

Chapter 10

Examination of Regional Production Activity Using City System and Regional Connection Indexes



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Abstract The agglomeration economy is changing with the progress of the globalized economy. In addition to the place-based economy, the connection economy has exerted its influence on firms' activities. This paper divides the connection economy into the city system economy and the regional connection economy and devises two indexes to indirectly measure their influence. Using these two indexes, the paper classifies 47 prefectures in Japan into four categories and considers the impact of connection economies on regional production activities. This study clarifies the following two points. The 47 prefectures in Japan are arranged with regularity according to the strength of the connection economy. Prefectures that largely enjoy the connection economies have large economic activities and factory scales in their territories becomes smaller. On the other hand, prefectures with low connection economies have larger factory scales in order to enjoy more place-based economies. It can be said as follows. The agglomeration economy continues to have a significant impact on the composition of firms' activity in each region.

10.1 Introduction

Agglomeration economy has had a decisive influence on the locations of the factories since the Industrial Revolution. From around 1900, the influence of agglomeration economy on economic society in general began to be widely recognized

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in the academic realm, and its analysis progressed.¹ Especially, research on the place-based agglomeration economy progressed in detail. Then, as the economic activity became wider and the production activity expanded, the firms' organization of production drastically changed. Along with this trend, the spatial formation of the agglomeration places that is a strong base of the production activities of the firms was also restructured. Also, the contents of the agglomeration economy changed significantly. In addition to the place-based agglomeration economy, the connection economy created by the connection among the agglomeration places has increased its influence on firms' activities. As a result, these days, the city system, which is constructed by the plural agglomeration places, and the connection between the city systems have become to have economic influence and they have provided a kind of economic infrastructure for the firms' activities.

The regional economics has successfully advanced theoretical research on the mechanism by that the connection between the cities influences regional economy. While, the progress of the analysis of the impacts of the connections within a city system and between the city systems on the firms' activities is currently in its infancy stage because the economic effects of these impacts are quite complex. This paper focuses effects of the city system and regional connection on production activity. Using two indexes that may represent the degree of the economic effect of the city system and the regional connection, the analysis tries to examine the effects of these connections on the production activities in the regions. This paper attempts to take the analysis one step further by examining the connection economy that functions in the regional production economy.

10.2 Classification of Agglomeration Economy and Connection Economy

10.2.1 Agglomeration Economy and Connection Economy

A factory enjoys various internal and external economy. These economies interact each other and influence factory's production. Some of the economies are created by the factory itself and by the surrounding districts. Other of the economies come from outside these districts and other regions. These economies are broadly divided into agglomeration economy and connection economy. The former is a place-based agglomeration economy that is stucked to a place and it is classified into mass production economy, large-scale economy, localization economy, and urbanization economy. The latter is generated by relationships between the places, and it is divided to the city system economy and regional connection economy. Let us reexamine the basic contents of the place-based agglomeration economy.

¹ Weber (1909) made the first systematic analysis of agglomeration from a location theory perspective.

10.2.1.1 Mass Production Economy and Large-Scale Economy

Since the mass production economy and the large-scale economy are generated within a factory, they are classified into the internal economy. They are examined in detail in microeconomics. The mass production economy is successfully represented by the average cost reduction by optimizing the production scale of a factory. And the large-scale economy is represented by the reduction of the average cost that results from optimizing the factory size. These internal economies have the locational influence of agglomerating factories' production activity into a certain place.

10.2.1.2 Localization Economy and Urbanization Economy

Localization economy arises from the agglomeration of the same kind of the factories in a certain place. An urbanization economy arises from the agglomeration of different kinds of the factories in place. Both come from outside a factory and they are regarded as an external economy. The essential nature of the localization economy is that spatial concentration of the factories of the same type generates many auxiliary factories and reduces the firms' production costs.

Then, the substantive economy of urbanization arises from a wide variety of production and infrastructure, and its unique economy arises from the availability of a wide variety of labor forces. This economy contributes to reduce the firms' various kinds of costs.

Localization and urbanization economies have the same locational influence as well as the internal economies: They agglomerate the factories and spatially concentrate production activity into a certain place. It should also be noted here that the internal and external economy interact and affect the production activity of a factory. This interaction contributes to create a new form of production activity within an agglomeration, and they lead to the new formation of economic organization in the region.² Agglomeration economies have the power to concentrate production activity to factory and region.^{3, 4}

² Changes in the field of corporate economy due to agglomeration are considered by Porter (1998).

³ The detailed and systematic consideration of the agglomeration economy was started by Weber (1909). Khalili-Muther-Bordenhorn (1974) has shown that the internal economy tends to drive the factories to a market place.

⁴ The importance of the socio-economic role of agglomeration-forming regions in the era of global economy extends to the field of technological innovation. Fratesi-Senn (2010) can be helpful in this regard.

10.2.2 *City System Economy and Regional Connection Economy*

This subsection explains the basic contents of the connection economy. A factory requires the production infrastructure to produce goods. Workers in the factory need living infrastructure to sustain their lives. Thus, agglomeration of the factories is inevitably formed at a place within the city area. As the production activity of the firms expands and sophisticates, it becomes difficult to efficiently perform the firms' production activity within a city. It is more efficient that the factory's production activity are fragmented and fragmented activities are carried out individually by the several cities. This forms economic connection between the cities and this connection provides the firms' production with a kind of external economy. The external economy is different from the place-based agglomeration economy, and this economy arises from the connection between the cities. This economy is named the city system economy in this analysis, and it is defined the economy created by the connection between the cities within a city system in a region.⁵

10.2.2.1 *City System Economy*

In a region where there is high social homogeneity, the cities are closely related to each other and form interdependence between them through a city system. From the city system the factories may enjoy various kinds of benefits. The city system combined the multiple cities generates high integration in the production activity and forms a labor market. It establishes high accessibility between the factories and forms a high division of labor and complementary relationships between them. These high integrations and various relationships have various positive effects on the factories operating in each city. This analysis considers these positive effects as a city system economy.⁶

Let us use three cases to explain the city system economy. Case 1) Suppose the following situation: there is one city system in a region, and there are three scales of the cities that make up the city system, large, medium, and small. A factory locates at the large city and it enjoys a large-scale economy in the production. Then, if the factory sells its products to the medium and small cities, the factory can enjoy more large-scale economy than the case selling only at the large city. Because this factory sells the goods at low price in the region, it can prevent the existence of the factories with low efficiency and high production cost in the region and it enables to provide the goods at a low price to all consumers in the region. Because the city system in a region has a relatively homogeneous economic environment, it is easy

⁵ As shown by the following section, according to the same logic, the regional connection economy is generated by the connection between the regions that contain a city system.

⁶ With the globalization of economic activities, studies on the functions of urban system economies have begun. Camagni et al. (2016) advances this consideration by incorporating a dynamic viewpoint.

to establish relationships that facilitate product movement between the cities and achieve an efficient production organization within the city system. This production organization established in the city system is advantageous for the factories located in the large city and the consumers in the region. Case 2) The city system promotes the vertical division of labor by that the factories in each city can utilize a large-scale economy and specialization economy, and the entire manufacturing processes can be done efficiently: If the multiple cities of the same size would individually produce the same kind of product, they cannot sufficiently enjoy a large-scale economy. By performing the vertical division of labor in production processes between the cities that form the city system, the factories in each city can adequately enjoy the large-scale economy. Case 3) There is no firm in the each of small cities that can perform the complex and large-scale financial activity. Therefore, if a small city exists in isolation, the factories in this small city cannot enjoy a high economic function. However, if the small city belongs to the city system, it has a cooperative relationship with a large city, it is possible to smoothly utilize the advanced economic functions in the large city. As a result, the factories in small cities can carry out some large-scale activities. The easy accessibility and the complementary relationships formed by the high degree of integration in a city system provides many benefits to the factories located in the cities forming the city system. In sum, small cities can exert some advanced economic functions through the city system. These benefits are considered a city system economy.

10.2.2.2 Regional Connection Economy

The spatial scope of the factories' activity in the global economy is not limited to a city system but expands to have connections with other city systems in other regions. The connections between the regions create the regional connection economy. By connecting between the regions that are at various distances, the factories can enjoy regional connection economy. Although this regional connection economy is similar to the city system economy, its spatial dimension is broader than the city system, and its economy goes beyond the category of the city system economy.⁷

Let us explain the regional connection economy using the following examples: (1) There is a firm in region manufactures goods. The firm can greatly benefit from a large-scale economy in its factory and it sells its product to promising markets in other regions. When selling products to other regions, the firm considers the transportation distance and time to the targeted region. According to the distribution cost, the firm may open an agent, a sales office, or a branch factory in the targeted region. In addition, if necessary, part of the production process is separated and a branch factory in charge of that process is built in the region. Spatial expansion of the firm's sales activity brings stable securing of a large demand for the products and contributes greatly to the overall firm activity. And this sales organization becomes

⁷ The analysis of Meeteren et al. (2016) is also useful for considering the regional connection economy.

to form the strong relationships between the regions. Excellent and stable sales organization provides various benefits with the factories.

(2) When labor wage rates and land costs rise in the region where the firm locates, the firm fragments the production process and disperse some of the processes to local areas or developing countries. These processes are connected by logistic and information connection. Such a production organization greatly reduces the production costs of firms and contributes to the enhancement of the international competitiveness of the firms. And this production organization also contribute to form close economic connection between the regions concerned. By the connection between them the movement of the goods manufactured by the individual firms and the flows of passengers such as diverse engineers and workers begin to grow quite large. With such movements, useful information in other regions acquired by the advanced firms is disseminated to among many firms surrounding the advanced firms, and many relationships are built and deepened between the regions. Stable connections between the regions make a great contribution to both of sales and production activity of the firms.

(3) As various relations between regions deepen, the firm's production activity also progresses. Especially, the horizontal division of labor is progressed: There are differences between the regions in technology and raw materials used in production, these differences enable product differentiation between the regions. And, in particular, the factories can utilize superior production technology developed in other regions in some of the production processes. Compared with the vertical division of labor, the horizontal division of labor requires less close proximity between the production processes, and there are few troublesome in the conducting production even when they are distant from each other. Connections between the regions can create the horizontal division of labor and become a pillar that supports the firms' activity. This further deepens the alliance between the regions.

(4) As the firms' production activity spatially expands to other heterogeneous regions, the firms become to need the support functions to smoothly carry out the production activity. The regions are required by the firms to have professional support functions in the fields of legal, tax, public relations, and consulting. These business service functions are better provided by the companies operating on a global scale that is located in the large cities. Connecting with other regions with the large cities, therefore, the region can provide the firms with superior professional service functions. This situation creates regional connection and it provides a regional connection economy.

The followings are considered as main factors to make up the regional connection economy, securing a large demand for the products, obtaining intermediate goods at low cost, promoting horizontal division of labor, and using excellent professional support functions.

10.2.3 Conceptual Arrangement of Agglomeration Economy and Connection Economy

From a spatial perspective, this subsection describes the agglomeration economy and the connection economy in a unified manner using Fig. 10.1. Economies of mass production and large-scale production are generated within a factory; these economies are closely related at the factory’s site that is shown by the center of Fig. 10.1. Localization economy is created in a district where the same kind of factories are spatially concentrated. And urbanization economy is generated in a region where various kinds of the factories are agglomerated. These economies adhere to certain place and region. They are depicted surrounding the center of Fig. 10.1. It is said that economies of mass production and large-scale production, and the economies of localization and urbanization have the property of being close to a place and a territory. They are associated with progressively larger geographical land, from a site to a region.

On the other hand, although the connection economy is based on the places where the production activity is spatially concentrated, it is generated by the collaboration between such the places. The degree of impact of the connection economy depends on the place’s capacity that is shown by the number of connections with other places and the degree of collaboration with other places. This connection economy can be divided into the two categories, the city system economy, and the regional connection

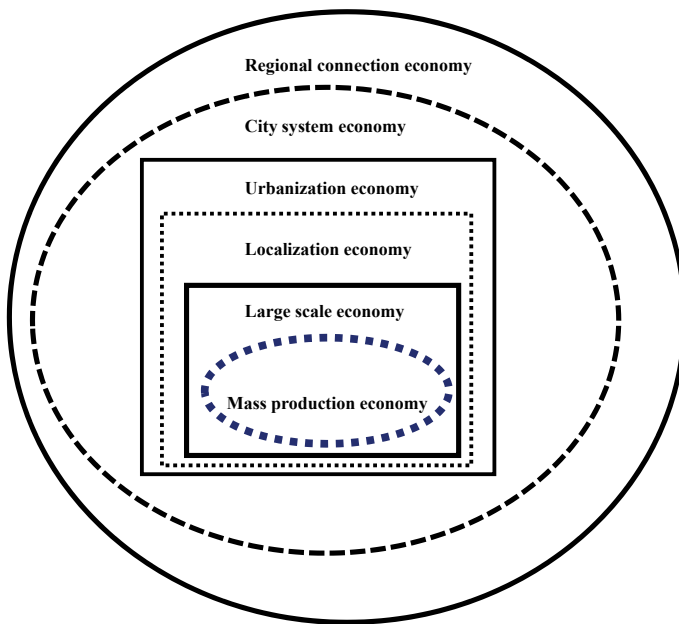


Fig. 10.1 Agglomeration economy and connection economy

economy. The city system economy is mainly created from high accessibility and complementarity among economic agents based on the high economic coherence. This coherence is based on a city system formed in a homogeneous region. While, the regional connection economy is mainly generated by the connection between the heterogeneous regions. It has, thus, a wider spatial range than a region where a city system exists. The regional connection economy is depicted by the outermost circle in Fig. 10.1. Lastly, it should be notified that these agglomerations and the connection economy interact each other and they influence the activity of the factories and the firms.⁸

10.3 Impact of Connection Economy on Production Activity

10.3.1 *A Procedure for Analysis of Impact of Connection Economy on Production Activity*

Empirical analysis is indispensable for deepening the study of agglomeration and the connection economy. As Weber (1909) suggested, however, empirical analysis of localization and urbanization economies has a lot of difficulties because these economies have strong sociality. The progress of analysis, therefore, has been taking a long time. Naturally, the analysis of the influence of the connection economy on the firms' production is still at the beginning of analysis.⁹

This subsection provides a kind of a clue to proceed the analysis of the influence of the connection economy on the production activity of the firms. To this aim this subsection takes an empirical analysis using data from the 47 prefectures in Japan. The analysis focuses on two kinds of the connection economy, city system economy, and regional connection economy. And this subsection devises the indexes as a proxy that have the potential to represent the influence of these two economies. The proxies are City System Index and Regional Connection Index. These indexes are derived from the economic data of the 47 prefectures in Japan. And, by these two indexes, the 47 prefectures are classified into 4 groups, and characteristics of the production activity of each group are examined.

⁸ See Ishikawa (2019) for a theoretical analysis of the relationships between agglomeration economies. From the interrelationships, Porter (1998) provides an interesting insight about innovation created by the firms.

⁹ Burger and Meijers (2016) gives a systematic look at city connection externalities.

10.3.2 Derivation of City System Index

The City System Index CSI is used as a proxy to reveal the effect level of the city system economy on production activity in a region (Ishikawa, 2016). This index is derived from two viewpoints as follows. One viewpoint is concerned with cities' population distribution within a city system. In order to describe the divergence of the cities' population distribution toward the primary city of the city system, the coefficient of the divergence CD was shown by Sheppard (1982). This coefficient is utilized to build half part of the City System Index. Let us obtain the coefficient of the divergence CD.

Suppose that there are N cities in a region, and p denotes the population share of a city for all cities' population within a city system. The value of CD obtained by Eq. (10.1) is considered as the coefficient of divergence of cities' population distribution to the largest city in a city system,

$$CD = (1/N) \sum_{x=1}^N p_x L_N(r) \quad (10.1)$$

where r is the rank of a city by population share order, and it is converted into a logarithmic value. CD is utilized as an index that indicates characteristic of the distribution of cities' population. As the divergence the distribution of the cities' population toward the largest city of the city system becomes larger, the value of CD lowers.

The second viewpoint is concerned with the location pattern of the cities within a city system. A city system's character can be captured by the location pattern of the cities. It offers a concept of the spatial convergence of the cities' locations within a city system. The spatial convergence of the cities' locations SC, within a city system is obtained by using Poisson distribution. The SC is used to build the other half part of the CSI. Assume that there are N_i ($i = 1, 2, 3 \dots N$) cities in a region of which the land area is M . The distance from a city N_1 to the nearest city is denoted as d_1 . This distance is named as the least distance of the city N_1 . The least distance is obtained for each of the cities N_i ($i = 1, 2, 3 \dots N$), and the average least distance AD of the cities is derived as Eq. (10.2).

$$AD = (1/N) \sum_{i=1}^N d_i \quad (10.2)$$

The spatial convergence of cities distribution within a city system in a region SC is expressed by Eq. (10.3),

$$SC = AD / (1/2(N/M)^{0.5}) \quad (10.3)$$

As the cities locate more closely each other, SC becomes smaller. The SC's value is used to specify a spatial characteristic of the city system.

The values of both CD and SC become smaller as the divergence of the distribution of cities' population to the largest city progresses and the spatial convergence of the cities distribution is higher. Hence, combining these two values, an index is built to reveal characteristic of a city system, City System Index CSI is derived by Eq. (10.4).

$$CSI ((\alpha CD)^2 + (\beta SC)^2)^{0.5} \quad (10.4)$$

where α and β are positive parameters. As mentioned above, the low value of CSI means that the structure of the city system has concentrating characteristics in terms of the cities' population distribution and the location of the cities. While, the high value of the CSI means that the structure of the city system has leveling characteristics. CSI can be used as an index that indicates the characteristics of the city system in the region.

Let us concretely obtain the values of the City System Index CSI based on data on the population and location of the cities in each of the 47 prefectures in Japan. The third column in Table 10.1 shows the CSI for each of the 47 prefectures using the data of 47 prefectures in Japan.^{10,11} (The parameters in the Eq. (10.4) are assumed as $\alpha = 20$ and $\beta = 1$ in this analysis). And the second column of Table 10.1 shows the number assigned to each prefecture.

10.3.3 Derivation of Regional Connection Index

The regional Connection Index RCI is derived by a method of the network analysis. In order to simplify the derivation of the Regional Connection Index, the Japanese case used in the above derivation of the CSI is used to the explanation. The Regional Connection Index is an index showing the degree of connectivity between a prefecture concerned and other prefectures. This index is considered as a proxy to reveal the effect level of the regional connection economy on production activity in the region. In the derivation, data of the passenger flow amount between the prefectures and the amount of its own prefecture are adopted.^{12,13} The derivation procedure of RCI is as follows (Ishikawa, 2019).

First, we obtain passenger flow amount $A_{i,j}$ ($i, j = 1, 2, \dots, 47$) from a prefecture i to each j of the 47 prefectures, including passenger flow within its own prefecture. And, each passenger flow is divided by the total passenger flow amount of the 47 prefectures, and the passenger flow ratio $a_{i,j}$ ($i, j = 1, 2, \dots, 47$) is derived. And

¹⁰ Data source is Chiiki keizai soran (2019).

¹¹ It can be considered that a city system exists in each of 47 prefectures.

¹² See Von Wouter et al (2005), the network analysis has made great progress in recent years.

¹³ Data source is Chiiki keizai soran (2019). RCI is derived using four items other than passenger flows.

Table 10.1 City system and regional connection indexes of 47 prefectures

Prefec	No	CSI	RCI	Prefec	No	CSI	RCI
Hokkaido	1	1.5325	305	Mie	24	2.7643	218
Aomori	2	3.0892	347	Shiga	25	2.6756	270
Iwate	3	3.2298	376	Kiyoto	26	2.2535	415
Miyagi	4	2.3012	438	Osaka	27	1.2892	450
Akita	5	3.151	225	Hiyogo	28	2.2265	241
Yamagata	6	2.3449	311	Nara	29	2.2103	222
Fukushima	7	2.7192	282	Wakayama	30	4.3667	65
Ibaraki	8	1.9486	206	Tottori	31	4.2606	127
Tochigi	9	2.1339	228	Shimane	32	3.7509	313
Gunma	10	2.5702	246	Okayama	33	2.7574	326
Saitama	11	1.6851	165	Hiroshima	34	2.5905	479
Chiba	12	2.1704	165	Yamanashi	35	3.646	109
Tokyo	13	1.2008	480	Tokushima	36	4.1194	200
Kanagawa	14	1.8164	253	Kagawa	37	2.3134	321
Niigata	15	2.143	445	Ehime	38	2.536	270
Toyama	16	1.9671	343	Kochi	39	3.7353	298
Ishikawa	17	3.5271	494	Fukuoka	40	1.7398	387
Fukui	18	3.0731	378	Saga	41	3.039	203
Yamanashi	19	2.3523	285	Nagasaki	42	2.8465	311
Nagano	20	2.139	400	Kumamoto	43	3.045	342
Gifu	21	2.2844	338	Oita	44	3.2104	281
Shizuoka	22	2.4623	403	Miyasaki	45	3.344	267
Aichi	23	1.5726	463	Kagoshima	46	2.8953	390
				Okinawa	47	2.4394	402

then, we obtain the ratios of the following four items: (b_1) (Gross Regional Product of each prefecture)/(Gross Domestic Product of Japan), (b_2) the ratio of (the passenger flow amount within the prefecture)/(the passenger flow amount of Japan), (b_3) the ratio of (the passenger flow amount from a prefecture to other 46 prefectures)/(the passenger flow amount of Japan), (b_4) the ratio of (the passenger flow amount of a prefecture)/(the passenger flow volume of Japan).

Second, using the elements $a_{i,j}$ ($i, j = 1, 2, \dots, 47$) and the elements $b_{i,j}$ ($i = 1, 2, 3, 4, j = 1, 2, \dots, 0.47$), we create the 51-by-47 matrix X that is shown by the matrix (5).

$$X = \begin{pmatrix} a_{1,1} & \cdots & a_{1,47} \\ \cdots & \cdots & \cdots \\ a_{47,1} & \cdots & a_{47,47} \\ b_{1,1} & \cdots & b_{1,47} \\ \cdots & \cdots & \cdots \\ b_{4,1} & \cdots & b_{4,47} \end{pmatrix} \quad (10.5)$$

In elements $a_{i,j}$ ($i, j = 1, 2, \dots, 7$) and $b_{i,j}$ ($i = 1, 2, 3, 4, j = 1, 2, \dots, 0.47$), if its value is close to 0, the value of the element is positively set to 0, and the value of the element having another numerical value is set to 1. By this procedure, the 51-by-47 matrix X is composed of elements 0 and 1.

Third, we build the matrix X' of the 47-by-51 by transposing the matrix X that is composed by 0 and 1, and we compute $X \cdot X'$ to create the 47-by-51 matrix X^* that is shown by the matrix (6).

$$XX' = X^* = \begin{pmatrix} ac_{1,1} & \cdots & ac_{1,47} \\ \cdots & \cdots & \cdots \\ ac_{47,1} & \cdots & ac_{47,47} \\ bc_{1,1} & \cdots & bc_{1,47} \\ \cdots & \cdots & \cdots \\ bc_{4,1} & \cdots & bc_{4,47} \end{pmatrix} \quad (10.6)$$

Finally, summing up the values of the elements ac_j ($j = 1, 2, \dots, 47$) in each of the 47 rows in the matrix (6), we derive the Regional Connection Index of each of the 47 prefecture. The fourth column in Table 10.1 shows the RCI for each of the 47 prefectures.

By using the values of CSI and RCI shown in Table 10.1 a basic production property of each prefecture can be suggested.

10.3.4 Characteristics of City System Index and Regional Connection Index

Before the derivation of a production environment of each prefecture of the 47 prefectures by two indexes of CSI and RCI, it is useful to know the characteristics of these two indexes. Figure 10.2 shows the relationship between the CSI and the Gross Regional Product (GRP) values, which are shown logarithmically in the figure, of the prefectures. As shown in Fig. 10.2, the GRP decreases as the CIS increases. The CSI is closely related to the GRP of each prefecture; the City System Index is related to the scale of prefecture's economic activity.

While, the Regional Connection Index is related to the scale of the socio-economic role of the prefectures and the distance from the prefecture in question to the specific

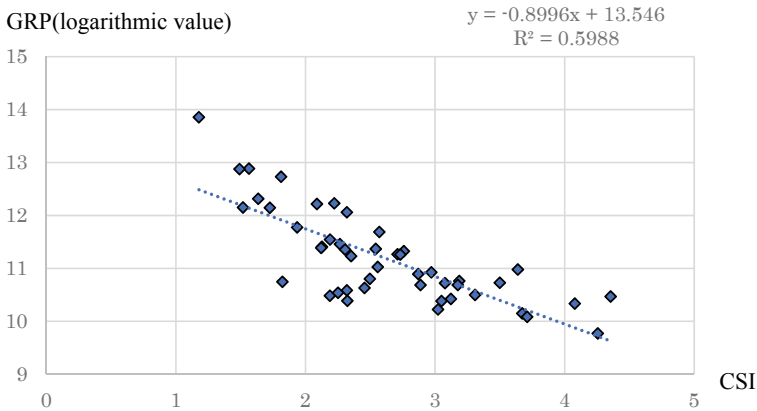


Fig. 10.2 Relationship between CSI and GRP. *Data source* Chiiki keizai soran (2019)

prefectures that play a large socio-economic role in the nation. Figure 10.3 shows the locations of the prefectures with high RCI by coloring. This figure is depicted by the standardized values of the RCI that are shown in Table 10.2.

Figure 10.3 shows the following points. All prefectures that play a large socio-economic role in the nation and in the local area have high RCI and they are dispersed

Fig. 10.3 Location of prefectures with high regional connection index (RCI > 0.5)



Table 10.2 Standardized values of CSI and RCI of 47 prefectures

Prefec	No	CSI	RCI	Prefec	No	CSI	RCI
Hokkaido	1	-1.4569	-0.0192	Mie	24	0.1934	-0.88462
Aomori	2	0.6341	0.4135	Shiga	25	-0.0702	-0.35577
Iwate	3	0.8076	0.6635	Kyoto	26	-0.5842	1.03846
Miyagi	4	-0.4266	1.2596	Osaka	27	-1.5093	1.375
Akita	5	0.6955	-0.7885	Hiyogo	28	-0.5194	-0.63462
Yamagata	6	0.3851	0.02759	Nara	29	-0.5562	-0.81731
Fukushima	7	0.1399	-0.2596	Wakayama	30	2.3597	-2.28846
Ibaraki	8	-0.9003	-0.9712	Tottori	31	2.1984	-1.73077
Tochigi	9	-0.6218	-0.7596	Shimane	32	1.4544	0.05769
Gunma	10	-0.5385	-0.5385	Okayama	33	0.1745	0.18269
Saitama	11	-1.3654	-1.3654	Hiroshima	34	-0.0383	1.65385
Chiba	12	-0.07022	-1.3654	Yamaguchi	35	1.3784	-1.89423
Tokyo	13	-1.9211	1.6635	Tokushima	36	1.9822	-1.03846
Kanagawa	14	-1.0735	-0.5288	Kagawa	37	-0.4295	0.11538
Niigata	15	-0.6464	1.3269	Ehime	38	-0.1298	-0.36538
Toyama	16	-0.8928	0.3462	Kochi	39	1.4916	-0.07692
Ishikawa	17	1.1968	1.7692	Fukuoka	40	-1.1872	0.88462
Fukui	18	0.6040	0.6827	Saga	41	0.5613	-1.01923
Yamanashi	19	-0.3783	-0.2115	Nagasaki	42	0.2978	0.02885
Nagano	20	-0.4033	0.9038	Kumamoto	43	0.4914	0.33654
Gifu	21	-0.3387	0.2596	Oita	44	0.7793	-0.26923
Shizuoka	22	-0.4783	0.9038	Miyazaki	45	0.9625	-0.58654
Aichi	23	-1.4110	1.4712	Kagoshima	46	0.3633	0.66346
				Okinawa	47	-0.2575	0.72115

throughout Japan, Tokyo, Osaka, Miyagi, and Fukuoka. Some prefectures, Aomori, Fukui, Kagoshima, etc., which are located quite far away from the Tokyo and Osaka also have high RCI.

Then, Fig. 10.4 shows the locations of the prefectures with low RCI by coloring. Figure 10.4 is depicted using the standardized values of the RCI. It shows that some of the prefectures with low RCI such as Saitama, Kanagawa, and Nara, are adjacent to the prefectures with large economic scale. And other prefectures with low RCI are located in the area a little far from Tokyo and Osaka. It can be said that prefectures adjacent to metropolitan areas and those located on the outer periphery of metropolitan areas have low RCI.

Fig. 10.4 Location of prefectures with low regional connection index ($RCI < -0.5$)



10.3.5 Classification of Regional Production Activity by Two Connection Indexes

Characteristics of production activity can be categorized into four groups by the two indexes, CSI and RCI. Figure 10.5 conceptionally shows the four states of enjoyment of two connection economies in the region by the quadrants, A, B, C, and D. It is also possible to classify the 47 prefectures into four groups.

Let us classify the 47 prefectures in Japan into the 4 quadrants by the CSI and the RCI. According to the procedures shown in the previous subsection, the values of CSI and RCI are derived for each of the 47 prefectures. And the values are transformed into the standardized values that are shown in the second and the third column of Table 10.2. Figure 10.6 shows the locations of the 47 prefectures and the number assigned to each prefecture.

Four quadrants formed by the CSI and the RCI are shown by Fig. 10.7. In Fig. 10.7, the horizontal axis represents the CSI and the vertical axis represents the RCI. The coordinate of each prefecture is indicated by the number of that prefecture. Figure 10.7 shows important facts: Quadrant A includes all prefectures that play a major socio-economic role in Japan as a whole and in local areas. Quadrant B includes many prefectures which are adjacent to Tokyo and Osaka prefecture. Quadrant C contains many prefectures located on the outer fringes of Tokyo and Osaka

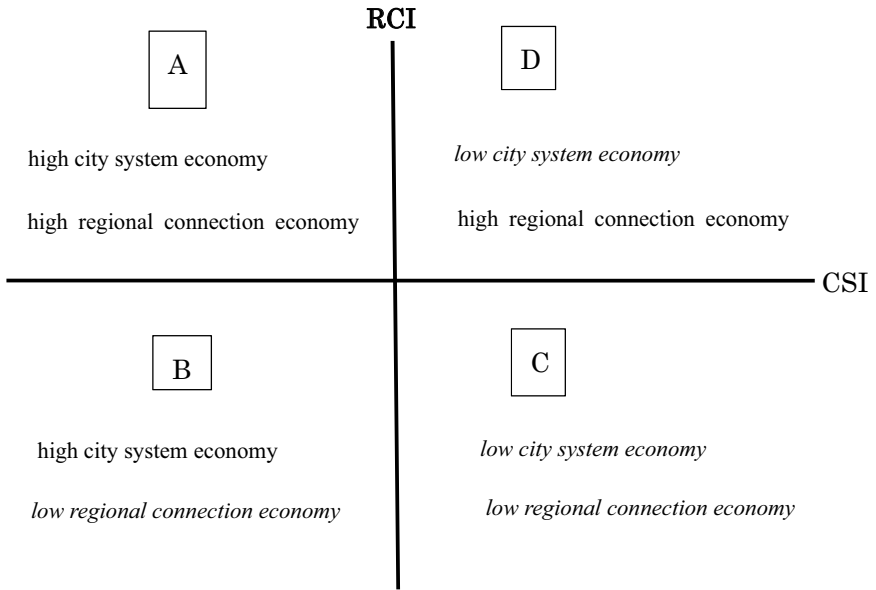


Fig. 10.5 Four conceptual groups of state of enjoyment of connection economies in region

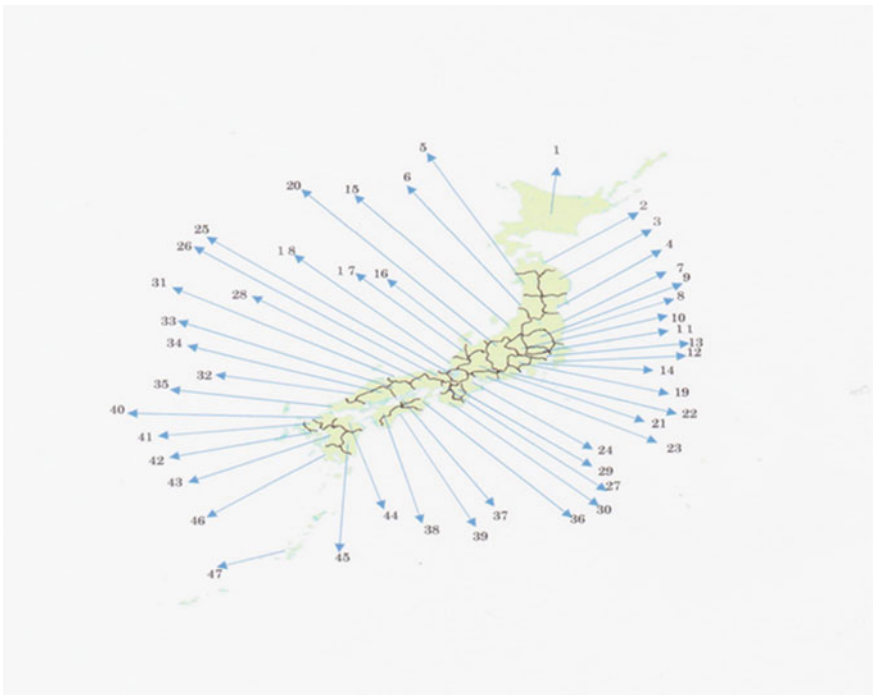


Fig. 10.6 Locations of 47 prefectures and their assigned numbers

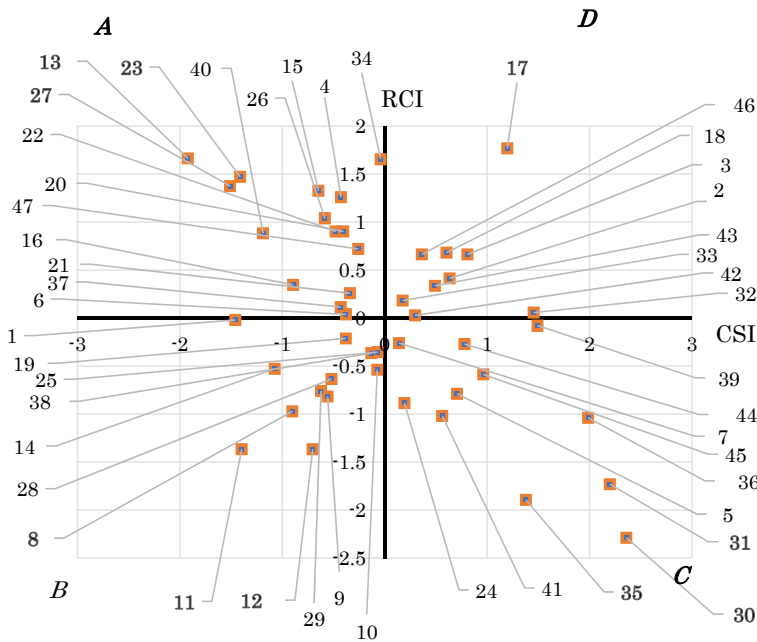


Fig. 10.7 Coordinates formed by CSI and RCI for 47 prefectures in Japan. *Source* Ishikawa (2019)

metropolitan areas. Quadrant D contains prefectures that deviate from the Tokyo and Osaka prefecture. It can be said that the spatial economic distance from Tokyo and Osaka prefecture decisively influence in the distribution of the prefectures in the four quadrants, A, B, C, and D.

The classification of the prefectures shown in Fig. 10.7 is made by the City System Index and the Regional Connection Index. These indexes are constructed from simple general materials for each prefecture, and they are effective in classifying the production activity of each prefecture into four categories. It is considered that these indexes useful to proceeds the analysis of the effects of agglomeration economies in production activity in regions.

10.4 Classification of Prefectures in Each Quadrant Based on Two New Regional Connection Indexes

This section proceeds the analysis based on the materials of machine industry of each prefecture. In the analysis in this section, two new regional connection indexes are devised from a firm-level perspective. And this analysis uses these indexes to further classify the prefectures into four categories in each of the quadrant, A, B, C, and D. The first one of the newly introduced regional connection index is the regional

connection index PCI based on the locations of the branch factory owned by the firms. The second one is the regional connection index SCI based on the locations of the sales office of the firms. Methods for deriving these indexes are explained in the next subsection.

10.4.1 Derivation of Regional Connection Indexes Based on Branch Factories and Sales Offices

This subsection explains how to derive RCI and SCI for each of the 47 prefectures in Japan. The index PCI is derived based on the location of the branch factory owned by a firm. First, 152 firms belonging to the machine industry are arbitrarily selected.¹⁴ And find out the number of branch factories of each firm and the prefecture where they are located. The main factory is also counted as a branch factory. Then, give the number of branch factories to the prefecture where the firm has the branch factories, and give 0 to the prefecture where the firm does not have a branch factory. These procedures are conducted for each of the 152 firms. As a result, a matrix X of 152 rows and 47 columns is created and it is shown in the form of a matrix (7).

$$X = \begin{bmatrix} A_{1,1} & A_{1,j} & A_{1,47} \\ \dots & \dots & \dots \\ \dots & A_{i,j} & \dots \\ \dots & \dots & \dots \\ A_{152,1} & A_{152,j} & A_{152,47} \end{bmatrix} \quad (10.7)$$

$$i = 1, \dots, 152, j = 1, \dots, 47$$

$A_{i,j}$ is the number of the factories that firm i has located in prefecture j . Correlation analysis about the matrix between the 47 prefectures is performed based on this matrix, and a correlation matrix X_C of 47 rows and 47 columns is obtained. This correlation matrix is shown in the form of a matrix (8), and each element $C_{i,j}$ ($i, j = 1, \dots, 47$) shown in matrix (8) indicates the correlation coefficient between the prefectures.

$$X_C = \begin{bmatrix} C_{1,1} & C_{1,j} & C_{1,47} \\ \dots & \dots & \dots \\ \dots & C_{i,j} & \dots \\ \dots & \dots & \dots \\ C_{47,1} & C_{47,j} & C_{47,47} \end{bmatrix} \quad (10.8)$$

¹⁴ The materials are based on Kaishiya-Shikiho (Data book on stock listed companies, in Japanese, 2017).

$$i = 1, \dots, 47, j = 1, \dots, 47$$

A partial correlation matrix is derived from the correlation matrix represented by matrix (8). A value of 0 is positively given to an element having an extremely low value in this partial correlation matrix. Based on the derived partial correlation matrix, the correlation matrix between the 47 prefectures is estimated. The partial correlation matrix is derived again from this correlation matrix. And repeat this process to find the correlation matrix with the most elements having a value of 0.. And then, replace the non-zero value of the elements of this correlation matrix with 1, and set the values of all the elements to 1 or 0. As a result, a matrix X_L composed of elements $L_{i,j}$ ($i, j = 1, \dots, 47$) having a value of 1 or 0 is obtained, and it is shown in the form of matrix (9).

$$\begin{aligned}
 XL = & \begin{bmatrix} L_{1,1} & L_{1,j} & L_{1,47} \\ \dots & \dots & \dots \\ \dots & L_{i,j} & \dots \\ \dots & \dots & \dots \\ L_{47,1} & L_{47,j} & L_{47,47} \end{bmatrix} & (10.9) \\
 & i = 1, \dots, 47
 \end{aligned}$$

Finally, the element L_j having a value of 1 is added to each of the 47 prefecture i to obtain the total value represented by Eq. (10.10). The total shows the regional index PCI derived based on the branch factories for each prefecture.

$$\begin{aligned}
 PCI_i = & \sum_{j=1}^{j=47} L_{i,j} & (10.10) \\
 & i = 1, \dots, 152
 \end{aligned}$$

Next, let us derive the index SCI based on the location of the sales office owned by a firm. It is created as follows. Once again, 152 firms belonging to the machine industry are arbitrarily extracted. Find out the number of sales offices of each firm and the prefecture where they are located. The head office is also included in the sales office. Then, the number of sales office is given to the prefecture where the firm places these offices, and 0 is given to the prefectures that the firm does not have sales office. The same procedures are conducted for each of the 152 firms. The following derivation work is the same as the derivation procedure of PCI. The regional connection index SCI based on the location of the sales office is derived for each prefecture.

10.4.2 Conceptual Classification of Regions by Two New Regional Connection Indexes

By the derived PCI and SCI indexes production and sales activities of manufacturing firms in regions are divided into four categories. And it is possible to conceptually infer the characteristics of production and sales activities of the firms in regions. Figure 10.8 divides the characteristics of production and sales activities of the firms into four quadrants, *a*, *b*, *c*, and *d* by PCI and SCI. Conceptual characteristics of the production and sales activities of the firms belonging to each quadrant can be suggested from Fig. 10.8.

The typical conceptual characteristics of the manufacturing firms in each quadrant are inferred as follows.

- (1) Firms in the quadrant *a* tend to carry out production activity in a vertical division of labor within the prefecture. Manufactured products tend to be sold outside the prefecture in the market by using sales offices.
- (2) Firms in the quadrant *b* tend to carry out production activity in a vertical division of labor within the prefecture. Manufactured products tend to be sold inside and outside the prefecture without using sales offices.
- (3) Firms in the quadrant *c* tend to carry out production activity in a horizontal division of labor between regions. Manufactured products tend to be sold inside and outside the prefecture without using sales offices.
- (4) Firms in the quadrant *d* tend to carry out production activity in a horizontal division of labor between regions. Manufactured products tend to be sold outside the prefecture in the market by using sales offices.

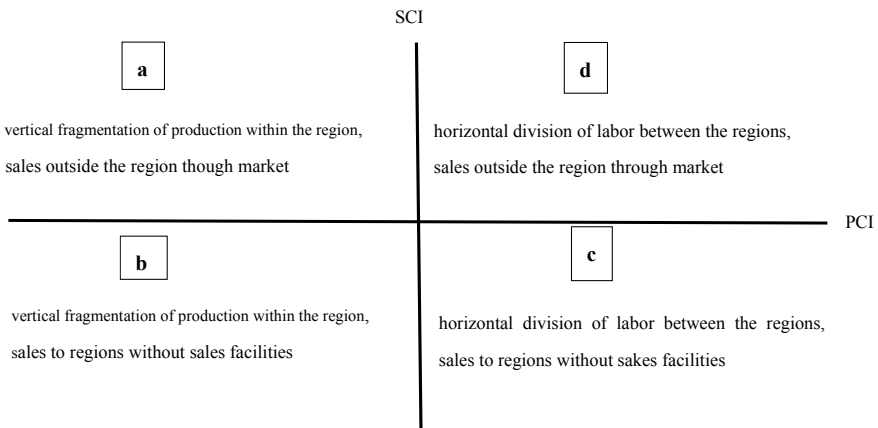


Fig. 10.8 Conceptual classification of production and sales activities by PCI and SCI

10.4.3 Classification of 47 Prefectures by Two New Regional Connection Indexes

This subsection shows the regional connection indexes PCI and SCI of the 47 prefectures in Japan and classify the type of their production and sales activity in each of the four quadrants into small four groups. Table 10.3 shows the PCI and SCI values of the 47 prefectures and their standardized values.

Let us classify the prefectures belonging to each quadrant A, B, C, and D into the small group a, b, c, and d, respectively. Figure 10.9 shows how the 15 prefectures belonging to quadrant A are divided into four small quadrants Aa, Ab, Ac, and Ad. Similarly, Figs. 10.10, 10.11, and 10.12 show how prefectures belonging to quadrants B, C, and D are divided into the small quadrants a, b, c, and d, respectively.

Figure 10.9 shows that all prefectures that play a major socio-economic role in Japan as a whole and in local areas belong to quadrant Ac. These representative prefectures have relationships with many other prefectures through branch factories, but few through sales offices.

Figure 10.10 shows that most of the prefectures adjacent to the prefectures with large economic scale belong to quadrants Bb and Bc. These prefectures do not have relationships with many other prefectures through sales offices.

Figure 10.11 describes that most of the prefectures that exist on the outer periphery of the metropolitan areas of Tokyo and Osaka belong to the quadrants Ca and Cd. These prefectures have relationships with many other prefectures through sales offices.

Figure 10.12 indicates that the prefectures far from the prefectures with large economic scale are evenly distributed in the quadrants Da, Db, and Dd. In the quadrant Dc, there is no prefecture.

The prefectures belonging to each of the 16 quadrants are shown in Table 10.4. And Table 10.5 shows the distribution ratios of the prefectures in each of the 16 quadrants.

The 47 prefectures are classified into the 4 categories *a*, *b*, *c*, and *d* by the regional connection index based on branch factories and sales offices of the machinery firms. This industry is not a standard criteria that covers all industries. But, the machine industry is a leading industry in Japan and create a relatively large number of cooperative relationships between the prefectures. The two new indexes are considered to be a powerful measure for estimating the degree of connection between the prefectures in Japan.

10.5 Extraction of Production Characteristics of Prefectures in Each of Four Quadrants

The 16 classifications of the 47 prefectures are considered to successfully represent the general production characteristics of the prefectures. This classification may proceed the analysis of the industrial economy of the 47 prefectures. However, the

Table 10.3 Regional connection indexes based on branch factories and sales offices (2017)

Prefec	PCI	Standardized PCI	SCI	Standardized SCI
Hokkaido	5	0.4519	9	-0.6616
Aomori	4	0.0188	13	0.0544
Iwate	0	-1.7135	9	-0.6616
Miyagi	4	0.0188	8	-0.8407
Akita	5	0.4519	14	0.2335
Yamagata	4	0.0188	19	1.1287
Fukushima	5	0.4519	19	1.1287
Ibaraki	2	-0.8473	12	-0.1245
Tochigi	2	-0.8473	12	-0.1245
Gunma	5	0.4519	12	-0.1245
Saitama	5	0.4519	8	-0.8407
Chiba	2	-0.8473	13	0.0544
Tokyo	8	1.7511	9	-0.6616
Kanagawa	7	1.3181	7	-1.0197
Niigata	7	1.3181	11	-0.3036
Toyama	9	2.1843	20	1.3077
Ishikawa	0	-1.7135	7	-1.0197
Fukui	4	0.0188	15	0.4125
Yamanashi	3	-0.4142	8	-0.8407
Nagano	1	-1.2804	12	-0.1245
Gifu	4	0.0188	23	1.8449
Shizuoka	3	-0.4142	9	-0.6616
Aichi	6	0.8850	10	-0.4826
Mie	3	-0.4142	16	0.5916
Shiga	2	-0.8473	7	-1.0197
Kyoto	2	-0.8473	15	0.4125
Osaka	7	1.3181	6	-1.1988
Hiyogo	10	2.6173	10	-0.4826
Nara	4	0.0188	0	-2.2730
Wakayama	2	-0.8473	14	0.2335
Tottori	4	0.0188	22	1.6658
Shimane	2	-0.8473	21	1.4868
Okayama	2	-0.8473	12	-0.1245
Hiroshima	5	0.4519	7	-1.0197
Yamaguchi	8	1.7512	12	-0.1245
Tokushima	5	1.7511	21	1.4868

(continued)

Table 10.3 (continued)

Prefec	PCI	Standardized PCI	SCI	Standardized SCI
Kagawa	5	0.4519	15	0.4125
Ehime	1	-1.2804	11	-0.3036
Kochi	2	-0.8473	2	-1.9150
Fukuoka	4	0.0188	7	-1.0197
Saga	3	-0.4142	14	0.2335
Nagasaki	7	1.3181	17	0.7706
Kumamoto	2	-0.8473	18	0.9497
Oita	3	-0.4142	22	1.6658
Miyasaki	3	-0.4142	14	0.2335
Kagoshima	2	-0.4142	24	2.0239
Okinawa	4	0.0188	7	-1.0197

Data Kaishiya-Shikiho (2017)

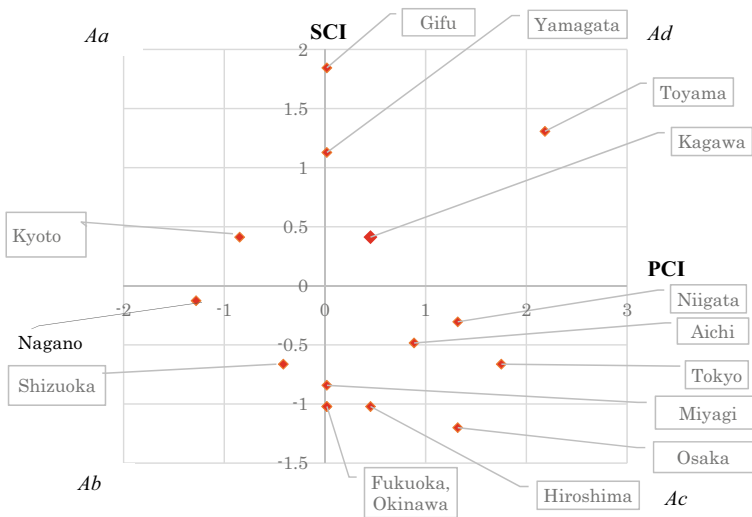


Fig. 10.9 Classification of prefectures in A quadrant

detailed analysis of the obtained results is too large in scale to the analysis in this paper. This section conducts an industrial economic survey of the prefectures that belong to the basic quadrants A, B, C, and D respectively.

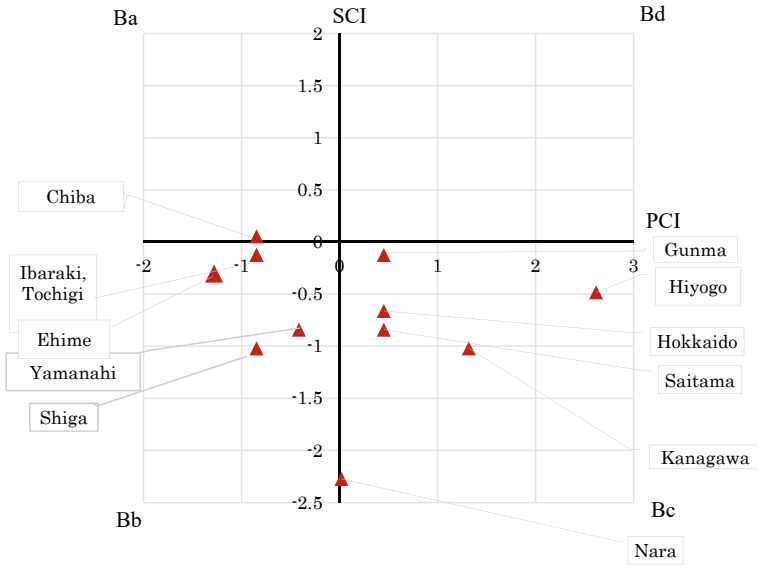


Fig. 10.10 Classification of prefectures in B quadrant

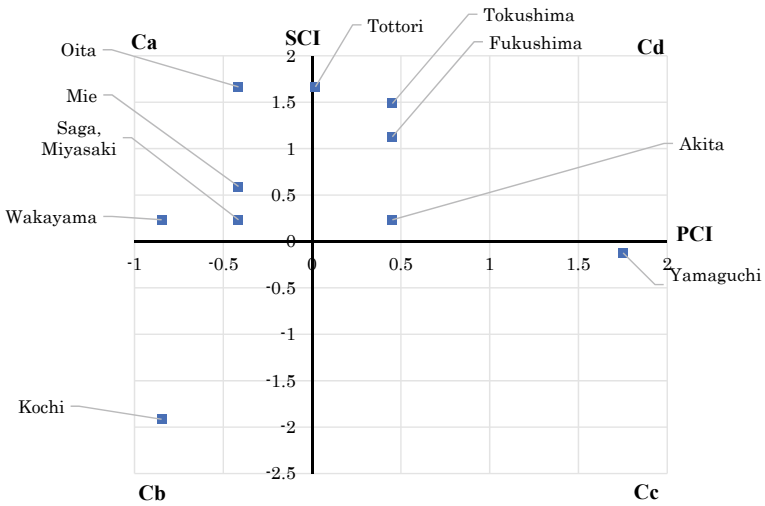


Fig. 10.11 Classification of prefectures in C quadrant

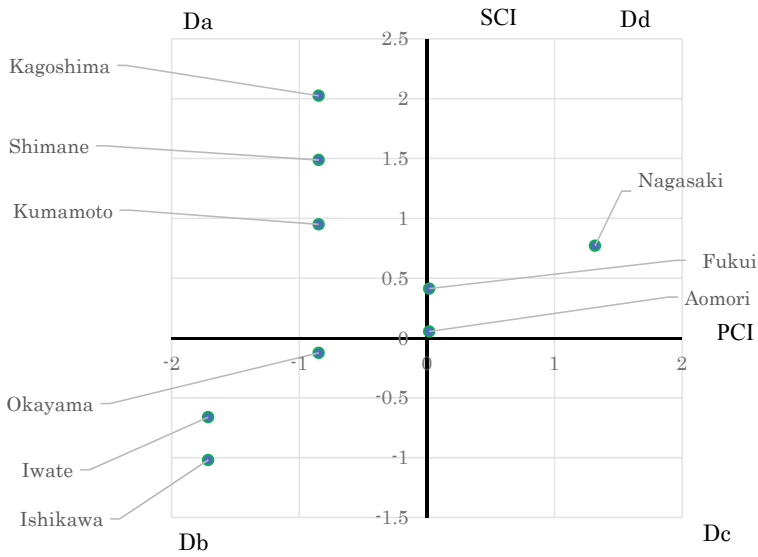


Fig. 10.12 Classification of prefectures in D quadrant

Table 10.4 Prefectures in 16 quadrants

Aa	Kyoto							
Ab	Nagano	Shizuoka						
Ac	Miyagi	Tokyo	Niigata	Aichi	Osaka	Hiroshima	Fukuoka	Okinawa
Ad	Yamagata	Toyama	Gifu	Kagawa				
Ba	Chiba							
Bb	Ibaraki	Tochigi	Yamanashi	Shiga	Ehime			
Bc	Hokkaido	Gunma	Saitama	Kanagawa	Nara	Hiyogo		
Bd	–							
Ca	Mie	Wakayama	Saga	Oita	Miyasaki			
Cb	Kochi							
Cc	Yamaguchi							
Cd	Akita	Fukushima	Tottori	Tokushima				
Da	Shimane	Kumamoto	Kagoshima					
Db	Iwate	Ishikawa	Okayama					
Dc	–							
Dd	Aomori	Fukui	Nagasaki					

Table 10.5 The distribution ratios of number of prefectures in each quadrant

A	Percent	B	Percent	C	Percent	D	Percent
Aa	6.7	Ba	8.3	Ca	45.5	Da	33.3
Ab	13.3	Bb	41.7	Cb	9.1	Db	33.3
Ac	53.3	Bc	50	Cc	9.1	Dc	0
Ad	26.7	Bd	0	Cd	36.4	Dd	33.3

10.5.1 *Difference in Production Scale of Factory Between Four Quadrants*

It may be generally inferred that the factories in the prefectures with a high level of two connection economies, city system economy, and regional connection economy, employ production methods that utilize these economies as much as possible. The production scale of the factories, therefore, tends to small and to specialize in the specific processes. On the other hand, the factories in prefectures with a low level of the economies adopt production methods that make maximum use of internal economies, mass production, and large-scale economy. Thus, the factories' scale tends to be large. To verify this inference, this subsection derives the specialization coefficients for the three factory's scales, small, medium, and large based on the data on the number of the employees of the factories in the prefecture. And it shows the factory's scale in the prefectures in each quadrant.

The factory's scale is divided into the three categories, small factory (1 to 3 employees), medium factory (3 to 99 employees), and large factory (300 or more employees). And specialization coefficient for each factory's scale is derived for each prefecture. And then, according to the coefficient value, the 47 prefectures are ranked in each category respectively. The results are shown in Table 10.6.

As shown in Table 10.6, the specialization coefficient of the small factory is quite high in Tokyo, Kyoto, and Okinawa that are in the quadrant A and also Ishikawa prefecture in the quadrant D. The specialization coefficient of the medium factory is the highest in Iwate that is in quadrant D and also Tottori in the quadrant C. The specialization coefficient of the large-scale factory is quite high in Yamaguchi in the quadrant C and also Shiga in the quadrant B. These rankings may generally support the inference regarding the factory scale in each quadrant.

Then, Table 10.7 shows the number of the prefectures in the top ten in each rank by the specialization coefficient for the three scales. Table 10.7 indicates important facts: In 15 prefectures in the quadrant A, 6 prefectures, 40% of 15 prefectures, are in the top 10 in the ranking of the specialization coefficient of the small factory. And in 12 prefectures in the quadrant B 4 prefectures are in the top 10 in the ranking of the specialization coefficient of the large-scale factory. And then, there are 11 prefectures in the quadrant C, none of them is in the top 10 in terms of the specialization coefficient

Table 10.6 Specialization coefficients by factory size in 47 prefectures and their ranking

Rank	Small factory (1-3workers)		Medium factory (33-99 workers)		Large factory (more than 300 workers)	
	Prefecture	Spatialization quotient	Prefecture	Spatialization quotient	Prefecture	Spatialization quotient
1	Tokyo	1.43	Iwate	1.62	Yamaguchi	2.17
2	Kyoto	1.25	Tottori	1.61	Shiga	2.03
3	Okinawa	1.18	Miyagi	1.42	Ibaraki	1.62
4	Ishikawa	1.14	Shiga	1.42	Mie	1.48
5	Yamanashi	1.12	Yamaguchi	1.40	Kumamoto	1.47
6	Niigata	1.11	Toyama	1.35	Saga	1.44
7	Fukui	1.10	Yamagata	1.34	Miyagi	1.42
8	Nara	1.09	Fukushima	1.32	Kanagawa	1.42
9	Gifu	1.07	Ibaraki	1.28	Tochigi	1.40
10	Osaka	1.06	Aomori	1.28	Oita	1.38
11	Wakayama	1.05	Hokkaido	1.28	Tottori	1.38
12	Kagoshima	1.03	Oita	1.28	Toyama	1.34
13	Saitama	1.01	Akita	1.27	Okayama	1.34
14	Nagasaki	1.00	Kumamoto	1.25	Hiroshima	1.33
15	Gunma	0.97	Okayama	1.24	Yamagata	1.32
16	Nagano	0.97	Chiba	1.23	Aichi	1.31
17	Kagawa	0.96	Miyasaki	1.17	Iwate	1.31
18	Tokushima	0.96	Fukuoka	1.16	Shizuoka	1.29
19	Tochigi	0.96	Niigata	1.15	Hiyogo	1.28
20	Hiyogo	0.94	Mie	1.14	Fukushima	1.26
21	Aichi	0.93	Shizuoka	1.13	Chiba	1.23
22	Saga	0.92	Hiroshima	1.12	Fukuoka	1.18
23	Mie	0.92	Ehime	1.12	Gunma	1.16
24	Kanagawa	0.92	Saga	1.12	Aomori	1.11
25	Aomori	0.91	Tochigi	1.12	Nagano	1.10
26	Yamagata	0.90	Hiyogo	1.11	Miyasaki	1.01
27	Miyasaki	0.90	Nagano	1.0	Ehime	0.99
28	Ehime	0.89	Shimane	1.0	Niigata	0.94
29	Shizuoka	0.89	Gunma	1.05	Tokushima	0.89
30	Okayama	0.88	Kagawa	1.02	Saitama	0.88
31	Fukushima	0.88	Kochi	1.02	Kagawa	0.84
32	Akita	0.88	Kanagawa	1.02	Nagasaki	0.81
33	Shimane	0.88	Aichi	0.98	Yamanashi	0.80

(continued)

Table 10.6 (continued)

	Small factory (1-3workers)		Medium factory (33-99 workers)		Large factory (more than 300 workers)	
34	Fukuoka	0.87	Kagoshima	0.94	Akita	0.78
35	Kochi	0.87	Yamanashi	0.92	Ishikawa	0.74
36	Ibaraki	0.86	Saitama	0.90	Gifu	0.73
37	Shiga	0.86	Wakayama	0.89	Hokkaido	0.71
38	Chiba	0.85	Nara	0.88	Shimane	0.69
39	Oita	0.83	Tokushima	0.87	Fukui	0.64
40	Hiroshima	0.83	Gifu	0.87	Kagoshima	0.61
41	Kumamoto	0.82	Nagasaki	0.81	Kyoto	0.61
42	Toyama	0.82	Fukui	0.77	Nara	0.60
43	Hokkaido	0.81	Ishikawa	0.74	Osaka	0.45
44	Yamaguchi	0.78	Osaka	0.73	Wakayama	0.33
45	Miyagi	0.77	Okinawa	0.66	Tokyo	0.28
46	Iwate	0.74	Kyoto	0.63	Okinawa	0.16
47	Tottori	0.69	Tokyo	0.45	Kochi	0.05

Source Kensei (Japanese Data book, 2019)

of the small factory. While, in the ranking of the specialization coefficient of the large-scale factory, 4 prefectures, 36% of them, are in the top 10. Finally, the prefectures in the quadrant D are distributed evenly between the three scales, it is a feature in the quadrant D.

The suggested inference of the factory scale of each quadrant may be generally supported by the facts shown in Tables 10.6 and 10.7: In the prefectures where the two types of the connection economies can be fully enjoyed, the factories tend to be small. In the prefectures where the connection economies are not enjoyed so much, the factory scale tends to be large. And the distribution of the factory scales in the prefectures where one of the two types of connection economies is not abundantly enjoyed tends to be uniform rather than extreme.

Table 10.7 Number of prefectures in the top 10 in specialization coefficient of factory scale

Quadrant (number of prefectures)	Small factory	Medium factory	Large factory
A (15)	6	3	1
B (12)	2	2	4
C (11)	0	3	4
D (9)	2	2	1

10.5.2 Characteristics of Production Activity in Prefectures in Each Quadrant

This subsection clarifies characteristics of production activity of the prefectures in each quadrant by survey of some economic items. The survey here focuses on two economic indicators; the manufactured product shipment value S per person that is shown in the fourth column in Table 10.8, the ration of gross value added V per person in manufacturing industry, which is shown in the third column in Table 10.8, to the value of S , V/S , which is shown the fifth column in Table 10.8.

Using the manufactured product shipment value S per person in each prefecture in Table 10.8, let us form the five ranks regarding the value of S in descending order of the value for each quadrant. The five ranks are shown by the top row in Table 10.9. Table 10.9 shows the number of the prefectures belonged to each rank. In the quadrant A, the number of the prefectures is evenly distributed in each rank. In the quadrant B, 9 out of 12 prefectures are in the rank 1st and 2nd. In the quadrant C, 4 prefectures are in the rank 1st, and 4 prefectures are also included in the lower ranks of 4th and 5th. It shows a bipolar distribution. In the quadrant D, 8 out of 9 prefectures are in the rank 4th. Table 10.9 clarifies that the prefectures belong to the four quadrants have different characteristics of production each other. Especially, the quadrant B and the quadrant D have contrasting characteristics.

Using the ratio V/S of each prefecture, let us form the five ranks regarding the value of V/S in descending order of the value for each quadrant. Table 10.10 shows the number of the prefectures that belonged to each of the five ranks.

The comparison of the results shown in Tables 10.9 and 10.10 is interesting. In the quadrant A, the distribution of the prefectures into the five ranks are not greatly changed. In the quadrant B, the numbers of the prefectures in the rank 1st and rank 2nd in Table 10.9 are significantly reduced from 9 to 3 in Table 10.10. In the quadrant C, the distribution of the numbers of the prefectures is changed from a bipolar in Table 10.9 to leveled in Table 10.10. In the quadrant D, the numbers of the prefectures in the rank 1st and rank 2nd in Table 10.9 increase from 1 to 5 in Table 10.10. And it is also interesting that in the quadrants B and D, the difference in between the ranking of the manufactured product shipment value S per person and that of the V/S ratio is large. It can be said that these survey results show the characteristics of the production activity of the prefectures that are divided into the four quadrants.

10.5.3 Similarity and Dissimilarity in Production Activity Between Prefectures

From the considerations in the previous sections and the values of the manufacture product shipment of the prefectures shown in the second column of Table 10.8, it is possible to derive similarities and differences in the production activities of

Table 10.8 Values of basic economic indicators of the prefecture

Prefec	Manufactured product shipment value (million yen)	Gross value added per person in manufacturing industry (10000 yen) V	Manufactured product shipment value per person (10000 yen) S	(V/S) ratio
Hokkaido	6,535,855	1130	3842	0.2941
Aomori	1,702,308	1252	3088	0.4054
Iwate	2,366,978	853	2800	0.3046
Miyagi	4,017,070	1204	3607	0.3337
Akita	1,224,139	869	2056	0.4226
Yamagata	2,550,977	951	2644	0.3596
Fukushima	4,915,726	1169	3272	0.3572
Ibaraki	12,037,605	1555	4599	0.3381
Tochigi	8,802,168	1598	4463	0.358
Gunma	9,050,380	1747	4415	0.39563
Saitama	12,760,252	1256	3318	0.3785
Chiba	12,668,824	1485	6160	0.2411
Tokyo	8,374,172	1261	3111	0.4053
Kanagawa	17,477,226	1545	4982	0.3101
Niigata	4,779,168	1063	2642	0.4023
Toyama	3,811,625	1235	3149	0.3921
Ishikawa	2,807,217	1200	2940	0.4081
Fukui	2,039,261	1205	2814	0.4282
Yamanashi	2,442,647	1433	3479	0.4118
Nagano	5,879,432	1197	3115	0.3842
Gifu	5,373,371	1059	2752	0.3848
Shizuoka	16,372,042	1551	4130	0.3755
Aichi	46,048,253	1811	5583	0.3243
Mie	10,898,556	1707	5673	0.3008
Shiga	7,371,769	1621	4589	0.3532
Kyoto	5,322,102	1574	3840	0.4098
Osaka	16,685,899	1273	3782	0.3365
Hyogo	15,445,672	1520	4437	0.3425
Nara	1,845,142	1150	3172	0.3625
Wakayama	2,648,002	1550	5037	0.3077
Tottori	704,352	834	2249	0.3708
Shimane	1,085,615	1109	2825	0.3925
Okayama	7,788,634	1507	5484	0.2747

(continued)

Table 10.8 (continued)

Prefec	Manufactured product shipment value (million yen)	Gross value added per person in manufacturing industry (10000 yen) V	Manufactured product shipment value per person (10000 yen) S	(V/S) ratio
Hiroshima	10,342,775	1626	4881	0.3331
Yamaguchi	6,303,285	1945	6734	0.2888
Tokushima	1,698,480	1985	3767	0.5269
Kagawa	2,491,700	1231	3715	0.3313
Ehime	4,094,964	1421	5391	0.2635
Kochi	558,495	838	2278	0.3678
Fukuoka	9,215,929	1253	4238	0.2956
Saga	1,815,391	1207	3145	0.3837
Nagasaki	1,628,207	1017	2827	0.3597
Kumamoto	2,712,683	1185	3079	0.3848
Oita	4,269,713	1625	6803	0.2388
Miyazaki	1,565,730	1113	2957	0.3763
Kagoshima	2,054,700	1019	2955	0.3448
Okinawa	544,069	806	2310	0.3489

Data source Chiiki keizai soran (2019)

Table 10.9 Five ranks by product shipment per person and number of prefectures in each group

Quadrant	1st–10th	11–20th	21–30th	31–40th	41–47th
A	2	4	3	1	4
B	3	6	3	0	0
C	4	0	3	1	3
D	1	0	0	8	0

Table 10.10 Five ranks by (V/S) ratio and number of prefectures in each group

Quadrant	1st–10th	11–20th	21–30th	31–40th	41–47th
A	3	4	2	5	1
B	2	1	4	2	3
C	2	3	2	2	2
D	3	2	2	1	1

Table 10.11 Similarity and dissimilarity between quadrants by items

Item	Quadrant	Quadrant
Manufactured product shipment value in prefecture	High A, B	Low C, D
Specialization quotient for small factory	High A, D	Low B, C
V/S ratio	High D	Low B

each quadrant. The results of the consideration are summarized in Table 10.11. The similarity and dissimilarity in production activity between the quadrants are shown in Table 10.11.

The following results can be derived from Table 10.11. First, the shipment value of the manufactured product of prefecture is high in the quadrants A and B where the CSI related with the economic scale of the prefecture is low, while its value of prefecture is low in the quadrants C and D where the value of CSI is high.

Second, the factory scale of the prefecture in the quadrant A is small because the factories effectively enjoy the two economies of the city system and the regional connection as well as the economies of localization and urbanization. And the factory scale of the prefecture in the quadrant D is also small because the factories enjoy the regional connection economy that is reflected by high RCI. On the other hand, the factory scale of the prefecture in the quadrant C where the two economies of the city system and the regional connection are less, the factory scale is large to enjoy the internal large-scale economy. The same thing could be said for the quadrant B.

Third, because the prefectures in the quadrant D are away from the prefectures with large-scale economy, the shipment value of the manufactured product of the prefecture is relatively low. These prefectures tend to interact between the firms within the prefecture in order to make their regional economy as active as possible. The result of the interaction is indicated by the high gross added value per person in manufacturing industry. In the context here, it is indicated by the high (V/S) value in the quadrant D. It could be said that in these prefectures the level of vertical transaction between the firms within the prefecture is high to make their economy active.

To inspect the third result, let us examine the ratio V/S in the quadrant D from a different view point: One effective way to increase the ratio V/S is to decrease the ratio of the raw material costs to the product manufacturing costs. It is, thus, a useful way to inquire the ratio of the freight flow within the prefecture to the total freight flow in each prefecture. Because if this ratio is high, the raw material cost may be low, as a result, the ratio V/S becomes high. Table 10.12 shows the ratio of the freight flow within the prefecture itself to the total freight flow. As shown in Table 10.12, the average freight flow ratio within the prefecture itself in the quadrant D is 78 percent that is the highest of the four quadrants. A high freight flow ratio within prefecture tends to procure raw materials within the prefecture and reduce the production costs. The high freight flow ratio within prefecture may be one of factors to keep the ratio V/S high in the quadrant D.

Table 10.12 Average rate of freight flow within prefecture for each quadrant

Quadrant	Average freight flow rate within prefecture, %
A	72
B	63
C	68
D	78

Data source Chiiki keizai soran (2019)

10.6 Summary and Conclusions

This paper firstly explains the agglomeration economy that has a great influence on regional economic activity even in an era when the globalized economy has progressed considerably. Then, the paper focuses on the connection economy and considers its influence on production activity: As the connection economy, two connection economies are taken up. One is the city system economy that is created by a city system composed of the cities located in a region, the other is the regional connection economy that is created by the connection between the regions. It is considered that the degree of economy created by the city system may be represented by the city system index CSI and that of the regional connection economy is represented by the regional connection index RCI. In addition, the paper devises the indexes PCI and SCI that are derived from firm's branch factories and sales offices to express the degree of the regional connection economy. Using these the connection indexes, the paper first classifies the regional economy into the 4 quadrants and then divides them into 16 quadrants and it derives production characteristics of the firms in the 47 prefectures in Japan. As a result of the examination, it can be obtained that the four quadrants formed by two indexes CSI and RCI have obvious characteristics: Quadrant A includes all prefectures that play a major socio-economic role in Japan and in local areas. Quadrant B contains many prefectures located adjacent to Tokyo and Osaka prefecture. Quadrant C contains many prefectures located on the outer fringes of Tokyo and Osaka metropolitan area. Quadrant D contains prefectures that are away from the Tokyo and Osaka prefecture. The spatial economic distance from Tokyo and Osaka decisively influences in distribution of the prefectures in Japan. In addition, the following spatial economic characteristics are clearly shown. Prefectures that play a major socio-economic role in Japan have high RCI and high PCI and have low CSI and low SCI. In most prefectures near prefectures with large economic scale, both RCI and SCI are low. Conversely, most prefectures on the outskirts of the sphere of the large-scale economic prefectures have low RCI and high SCI. The prefectures that are away from Tokyo and Osaka have high RCI and low CSI.

It is not possible to draw operable and functional conclusions by only categorizing the regional economy by the indexes used in this analysis. This kind of categorization, however, can contribute to show the entrance and direction of a clearer economic analysis of how and to what extent the economies of the city system and connection between the regions influence regional production activity.

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