urban system.

Then, taking account of these aspects of the urban system in the early Meiji era, we can sketch the transition of its hierarchical aspect by examining the rank-size curve. The rank-size curves for the twenty-five largest cities in 1879, 1888, 1893, 1898, 1903, 1908, 1913 and 1920 are drawn in Fig. 4. The use of the data for the year of 1925, the final census year during the Taisho era, is omitted here, because they could not be correctly compared with the others, the population of Tokyo being accidentally decreased by the disastrous Great Earthquake of 1923. The number of cities, twenty-five, chosen for the study is determined to correspond with that used for the analysis in the next section.

Table 2 is the result of equation of rank-size relationship, $K=P_i \cdot r_i^q$, obtained by applying least squares method, where r_i is the rank of city i, P_i is population of city i, and K and q are

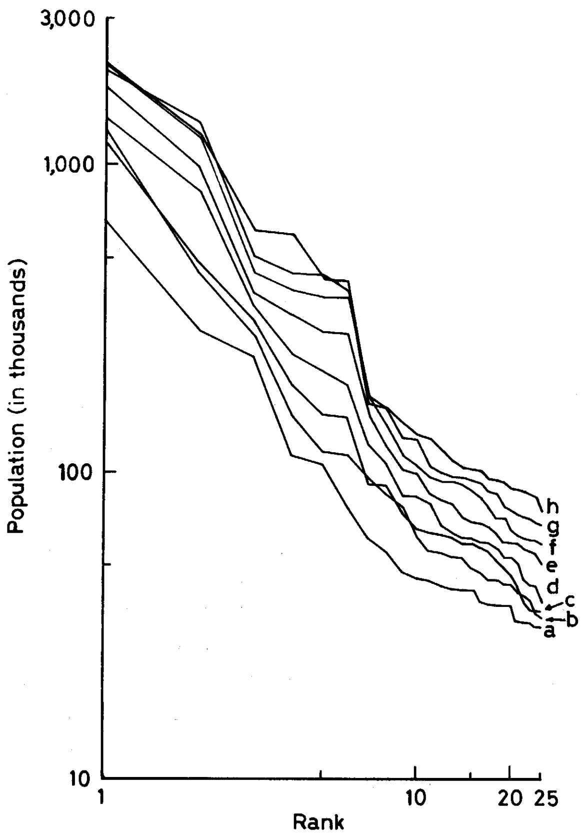

Fig. 4 Rank-size curves for the twenty-five largest cities in 1879(a), 1888(b), 1893(c), 1898(d), 1903(e), 1908(f), 1913(g) and 1920(h)

Table 2 Rank-size relationship

Year	K	q	Coefficient of determination
1879	478,700	0.9141	0.9434
1888	822,800	1.0336	0.9626
1893	918,300	1.0404	0.9736
1898	1,275,300	1.1125	0.9759
1903	1,598,100	1.1282	0.9673
1908	1,998,000	1.1575	0.9614
1913	2,079,200	1.1285	0.9569
1920	2,100,900	1.0858	0.9537

parameters. Goodness-of-fit of equations are generally high throughout the period. Goodness-of-fit of the curve in 1879 is the lowest with a discontinuity between the rank 3rd and 4th cities. This indicates the remnants of the castle town system in which Edo (Tokyo), Osaka and Kyoto dominated over other castle towns. Furthermore, twenty out of twenty-five cities in 1879 were formerly castle towns. Parameter q, which expresses the degree of concentration or dispersion of population within urban system, is less than 1.0 only in this year, showing the fact that the Force of Diversification operated more strongly than that of Unification (Zipf, 1949). Goodness-of-fit of equation continuously increases till 1898, and then decreases. The major reason for this trend is the rapid growth of the rank 4th~6th cities as evidently shown in Fig. 4. Especially the urban system seems to have begun to be differentiated into three classes in the years of 1908 and 1913; the rank 1st~2nd cities, the rank 3rd~6th cities, and the rank 7th or more cities. The creation of such tendency to form an urban hierarchy is attributed to a weakening increase of parameter K which expresses the theoretical population of the largest city. In Table 2, K increases almost in the order of 100,000 till 1908, while it increases only in the order of 10,000 after 1913. Together with the change of K, q becomes decreased after 1908 when it gets the maximum value, 1.1575. These changes of q and K may suggest the fact that Japanese urban system rapidly grew toward the unification during the Meiji era, and slowed down its growing tempo in the Taisho era. It can be assumed that Japanese urban system had achieved some level of unification in 1908, when the cities for reclamation, the foreign trade port cities and the naval cities (Kure, Sasebo and Yokosuka) appeared collectively among the twenty-five largest cities. The status seems, to some extent, to inherit the castle town system, and, on the other hand, to respond to the national policy which promoted the opening of the country to the foreign trade, the reclamation of Hokkaido and the military fortifying strategy. At that time, however, another type of new change also began in terms of industrialization. This fact is proved by the rapid increase of population of the two foreign trade port cities, Yokohama and Kobe, which developed infant industrialization (Yazaki, 1962), and is also revealed by the growing of Yahata, an iron-manufacturing city, to the twenty-five largest cities in the year of 1920. Surely, the industrialization became a new and the most important constituent element of the system just at the beginning of the Taisho era. The purpose of the discussion in the next section is to elucidate the relationship between the change of Japanese urban system and spatial diffusion pattern of innovations which brought the new situations on it.

SPATIAL DIFFUSION PATTERN OF INNOVATIONS

For the reasons already described, the period chosen for the study in this section is the Meiji and Taisho era. Twenty-five cities are selected for the study, whose population were 50,000 or more in 1903, approximately the middle year of the studied period. Fifteen out of these cities originated from the feudal castle town, and seven from the port city, two from the naval city and the remaining one from the newly established local administrative center in the Meiji era. Nine innovations are chosen for the study, that is, establishment of daily paper publishing company, gas supply company, office of national bank, university, higher (professional) school, electric supply company, water service facility, streetcar transportation system and department store. The method follows Pedersen (1970): first, the adoption ranking 1~25 is determined for the nine innovations respectively based on the years of adoption (Table 3); second, the 9x9 Spearman's rank-correlation matrix is calculated

Table 3 Data for the years of adoption

No.	City	Origin of city	Daily paper publishing co.	Gas supply co.	National bank	University	Higher (professional) school	Electric supply co.	Water service	Streetcar	Department store
1	Tokyo	Castle town	1872	1874	1873	1886	1886	1887	1911	1903	1904
2	Osaka	Castle town	1876	1905	1873	1922	1901	1889	1895	1903	1907
3	Kyoto	Castle town	1877	1910	1878	1897	1886	1889	1912	1895	1908
4	Nagoya	Castle town	1873	1907	1877	1920	1905	1889	1914	1898	1910
5	Kobe	Port city	1880	1901	1878	1929	1903	1888	1905	1910	1908
6	Yokohama	Port city	1871	1872	1874	–	1920	1890	1887	1904	1921
7	Hiroshima	Castle town	1879	1910	1879	1929	1920	1894	1898	1912	1929
8	Fukuoka	Castle town	1880	1906	1877	1903	1907	1897	1923	1910	1925
9	Nagasaki	Port city	1882	1903	1877	1923	1887	1893	1891	1915	1934
10	Hakodate	Port city	1882	1912	1879	–	1935	1896	1889	1913	1923
11	Sendai	Castle town	1878	1910	1878	1911	1887	1894	1923	1926	1932
12	Kure	Naval city	1903	1911	–	–	–	1899	1918	1909	1934
13	Sapporo	Administrative center	1887	1912	–	1907	–	1891	1937	1918	1916
14	Kumamoto	Castle town	1883	1911	1877	1922	1887	1891	1925	1924	1916
15	Kanazawa	Castle town	1881	1908	1877	1923	1887	1900	1932	1919	1930
16	Oakayama	Castle town	1879	1910	1877	1922	1887	1894	1905	1912	1925
17	Otaru	Port city	1894	1912	–	–	1910	1894	1914	–	1923
18	Kagoshima	Castle town	1881	1911	1879	–	1887	1898	1922	1914	1917
19	Sasebo	Naval city	1905	1912	–	–	–	1906	1908	–	1920
20	Niigata	Port city	1877	1911	1874	1922	1919	1898	1910	–	1937
21	Sakai	Port city	–	1910	–	–	–	1894	1910	–	–
22	Wakayama	Castle town	1892	1911	1878	–	1922	1897	1926	1909	1931
23	Tokushima	Castle town	1888	1915	1879	–	1922	1895	1927	–	1934
24	Toyama	Castle town	1886	1913	1879	–	1920	1899	1938	1913	1932
25	Fukui	Castle town	1879	1912	1878	–	1923	1899	1925	–	1928

* The years of adoption are limited to pre-World War II.

from the above data matrix; third, it is subjected to factor analysis to extract the general diffusion pattern. Forward stepwise multiple regression analysis was applied to interpret the factors. The chosen independent variables are population (log transformation) in 1903, *kokudaka* or yields of rice of castle town in 1869, the number of vessels entering foreign trade port in 1878, distance from Tokyo (log transformation) and distance from Osaka (log transformation), and the dependent variable is, of course, factor score. These independent variables are selected, taking account of the result of the investigation in the preceding section.

Three factors with eigenvalues of 1.0 or more, accounting for 77.0% of the total variance, were extracted by application of factor analysis (Table 4). Factor I with eigenvalue

Table 4 Matrix of factor loadings

Innovation	Factor I	Factor II	Factor III
Daily paper publishing company	0.7565	0.2971	0.3124
Gas supply company	0.6348	0.2954	0.5558
National bank	0.8776	0.0792	0.2726
University	0.7229	0.4331	−0.2137
Higher (professional) school	0.8072	0.2600	−0.0641
Electric supply company	0.3231	0.7441	0.2794
Water service	0.0295	0.1529	0.9205
Streetcar	0.2984	0.6492	0.3113
Department store	0.1458	0.8922	−0.0002
Eigenvalue	4.7031	1.2016	1.0145
Variance (%)	52.3	13.4	11.3

of 4.7031 accounts for 52.3% of the total variance. Innovations with factor loadings of 0.5 or more are daily paper publishing company, gas supply company, national bank, university and higher (professional) school. The kinds of innovations are so diverse as covering cultural, economic, social life and educational dimensions, but they have a striking common feature in that each chronologically began to spread in the early Meiji era. The cities with scores of −1.0 and less are Tokyo, Kanazawa, Niigata, Sendai and Fukuoka in order of the absolute value as shown in Fig. 5, while those with scores of 1.0 or more are Sasebo, Hakodate, Kure, Sakai, Otaru and Sapporo. The castle towns in big feudal clans have generally high negative

Table 5 Result of multiple regression analysis of scores for Factor I
(F statistic of significant variable is 2.0 or more)

	Yields of rice *(kokudaka)* of castle town	Population (Log)
Coefficient of correlation (r)	−0.4707*	−0.4674*
Order of entry	1	2
Standard partial regression coefficient (β)	−0.3335	−0.3277
Coefficient of multiple correlation (R)	0.4707*	0.5569*
Coefficient of multiple determination (R^2)	0.2216	0.3101
F value	2.923	2.823

* Significant at the 0.05 level

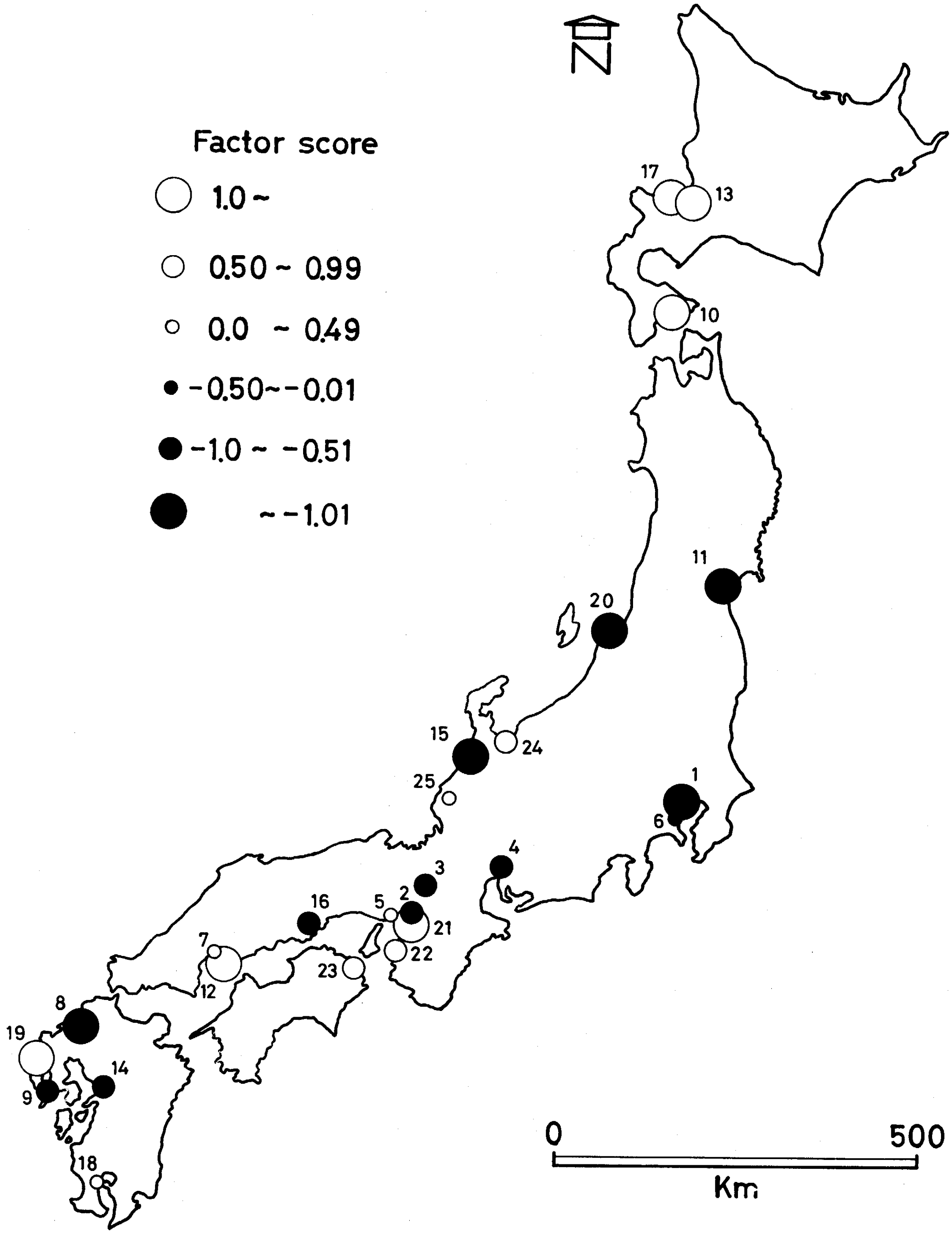

Fig. 5 Distribution of scores for Factor I
(Numbers correspond to those in Table 3)

scores, and inversely the cities for reclamation of Hokkaido and the naval cities, both developing in the Meiji era, are endowed with high positive scores. Hence Factor I is inferred to represent such kinds of innovations as to spread on the castle town system. Multiple regression analysis reveals that both yields of rice of castle town and population as the significant variables account for about 30% of the total variance (Table 5). That is, the innovations summarized in Factor I tended to be adopted earlier in the larger castle town with greater population.

We have already observed that the urban system in the early Meiji era, to a great extent, had inherited the castle town system. Therefore, it may be quite natural that the innovation diffusion pattern in those days closely correlated to the latter system. But it is necessary to annotate the aspects in a little more detail here. First, newspaper in Japan had already been published in Edo (Tokyo) by means of translation newspaper of European language paper by the Tokugawa government in the Edo era. Furthermore, English papers were published in Yokohama, Kobe and Nagasaki where foreigners lived, too. Such antecedent facts were, however, not directly linked with daily paper publication in the Meiji era. The first daily paper in Japan was published by the prefectural governor of Yokohama in 1871. Since then, the newspaper publication in the early period of its diffusion generally linked itself to administrative agencies, who intended to make publishers print the official document or decree. It is after 1877 that the progress of the democratic movement pushed forward the publication for the purpose of expressing political fellowship's opinions. These are the reasons why daily paper publication developed in close touch with politics and policy, and, consequently, with the castle town system which was, to some extent, utilized for the frame of local administrative organization in the Meiji era (Ido, 1969). In addition, such diffusion pattern was also caused by the fact that many of literates in those days were limited to the feudal *samurai* or warrior class before the enforcement of national compulsory education system.

The national bank system had spread in all the cities chosen for the study within only seven years, though the other types of innovations took at least twenty years to be fully adopted among them. One of the reasons of its speedy diffusion is explained by the fact that the government hurried to foster the modern banking facilities in order to start industry and to develop the national economy. Copying the American national bank system, the government preferred the decentralized bank system in which establishment of small banks was much encouraged in various areas of the country. These scattered small banks were purely private companies, though they were named as the National Bank, and their function was much similar to that of the credit company that issued bank notes and loaned them. It was not substantial affairs for these banks to collect deposits and to employ them, because majority of people were not accustomed to save money in those days. Therefore, their main working capital had to depend on their own funds, and such people who could establish a bank were, consequently, restricted to those who were the peer and the *shizoku* (descendants of the feudal *samurai* or warrior class), large land owners or big feudal merchants. In 1880 the sum of 18,572,000 Yen invested by the peer and 13,417,000 Yen invested by the *shizoku* amounted to 76% of the total stocks, 42,111,000 Yen. As the result, the cities of the castle town system where these people tended to live were preferred for the locational places of the national banks.

In the cases of two types of higher educational institutions, university and higher (professional) school, the diffusion pattern was almost shaped by the national policy in contrast with the cases of the above two innovations being indirectly conditioned by administrative factors. The policy was intended first to arrange the government higher educational institution system, consisting of higher middle school (the predecessor of higher school) and Imperial University, and second to establish the professional educational institution system besides the work to expand Imperial University and to reorganize higher school. Especially for organizing the higher middle school system as a preparatory educational step to the Imperial University, the Ministry of Education prospectively divided the whole country except Hokkaido and Okinawa Districts into five areas, and arranged the schools on the five larger cities in each division; Sendai, Kanazawa and Kumamoto that had been the castle towns of great feudal clans, Kyoto that had been the former national capital and Tokyo where the preparatory school of Tokyo University had already been established. Many cities holtly made efforts to attract them to locate, but decisive factors in governmental assignment were the history of feudal educational institutions in these castle towns, and, more importantly, the excellent local ability to burden the foundation cost of school. For example, the foundation cost of school in Kanazawa was contributed by the Maeda family, and that in Kumamoto was by the Hosokawa family, who were both the former lords of feudal clans. Coupling to the higher school system, the Meiji government furnished the Imperial University system at the top of training institutions for elites. So its diffusion pattern was closely tied up to that of higher school. The public higher professional school system was originally designed as a part of the civilizing policy of the Western culture style. Higher professional schools were much expected to help rapid industrialization by the government, and then to increase the national production. But, with the progress of industrialization in later days, they were much more requested by local merchants and manufacturers in various districts. Therefore, the diffusion pattern of higher professional school deviated from that of the other higher educational institutions and it did not necessarily spread on the castle town system in the later period of diffusion. This is partially proved by the fact that the score of Factor I was explained not only by yields of rice of castle town, but also by population. Provided that the castle town system constituted a kind of hierarchical structure, hierarchy effect would operate in the diffusion process of such innovations as summarized in Factor I.

Factor II with eigenvalue of 1.2016 accounts for 13.4% of the total variance. Innovations with factor loadings of 0.5 or more are electric supply company, streetcar and department store. Contrary to Factor I, those summarized in Factor II spread characteristically after the middle Meiji era. The distribution of factor scores (the figure is omitted here) reveals that the cities with scores of −1.0 and less are Kyoto, Sapporo, Tokyo, Kobe, Nagoya, and Osaka in order of the absolute value. As five out of six cities whose population were 200,000 or more in 1903 show high negative scores, Factor II seems to summarize innovations relevant to population size. There is a correlation between population and factor score, the coefficient being −0.6620** (Fig. 6). Then, application of multiple regression analysis clarifies that such independent variables as distance from Tokyo, distance from Osaka and the number of vessels entering foreign trade port as well as population are statistically significant in this case. But any of these variables did not operate to hasten the adoption;

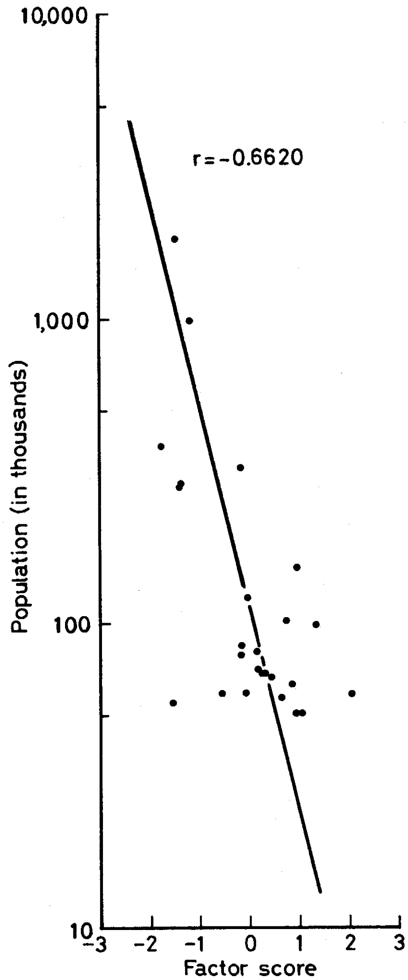

Fig. 6 Correlation between population size and scores for Factor II

that is, the signs of standard partial regression coefficients of distance from Tokyo and distance from Osaka are negative, and that of the number of vessels entering foreign trade port is positive. This is the reason why only population variable can contribute to explain Factor II.

Innovations summarized in Factor II are usually established by private organization, which Brown (1975) named as profit-motivated polynuclear innovation. Therefore, the correlation between factor score and population in this case demonstrates the hierarchical diffusion process in which adoptions are realized in sequence of market size. With regard to electric supply company, city size conditioning to secure the establishment funds, too, were another important factor to quicken the innovation adoption. Provision of the establishment funds was far more serious problem than the subsequent business management, because all the equipments of electric supply company depended on plant import in those days. Further, the effect of propagation by such pioneer electric enterprise as Tokyo Electric

Supply Company also much promoted the hierarchical diffusion. Tokyo Electric Supply Company tested to light at Kyoto and Osaka in 1883, preceding to the creation of its business management. The selection of these two cities seems to have resulted from the higher evaluation of their market potential next to Tokyo. And then, the president of the company visited Kyoto and Osaka after the opening of his business to advise businessmen to establish other electric supply companies. This resulted in endowment of technical support to the electric supply companies in Kobe, Kyoto, Nagoya, Yokohama, Sapporo and Kumamoto, that opened sequentially from 1888 to 1891. Any of these facts suggests a kind of information or influence diffusion spreading from the first adopter city, Tokyo, to the lower-ranking cities through hierarchical system.

It will be obvious that the adoption of streetcar also shows a similar hierarchical diffusion pattern, because its opening can be realized only when electricity supply is guaranteed by electric supply company. The first adoption of streetcar was in Kyoto, 1895. This is worthy of note in its conformity with the opening of a power station at Keage in Kyoto, the first hydroelectric power generation for business purpose in Japan.

It may be felt to be curious that the department store has high loading on Factor II. We usually think of it in combination with the cities of the castle town system, because its origin in Japan can often be traced back to the dry-goods store in the Edo era. Then, why does it not have high loading on Factor I? One of the reasons may be the fact that so far as the cities chosen for the study are concerned, the department stores in only seven out of fifteen cities originated in the castle town merchants of the Edo era. Several dry-goods stores in Edo (Tokyo), Osaka, Kyoto and Nagoya had then already accomplished a kind of chain store system and opened branch shops in one of the other three cities, but they were merely exceptional cases, raised by the special condition that Edo (Tokyo), Osaka and Kyoto in those days had already been equipped with the urban character in a modern sense. Excepting these four cases, the department stores derive from the feudal dry-goods stores only in the three castle towns of Kagoshima, Sendai and Okayama. Another reason is that the peculiar style of modern department store itself appeared first in Tokyo in 1904 when the castle town system was disappearing; the new style is to increase the items of selling goods and to reform the management system into the joint-stock corporation. The adoption of modern department store style thus spread on the non-castle-town urban system which emerged after the Meiji era.

Table 6 Result of multiple regression analysis of scores for Factor III
(F statistic of significant variable is 2.0 or more)

	Number of vessels entering foreign trade port in 1878	Distance from Osaka (Log)
Coefficient of correlation (r)	−0.5970**	0.2756
Order of entry	1	2
Standard partial regression coefficient (β)	−0.6413	0.3555
Coefficient of multiple correlation (R)	0.5970**	0.6934**
Coefficient of multiple determination (R^2)	0.3564	0.4808
F value	17.156	5.273

** Significant at the 0.01 level

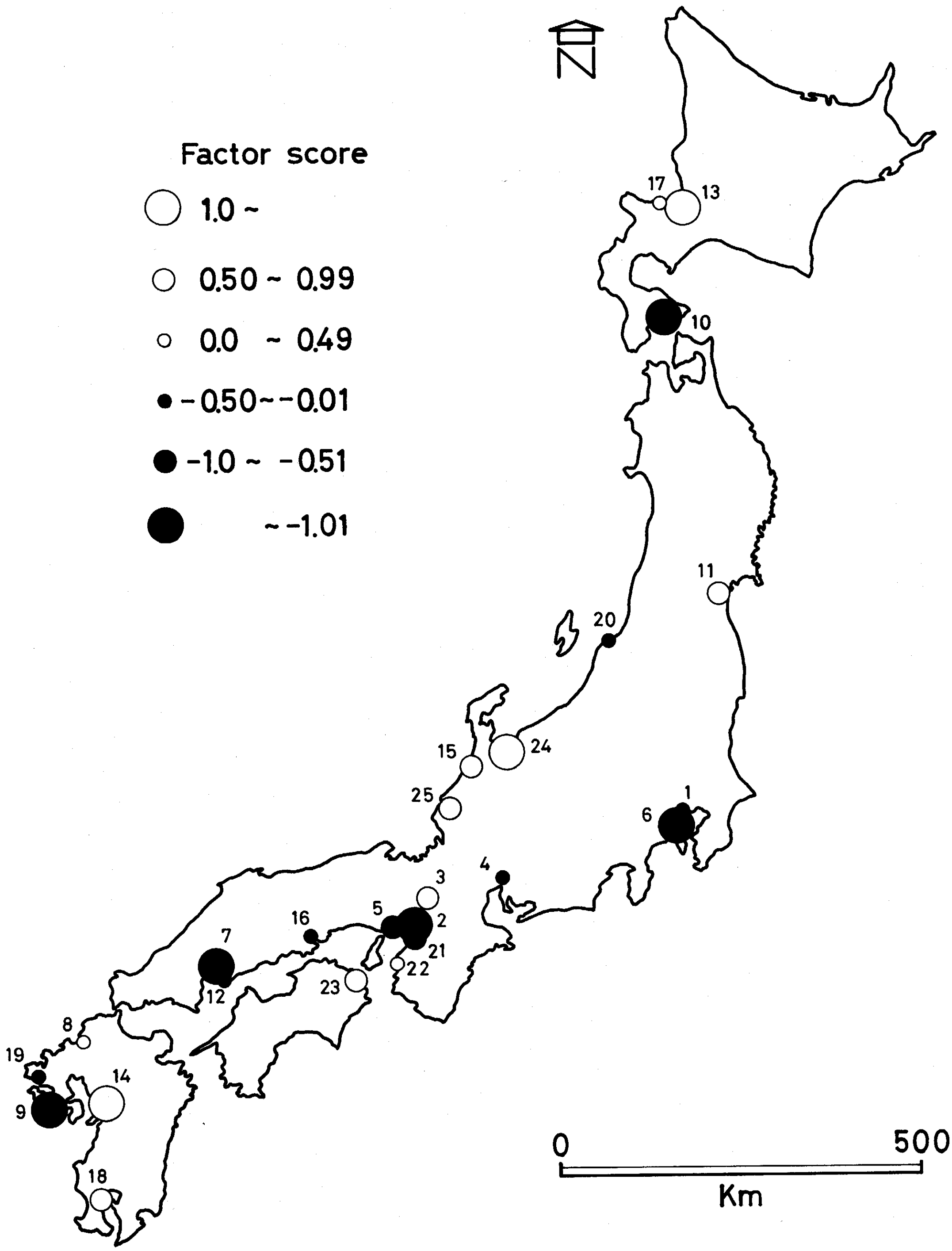

Fig. 7 Distribution of scores for Factor III
(Numbers correspond to those in Table 3)

Factor III with eigenvalue of 1.0145 accounts for 11.3% of the total variance. Innovations with factor loadings of 0.5 or more are gas supply company and water service. The starting times of the two innovation diffusions are not coincident, but they are common in their effect on social life. The distribution of factor scores shows that the cities with scores of −1.0 and less are Yokohama, Nagasaki, Hakodate, Osaka and Hiroshima in order of the absolute value (Fig. 7). They are mostly trade port cities which were functioning as the main gates to foreign countries in those days. The innovations with high loadings on Factor III are supposed to have a common character in that the culture style of foreigners residing in foreign trade ports promoted the adoption. In the case of gas supply company, for example, the companies in Yokohama (the first adopter city) and Kobe (the third adopter city) were started by residing foreigners' request. Multiple regression analysis reveals that the number of vessels entering foreign trade port and distance from Osaka account for about 50% of the total variance (Table 6). This means that the innovations summarized in Factor III more rapidly spread to the cities nearer to Osaka via foreign trade port cities as the early adopters.

SUMMARY

In this paper, the author examined the dominant pattern of spatial diffusion of nine entrepreneurial innovations in the Meiji and Taisho era with reference to Japanese urban system. Factor analysis was applied to the adoption ranking matrix of the innovations for the selected twenty-five largest cities in 1903. As the result, three types of diffusion patterns were identified; the patterns to correlate to the castle town system, to link to population size and to relate to the locations of foreign trade port cities. Conclusively said, these patterns would reflect the constitution of Japanese urban system developing after the Meiji era, which consists of two kinds of constituent elements; (1) the foreign trade port city, the city for reclamation of Hokkaido, the naval city and the industrial city as the new constituent elements, and (2) the remnants of the castle town system as the proper element. Commonly to these patterns, however, the influence of hierarchy effect in a broad sense was apparently observed, though its explanatory power was low. Therefore, the conclusion should be represented most accurately by the words that the urban system in those days, *being on reformation toward the unification*, performed the role as a channel of these innovation diffusions.

ACKNOWLEDGEMENT

The author wishes to express his gratitude to Professor Y. Watanabe, Associate Professor A. Terasaka and Associate Professor K. Nakamura, Department of Geography at Tokyo Metropolitan University, for their kind advices and encouragements.

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* in Japanese