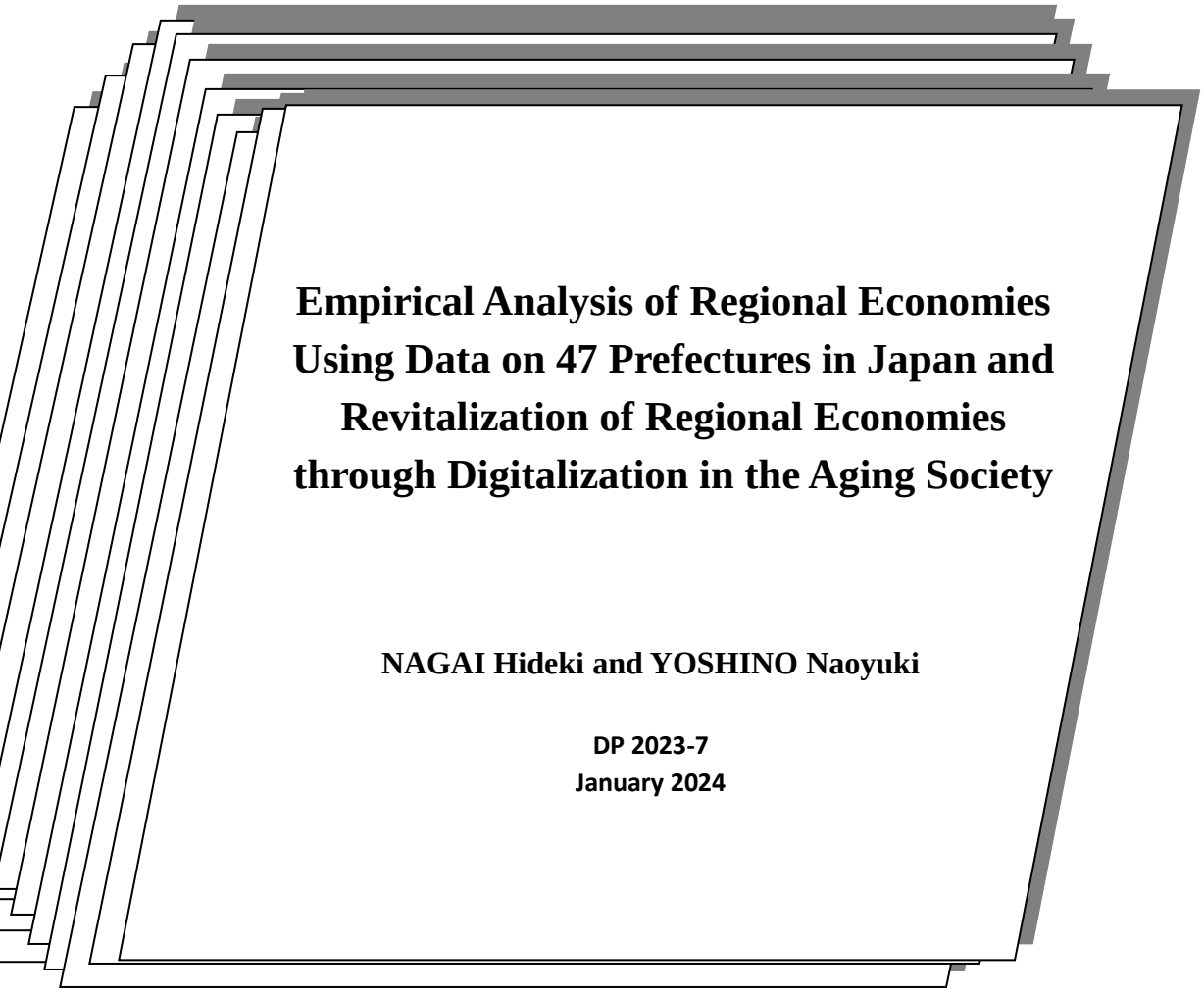

FSA Institute Discussion Paper Series

Empirical Analysis of Regional Economies Using Data on 47 Prefectures in Japan and Revitalization of Regional Economies through Digitalization in the Aging Society

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Empirical Analysis of Regional Economies Using Data on 47 Prefectures in Japan and Revitalization of Regional Economies through Digitalization in the Aging Society

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Abstract

In this paper, we use principal component analysis (PCA) and cluster analysis to categorize the characteristics of 47 prefectures in Japan from a wide range of data on regional economies and on the flow of people, goods, and money in each prefecture, and examine what is needed for balanced growth in regional economies in Japan. We discuss the importance of promoting remote education and remote work.

First, focusing on the flow of people, we observe that a large population movement is prominent when people enter universities and also when they find jobs, but that the population movement at other stages of life is small, except for in some prefectures. There is hardly any movement of people returning to their hometowns after retirement.

Next, looking at the flow of goods from the value of product shipment, there is a significant difference between prefectures with and without a strong industrial sector. The area around Aichi Prefecture, the area around Hiroshima Prefecture, and the Keihin Industrial Zone (the area around Tokyo and Yokohama) have a strong industrial sector and have large outflow of goods and services. The ratio of outflow of goods to gross prefectural product (which includes secondary products and services) is high for Tokyo, Tochigi, and Aichi.

In terms of the flow of money, we can see distinct features, as loans and deposits relative to gross prefectural product differ from prefecture to prefecture. In some prefectures, there are no lending opportunities even when deposits are accumulated. Where lending is small relative to the amount of deposits, such prefectures

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have little demand for loans within their prefectures.

When we conduct a cluster analysis of prefectures, we can classify prefectures into four clusters, excluding Tokyo. First is prefectures with a strong industrial sector. Second is prefectures that have economic strength and population inflow. Third is prefectures with an aging population and weak fiscal base. And fourth is prefectures in the intermediate group.

To curb population movement when people move to higher education and/or find jobs, it will be effective to promote digital education and increase employment in regional economies through digitalization. Using a theoretical model, we show that the promotion of remote education and remote work will have a positive impact on the economy.

Finally, local financial institutions have central roles to play in regional economies. They can provide loans to support companies' digitalization, including the development of a remote working environment, and can also provide loans for projects that create jobs in the community, such as the offshore wind power generation project in Akita Prefecture.

Keywords: cluster analysis of 47 prefectures; remote education and work; population movement; role of local financial institutions.

1. Relationship between Population and Bank Loans and Deposits

When we examine developments in loans and deposits of regional banks, we find that population is the largest explanatory factor. For prefectures other than Tokyo and Osaka, the correlation between working-age population, the amount of deposits and loans in each prefecture reveals a high correlation coefficient of 0.99 for deposits and 0.94 for loans.

Population trends have a significant impact on banking business. This is evident from the breakdown of regional financial institutions' revenues, which shows that revenues from deposits and loans business account for a large part of total revenues.

In regions where depopulation is progressing, it would be difficult to secure deposits and also to find borrowers in the future. Figure 1 shows the percentage of depopulated areas and the percentage of the population living in depopulated areas by prefecture. Based on both indicators, prefectures such as Akita and Shimane are experiencing significant depopulation.

We analyze the situation of each prefecture from the perspective of the flow of people, goods, and money.

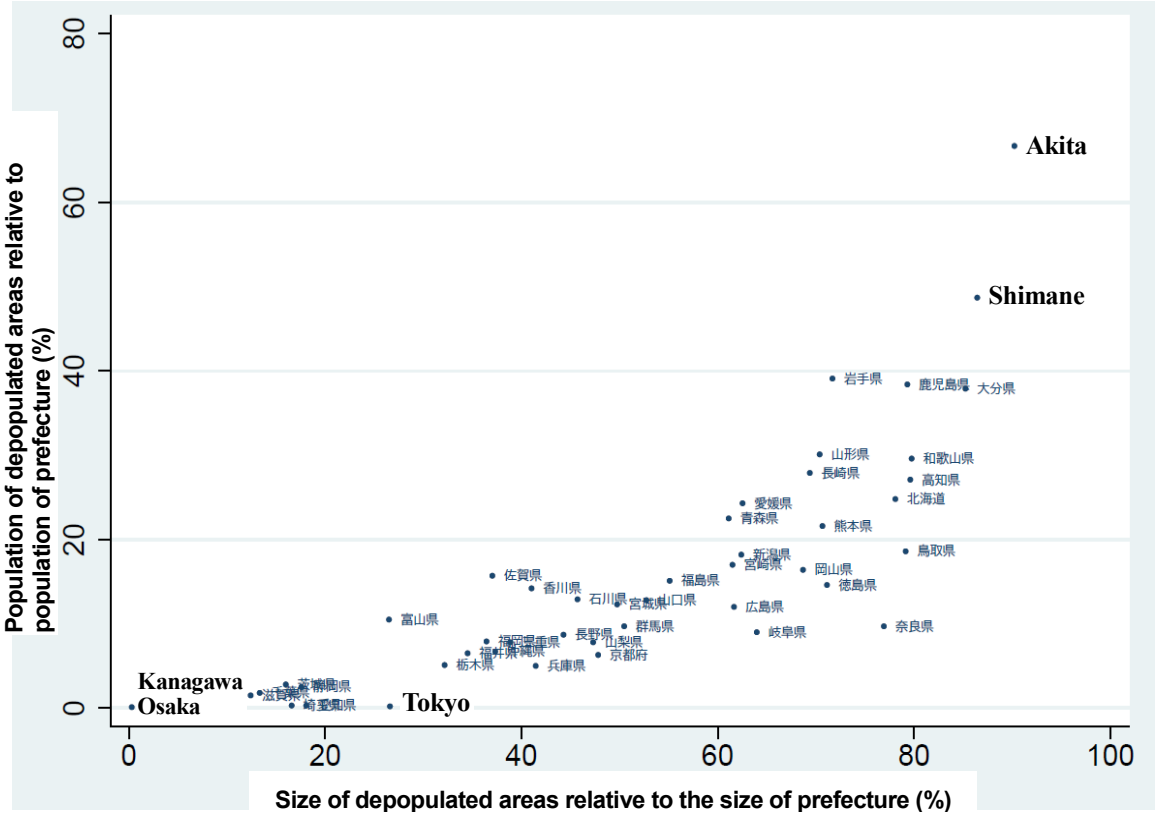


Figure 1: Progress of depopulation by prefecture

(Source) Compiled based on data from the National Federation of Depopulated Areas

2. Flows of People, Goods, and Money

2.1 Flow of people

Population is expected to decline significantly throughout Japan, by approximately 15% in 2045 compared to 2015 (Figure 2), according to regional population projections. The latest projections of population by prefecture are data as of June 2023. Three prefectures in north eastern Japan, namely Akita, Aomori and Yamagata, show the largest declines. Looking at trends of each prefecture relative to the average decline for Japan as a whole, there are regional differences, as we can see from slower declines in the Kanto region and Okinawa compared to the national average (Figure 3).

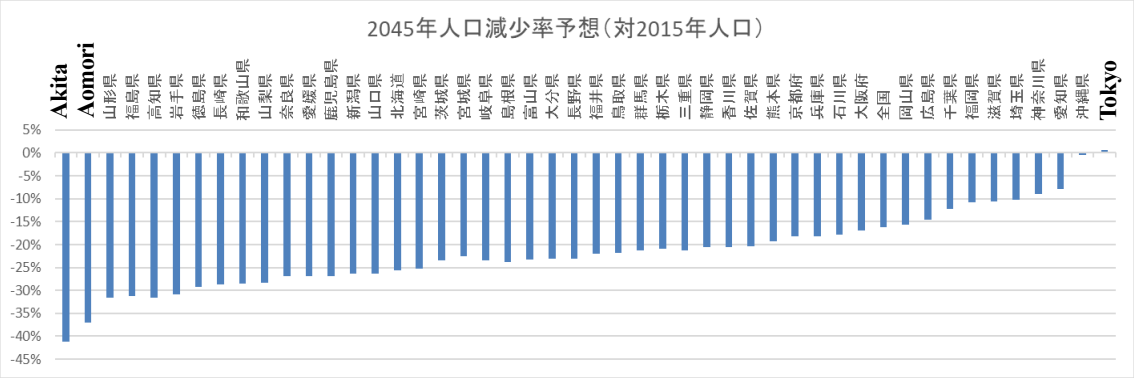


Figure 2: Expected rate of decline of population by prefecture in 2045 from 2015 (plotted in order of largest decline rate)

(Source) Compiled from the National Institute of Population and Social Security Research, "Regional Population Projections for Japan: 2015-2045 (2018)"

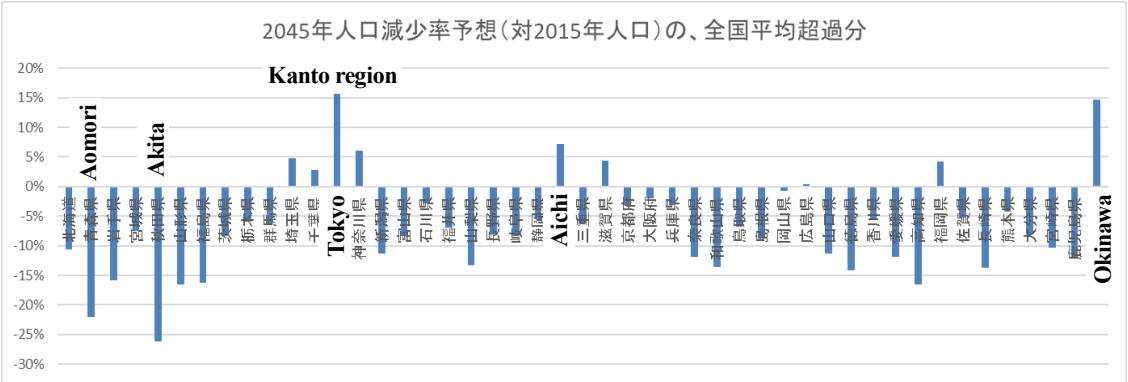


Figure 3: The extent exceeding the national average for expected rate of decline of population by prefecture in 2045 from 2015 (in order of prefecture number)

(Source) Compiled from the National Institute of Population and Social Security Research, "Regional Population Projections for Japan: 2015-2045 (2018)"

Looking at the current demographic change, including natural increase/decrease of population, Okinawa is the only prefecture where population is increasing naturally (net change in population due to births and deaths is positive) in 2019 (Figure 4). Even if the extent of natural decrease in population is

similar for prefectures, considerable difference in total population can occur depending on the social-factor change in population. In other words, flow of people has a significant impact on each prefecture's population.

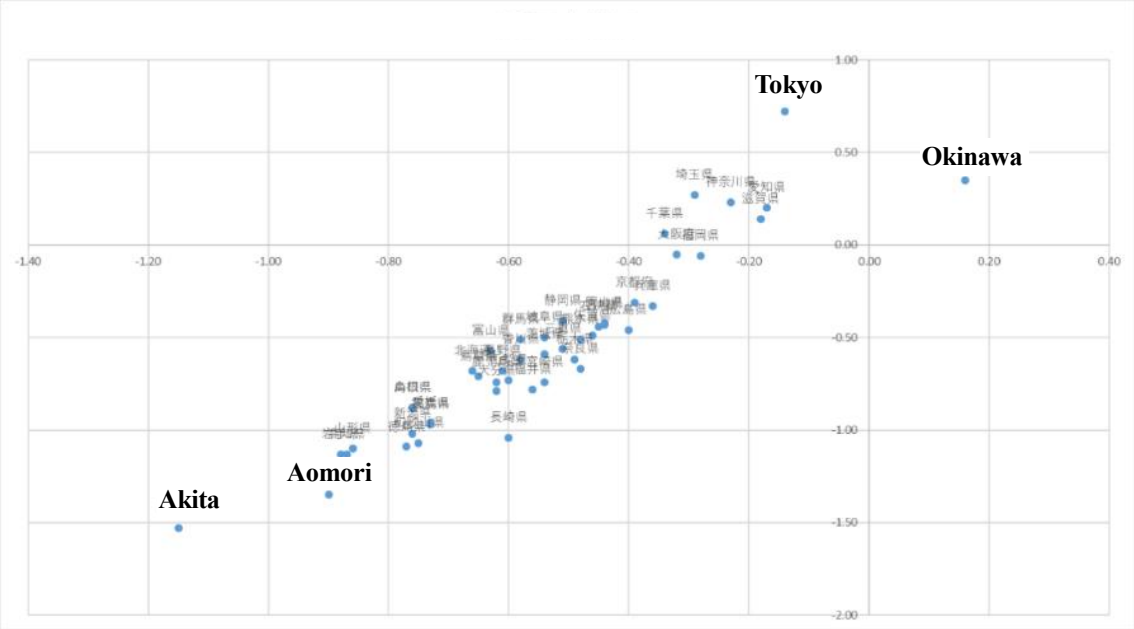


Figure 4: Change in total population (vertical axis) and natural increase/decrease of population (horizontal axis)

(Source) Compiled based on "Population Estimates," Statistics Bureau of Japan.

2.2 Flow of goods

Looking at the value of product shipment by prefecture (Figure 5), an indicator for flow of goods, there is a significant difference between prefectures with strong industrial sectors and those without. Regional concentration is evident too. For example, Aichi prefecture and regions around it, Hiroshima prefecture and regions around it, and the Keihin Industrial Zone (the area around Tokyo and Yokohama) have a strong industrial sector and the value of products shipped to other prefectures is high. Inter-prefectural transaction value that includes tertiary sectors as well as secondary sectors account for large part of prefectural GDP for Tokyo, Tochigi, and Aichi (Figure 6).

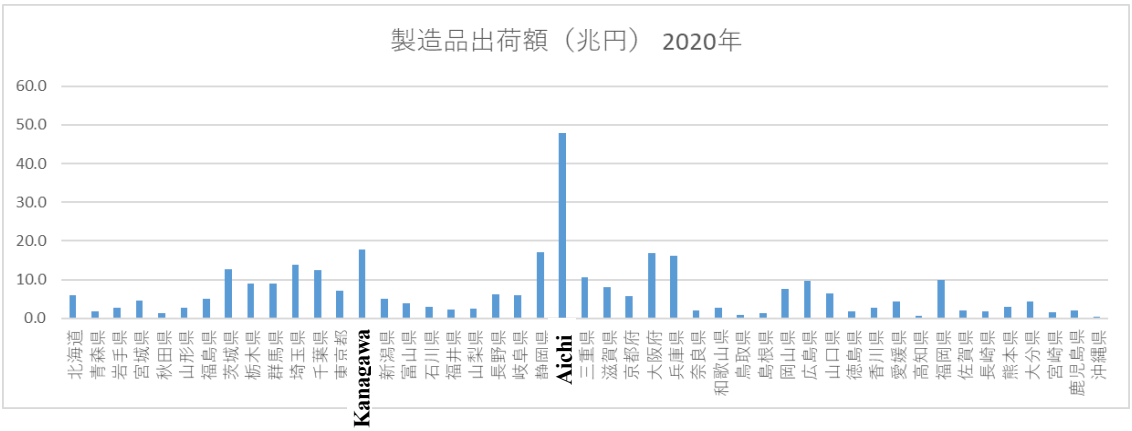


Figure 5: Value of product shipment (in 2020, JPY trillion)

Source: "Census of Manufacture," the Ministry of Economy, Trade and Industry.

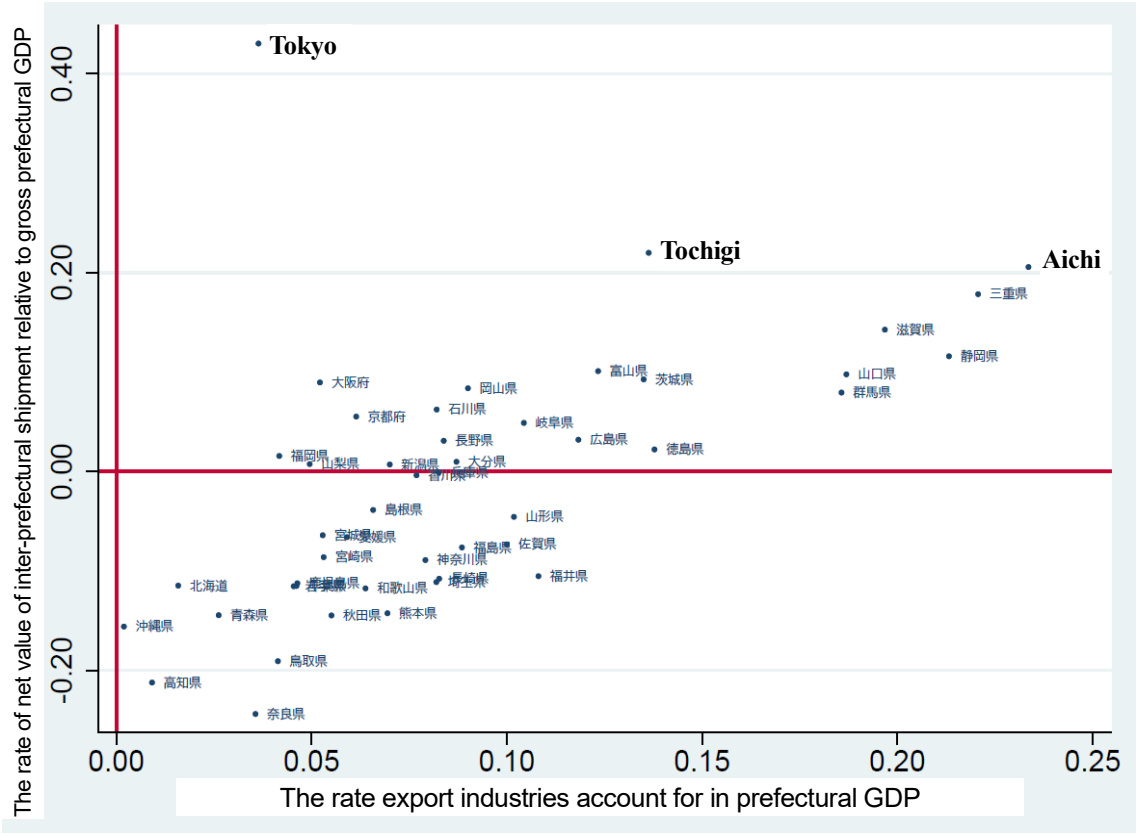


Figure 6: Relationship between the size of net inter-prefectural shipment and industries with large exports

Source: "Trade Statistics of Japan," Ministry of Finance and "Prefectural Account," Economic and Social Research Institute, Cabinet Office.

The flow of goods can also be examined from how they are physically distributed. For example, the use of ship is high for Hokkaido and Shikoku in the distribution of goods to regions outside them.

2.3 Flow of money grasped from deposits and loans

When we compare the ratio of loans extended within a prefecture and deposits collected within a prefecture to gross prefectural product respectively, we find distinctive characteristics of prefectures (Figure 7). In Figure 7, blue lines (left) and red lines (right) show the amount of deposits collected and the amount of loans divided by gross prefectural product of each prefecture respectively. Nara prefecture and Tokushima prefecture have low ratios of loans relative to deposits, while Tokyo and Ehime prefectures have high ratios. The feature of Shikoku island is that only Ehime prefecture has high ratio of loans to GDP, while those of the other three prefectures (Kagawa, Tokushima, and Kochi) are low.

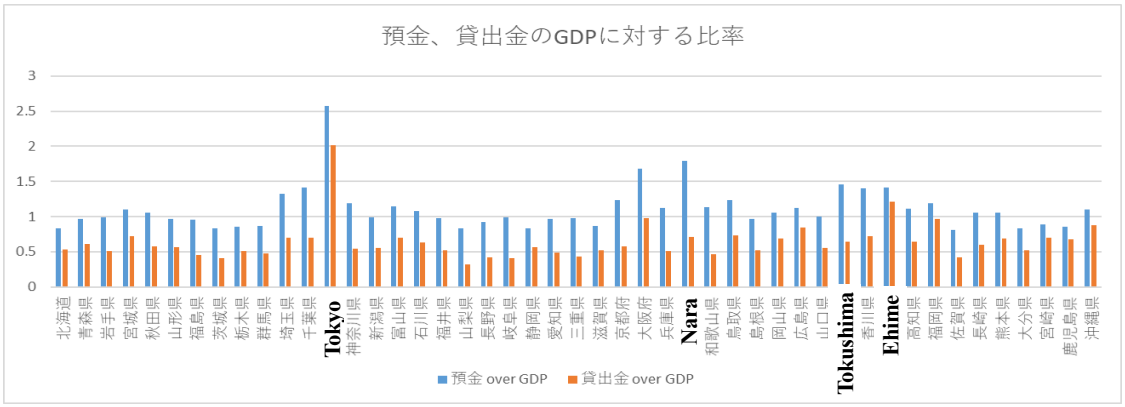


Figure 7: Ratio of deposits and loans to prefectural GDP

(Source) Compiled based on "Deposits, Vault Cash, Loans and Bills Discounted by Prefecture (Domestically Licensed Banks)" the Bank of Japan; and "Prefectural Accounts," Economic and Social Research Institute, Cabinet Office.

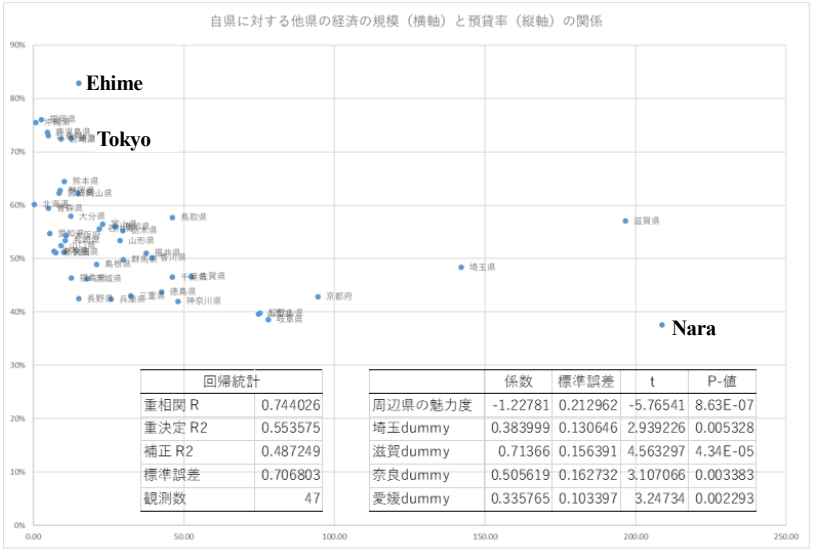
There are prefectures in which the amount of loans extended within the prefectures is small relative to deposits collected and those prefectures where loans are large relative to deposits. Deposits collected in the former may have flowed into the latter as loans. To analyze this point, we consider an indicator on the "economic attractiveness" of a prefecture seen from other prefectures.

(i) For all 47 prefectures, the distance between two prefectural capitals is created into an indicator of the distance between the two prefectures.

(ii) For each prefecture, gross prefectural product of the other 46 prefectures is divided by the square of the distance calculated in (i) and added up.

(iii) (ii) is divided by the gross prefectural product of the prefecture concerned, and we get an indicator on the economic attractiveness of this prefecture seen by other prefectures.

We plot this indicator on the horizontal axis and its loan-deposit ratio on the vertical axis for each prefecture (Figure 8), it seems that there is a certain degree of correlation on the left-hand side of the graph. When the economic attractiveness of neighboring prefectures are relatively higher than that of the prefecture concerned, the loan-deposit ratio of the prefecture is lower.



（純額）

$$\text{Indicator (i)} = \sum_{\text{other prefectures}} \frac{GDP_{\text{other prefectures}}}{Distance^2}$$

（指標の相対化）

$$\text{Indicator (ii)} = \frac{\text{Indicator (i)}}{GDP_{\text{prefecture}}}$$

GDP:県民総生産（百万円）
Distance:県庁所在地間距離（物理的最短距離km）

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Figure 8: The size of a prefecture's economy relative to other economies in other prefectures (horizontal axis) and loan-deposit ratios (vertical axis)

Source: "Prefectural Accounts" (Economic and Social Research Institute, Cabinet Office); compiled based on "Distance between prefectural governments" (Geospatial Information Authority of Japan, Ministry of Land, Infrastructure, and Transport)

3. Flow of People: Analysis of Population Movement

We further examine flow of people based on the results of the 2010 and 2015 national censuses. Specifically, (i) the rate of change in population for the five years from 2010 to 2015 was calculated for each age group (the age range was five years), and (ii) the amount of changes due to population movement is obtained by applying data adjustment using the rate of population change on a national basis. Furthermore, based on the results of the above calculation, we estimate (iii) the population change rate across multiple age classes.

The results are summarized in Table 1, from which we can observe that the population movement at the time of entering university and seeking employment is large, and that there are distinctive features by prefectures. It should be noted that Fukushima prefecture is an exceptional case due to the aftermaths of the Great East Japan Earthquake.

In Table 1, there are five columns showing population change. The first column shows the population change between infancy (0 to 4 years old) and intermediate school years (10 to 14 years old). The ratio is around 1.0, suggesting there is little movement of population during this period.

The second column shows the population change between intermediate school years (10-14 years old) and the university age (20-24 years old). A value less than 1.0 indicates an outflow of population, while a value greater than 1.0 indicates an inflow. In Tokyo and Kyoto prefectures, there is a large inflow of people at the time of entering university and seeking employment after graduating from high schools. On the other hand, in the Tohoku region for example, nearly 30% of the population is flowing out at the same year range, except for Miyagi prefecture.

The third column shows the changes in population between the university age (20-24 years old) and the employment age (25-29 years old). Kyoto prefecture experiences a large population outflow, which indicates that although it attracts students during the university period, there are not enough places for them to find jobs, leading to a population outflow at the year range around graduates' job seeking.

The fourth column compares the timing of entry into employment (ages 25-29) and the period immediately before retirement (ages 55-59). Excluding Fukushima prefecture, which was affected by the earthquake, the ratio is close to 1.0. During this period (i.e., employment years), it is evident that the population does not change significantly over time. The figure for Okinawa prefecture is high, indicating that there are many working-age migrants. On the other hand, the figure for Nara prefecture is 0.90, which suggests that workers are migrating to Osaka and Kyoto prefectures from Nara.

The fifth column shows the population change between immediately before retirement (55-59 years old) and elderly years (80-84 years old). While the figure is close to 1.0 nationwide, that of Okinawa prefecture is exceptionally large with 1.12. This is likely due to both longevity of people of Okinawa relative to the national average and the presence of people moving to live in Okinawa.

Table 1: Calculation of rate of population change from 2010 to 2015 due to movement of people

Rate of population change due to movement of people (from 2010 to 2015)					
	column 1	column 2	column 3	column 4	column 5
age group	**kinder and school age**	**higher eduction, employment**	**employment age 2**	**working age**	**retiring age**
no. of age groups	2	2	1	6	5
from	**0−4 yrs**	**10−14 yrs**	**20−24 yrs**	**25−29 yrs**	**55−59 yrs**
to	**→10−14 yrs**	**→20−24 yrs**	**→25−29 yrs**	**→55−59 yrs**	**→80−84 yrs**
Hokkaido	1.01	0.90	0.94	1.00	1.02
Aomori	0.97	0.69	0.95	0.95	0.97
Iwate	0.98	0.71	1.00	1.07	1.00
Miyagi	0.99	1.04	0.94	1.01	1.07
Akita	0.97	0.61	1.00	0.95	1.01
Yamagata	0.99	0.71	1.00	1.00	1.01
Fukushima	0.86	0.66	0.99	0.89	0.99
Ibaraki	1.00	0.89	0.99	0.95	1.01
Tochigi	0.99	0.86	1.05	0.98	0.94
Gunma	1.01	0.86	1.02	1.01	1.01
Saitama	1.02	1.10	0.96	1.05	1.01
Chiba	1.01	1.10	0.99	0.99	0.99
Tokyo	1.01	1.59	1.11	1.02	0.93
Kanagawa	0.99	1.21	0.99	0.98	1.00
Niigata	1.02	0.81	1.01	1.01	1.00
Toyama	0.99	0.81	1.04	1.01	1.01
Ishikawa	0.99	1.02	0.93	1.03	1.03
Fukui	0.99	0.79	1.03	1.01	1.03
Yamanashi	0.99	0.83	0.93	0.92	1.05
Nagano	0.99	0.72	1.08	1.00	1.08
Gifu	1.02	0.85	0.96	0.96	1.00
Shizuoka	0.99	0.81	1.09	0.95	1.01
Aichi	0.98	1.10	1.04	0.99	0.99
Mie	0.99	0.85	1.01	0.97	0.99
Shiga	1.01	1.01	0.92	1.00	1.04
Kyoto	0.99	1.30	0.83	0.95	1.02
Osaka	0.99	1.11	0.99	0.98	0.95
Hyogo	1.00	0.93	0.96	1.01	1.02
Nara	1.05	0.91	0.86	0.90	1.03
Wakayama	1.07	0.74	1.00	1.01	0.92
Tottori	1.04	0.78	1.04	1.00	1.03
Shimane	1.03	0.75	1.07	1.06	1.07
Okayama	0.99	1.00	0.96	1.02	1.05
Hiroshima	1.03	0.97	1.01	1.04	0.99
Yamaguchi	0.98	0.83	0.97	0.99	1.02
Tokushima	0.99	0.84	1.00	1.01	1.00
Kagawa	0.99	0.83	1.07	1.05	1.00
Ehime	0.99	0.75	1.03	0.98	1.02
Kochi	0.99	0.73	0.97	0.98	0.99
Fukuoka	1.03	1.06	0.95	1.07	1.04
Saga	1.05	0.77	1.00	1.03	1.04
Nagasaki	0.99	0.71	0.98	1.01	1.02
Kumamoto	1.03	0.79	1.00	1.04	1.07
Oita	1.01	0.82	0.98	1.00	1.02
Miyazaki	1.01	0.68	1.02	1.02	1.05
Kagoshima	0.99	0.68	0.97	1.00	1.04
Okinawa	1.03	0.81	1.04	1.12	1.10

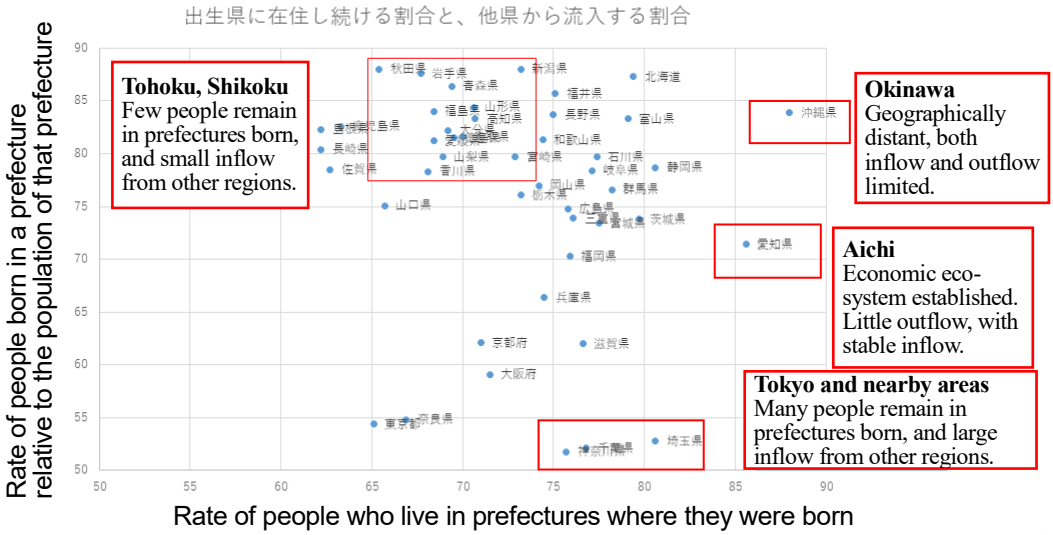
(Source) Compiled based on the "Population Census," Statistics Bureau of Japan

(Note) Red highlights represent a decrease of 2% or more; green highlights represent an increase of 2% or more.

In summary, population movement is particularly evident at the ages people start university or working. In other age groups, on the other hand, movement of people is, on a net basis, little except for some prefectures.

For each prefecture, we calculated the rate of people who were born in a given prefecture and remain in that prefecture, and the rate of people who were born in a given prefecture among those who are living in that prefecture, based on data for 2016 in "the National Survey on Migration." Figure 9 is a diagram that plot the rates. It shows that prefectures around Tokyo and Tohoku regions have noticeable characteristics.

Comparing the rate of people who remain in a prefecture where they were born and the rate of people who are born in other prefectures



（出所）国立社会保障・人口問題研究所「第八回人口移動調査（2016年）」より作成

Figure 9: Rate of people who remain in prefectures where they were born and rate of people who were not born in prefectures they now live

(Source) Compiled based on the eighth "National Survey on Migration" (2016), The National Institute of Population and Social Security Research.

We take up Tohoku, Kyushu and Shikoku regions as examples of regions other than the three metropolitan areas of Japan, and compare them with Kansai region, which is one of the three metropolitan areas in Japan (Table 2). For all the prefectures in Tohoku and Shikoku, the primary destination of migration is Tokyo besides migration within their prefectures. In Kansai and Kyushu, people tend to move to the regions' central prefectures such as Osaka or Fukuoka rather than Tokyo.

Table 2: Major destinations from selected prefectures (as of 2016)

Destinations of people moving from Tohoku, Kyushu and Shikoku, comparing with Kansai region

Prefectures currently living, by prefectures of origin		Prefectures currently living (%)											
	Prefectures of origin	Living in the same prefecture	Moving to other prefectures (in order of high percentage)										
Tohoku	**Aomori**	69.4	Tokyo	8.1	Saitama	3.8	Kanagawa	3.3	Hokkaido	3.1	Miyagi	2.4
	Iwate	67.7	Tokyo	9.1	Saitama	5.0	Miyagi	3.9	Kanagawa	3.8	Chiba	2.7
	Miyagi	77.5	Tokyo	5.9	Kanagawa	4.0	Saitama	2.8	Chiba	1.9	Fukushima	1.2
	Akita	65.4	Tokyo	7.3	Chiba	4.1	Saitama	3.7	Kanagawa	3.2	Miyagi	3.0
	Yamagata	70.6	Tokyo	8.5	Saitama	4.4	Kanagawa	4.0	Chiba	2.4	Miyagi	2.2
	Fukushima	68.4	Tokyo	7.7	Saitama	5.2	Kanagawa	4.9	Chiba	3.0	Miyagi	2.5
Kansai	**Shiga**	76.6	Kyoto	5.0	Osaka	4.5	Aichi	3.1	Hyogo	2.4	Tokyo	1.6
	Kyoto	71.0	Osaka	7.0	Shiga	4.1	Tokyo	2.8	Aichi	2.3	Kanagawa	1.9
	Osaka	71.5	Hyogo	6.1	Nara	3.2	Tokyo	3.0	Kyoto	2.4	Kanagawa	2.2
	Hyogo	74.5	Osaka	8.2	Tokyo	3.6	Kyoto	2.0	Aichi	1.5	Kanagawa	1.4
	Nara	66.9	Osaka	14.4	Kyoto	4.3	Tokyo	2.8	Hyogo	2.4	Mie	1.2
	Wakayama	74.4	Osaka	12.2	Hyogo	2.8	Shiga	1.1	Saitama	1.1	Nara	0.9
Kyushu	**Fukuoka**	75.9	Tokyo	3.9	Kanagawa	2.7	Osaka	2.3	Chiba	1.8	Aichi	1.5
	Saga	62.7	Fukuoka	13.4	Tokyo	4.8	Kanagawa	3.1	Nagasaki	2.8	Osaka	2.6
	Nagasaki	62.2	Fukuoka	8.8	Osaka	4.7	Tokyo	4.1	Kanagawa	3.0	Hyogo	2.6
	Kumamoto		Fukuoka	18.9	Tokyo	11.7	Osaka	9.4	Aichi	9.1	Chiba	8.2
	Oita	69.2	Fukuoka	7.8	Aichi	2.9	Kanagawa	2.6	Osaka	2.3	Chiba	2.1
	Miyazaki	72.9	Osaka	4.4	Fukuoka	3.1	Saitama	2.4	Aichi	2.4	Kanagawa	2.2
	Kagoshima	63.3	Osaka	7.0	Tokyo	4.2	Kanagawa	3.6	Fukuoka	3.5	Aichi	2.8
Shikoku	**Tokushima**	69.5	Osaka	9.4	Kanagawa	3.0	Tokyo	2.1	Hyogo	1.9	Chiba	1.8
	Kagawa	68.1	Osaka	7.6	Tokyo	5.6	Hyogo	2.8	Ehime	2.3	Kanagawa	2.1
	Ehime	68.4	Osaka	7.9	Hyogo	3.4	Hiroshima	2.9	Tokyo	2.8	Kanagawa	2.0
	Kochi	70.7	Osaka	6.9	Kanagawa	2.8	Aichi	2.4	Ehime	2.2	Tokyo	2.1

(Source) Compiled based on the eighth "National Survey on Migration" (2016), The National Institute of Population and Social Security Research.

The Shikoku region has a feature that the largest destination of migration is Osaka, followed by Kanto area. We observe that migration to prefectures with close geographical proximity is common; for example, from Ehime prefecture people tend to move to Hyogo and Hiroshima prefectures, and from Kagawa prefecture to Hyogo prefecture. Among the four prefectures in Shikoku, Kochi has the highest rate of population remaining in its prefecture. If remote work becomes more prevalent, commuting to Osaka from Ehime and Kagawa few times a week is practical, and it would be quite possible for people living in Ehime and Kagawa prefectures to stay in their hometowns and work from there.

Wage difference may also be affecting people's movement. A comparison of minimum wages in Shikoku, Osaka, and Tokyo (Table 3) shows that Kochi has the lowest minimum wage in Japan, followed by Ehime and Tokushima prefectures, both of which have lower wage levels. We consider that this wage gap might be influencing people's choice when they look for employment.

Table 3: Minimum wage in each prefecture (average rent as reference)

Prefectures	Minimum wage	Average rent	Rent/wage	Prefectures	Minimum wage	Average rent	Rent/wage
Hokkaido	889	42,961	48	Shiga	896	49,251	55
Aomori	882	39,882	49	Kyoto	937	55,955	60
Iwate	821	42,068	51	Osaka	992	56,464	57
Miyagi	853	49,983	59	Hyogo	928	56,546	61
Akita	822	40,366	49	Nara	866	49,365	57
Yamagata	822	43,552	53	Wakayama	859	42,971	50
Fukushima	828	42,931	52	Tottori	821	41,430	50
Ibaraki	879	46,203	53	Shimane	824	41,139	50
Tochigi	882	46,181	52	Okayama	862	46,988	55
Gunma	865	43,783	51	Hiroshima	899	49,339	55
Saitama	956	60,336	63	Yamaguchi	857	40,512	47
Chiba	953	58,609	61	Tokushima	824	42,540	52
Tokyo	1,041	82,383	79	Kagawa	848	45,163	53
Kanagawa	1,040	69,245	67	Ehime	821	42,080	51
Niigata	859	46,116	54	Kochi	820	41,271	50
Toyama	877	44,034	50	Fukuoka	870	49,306	57
Ishikawa	861	46,527	54	Saga	821	43,744	53
Fukui	858	43,640	51	Nagasaki	821	42,434	52
Yamanashi	866	43,612	50	Kumamoto	821	42,796	52
Nagano	877	44,148	50	Oita	822	42,400	52
Gifu	880	45,038	51	Miyazaki	821	39,261	48
Shizuoka	913	51,167	56	Kagoshima	821	39,304	48
Aichi	955	53,334	56	Okinawa	820	47,524	58
Mie	902	45,529	50				

(Source) Ministry of Health, Labor and Welfare, "National List of Regional Minimum Wages;" Ministry of Internal Affairs and Communications, Statistics Bureau, "2018 Housing and Land Survey."

On the other hand, when we look at how high the rent is relative to minimum wage, we find that the burden of housing costs is heavy in metropolitan areas (Figure 10).

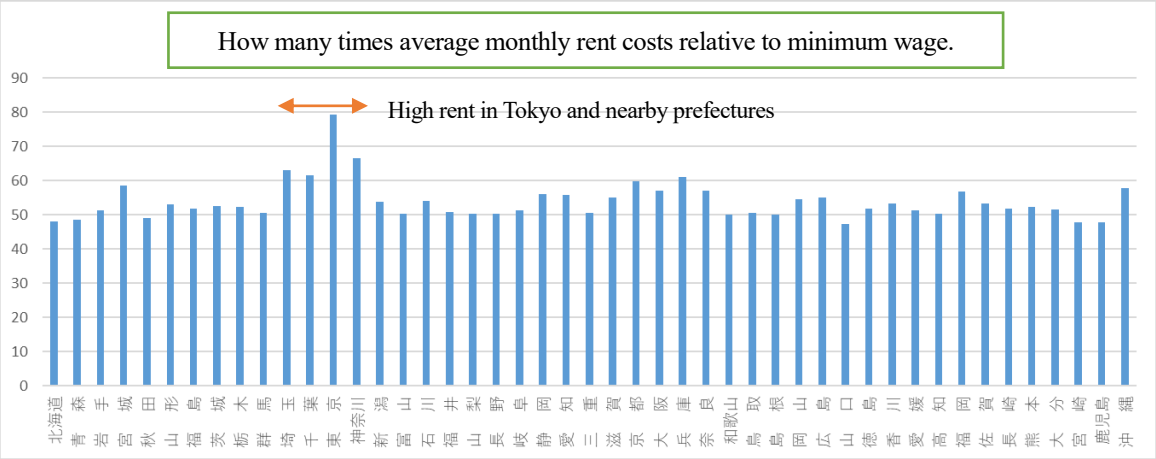


Figure 10: Ratio of average rent to minimum wage by prefecture

4. Principal Component Analysis and Cluster Analysis

Having looked at various indicators on flow of people, we perform a principal component analysis of economic variables listed below (Table 4). If we keep principal components with eigenvalues greater than 1, we get three principal components.

The first principal component (PC1) is an indicator of prefectures' strength (industrial production capacity), comprised of variables such as per capita prefectural income, shipment value of secondary sector, population inflow at the time of entering university, and productivity in the manufacturing and services industries. The second principal component (PC2) is an indicator of how much money is earned by the services industry rather than by manufacturing. The third principal component (PC3) is an indicator of employment absorption capacity, and it has a positive value in prefectures where there is population inflow of people at employment.

Table 4: Principal component analysis of economic indicators for each prefecture (showing items with load over 0.3 only)

	PC 1	PC 2	PC 3
Population density in 1 km^2 of habitable areas (2019)	0.35		
Population ratio in densely populated districts (2019)		0.33	
Per capita prefectural income for fiscal 2018 (2011 basis)	0.43		
Percentage of employees in secondary sector (2019)		-0.44	
Percentage of employees in tertiary sector (2019)		0.45	
Unemployment rate (2019)		0.34	
Ratio of job offers to job seekers (2019)			0.54
Percentage of industries with large export to GDP (fiscal 2018)		-0.37	-0.32
Ratio of net shipment value relative to prefectural GDP before considering inflow and outflow of shipment (fiscal 2018)	0.39		
Change in population between age group "15-19" and "20-24" for the five year period (2010-2015)	0.38		
Change in population between age group "20-24" and "25-29" for the five year period (2010-2015)			0.54
Per capita GDP of employees of secondary sector (2019)	0.36		
Per capita GDP of employees of tertiary sector (2019)	0.37		0.33

(Note) PC 1 = Prefectural strength (industrial productivity); PC 2 = the proportion of earnings from the services industry; and PC 3 = employment absorption capacity.

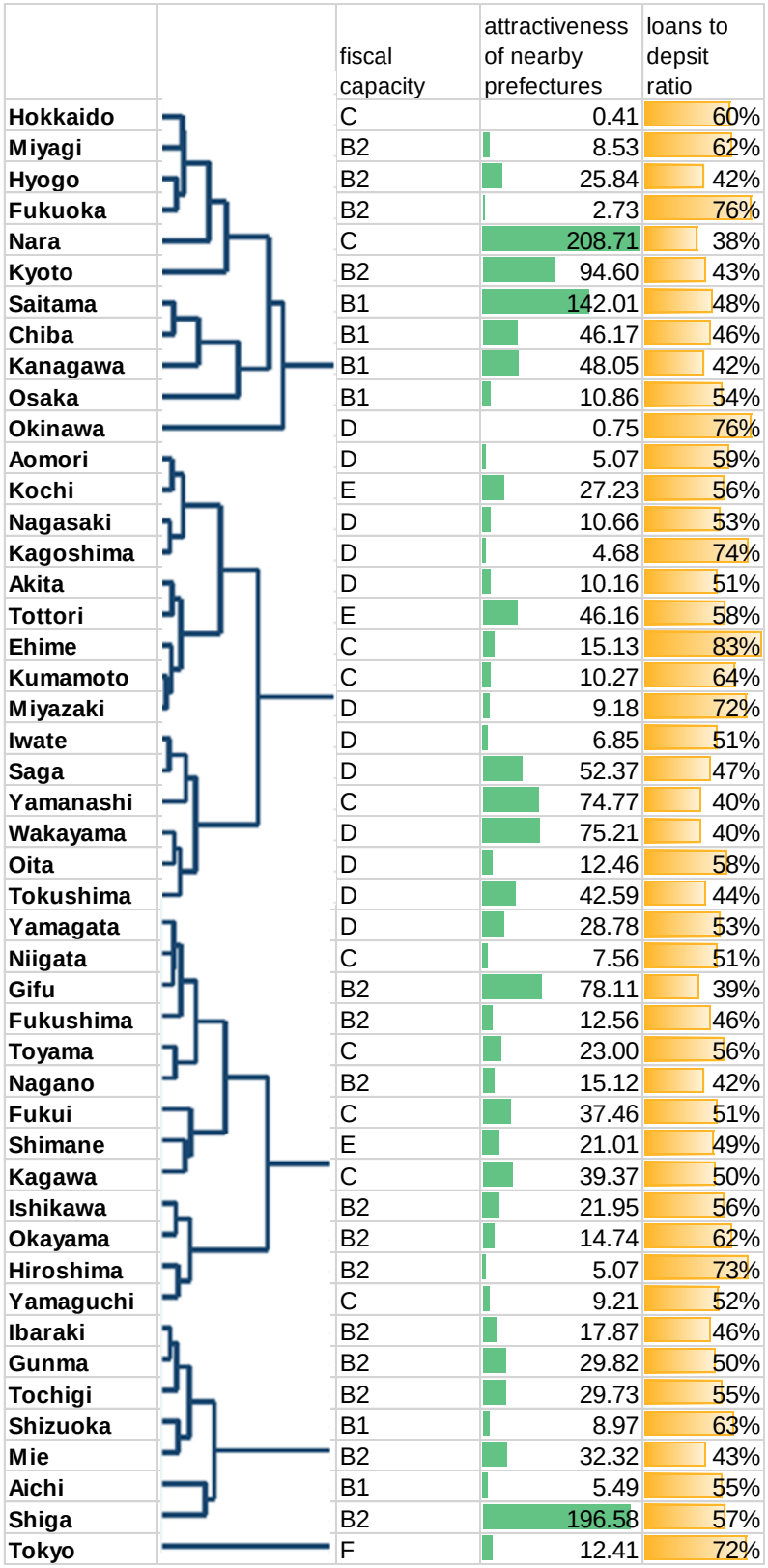
We compare these principal components with indicators of fiscal capacity of each prefecture. Specifically, we perform regression analysis of indicators on fiscal strength using the above three principal components and a dummy for Tokyo (a dummy variable that takes 1 only for Tokyo). The result is, the first and second principal components are significant, but the third principal component is not significant. In other words, employment absorption capacity as indicated by the third principal component is not incorporated in the fiscal capacity index. Further, when we conduct regression analysis of the value of loans, the third component is also significant and therefore contributes to fiscal capacity (Table 5).

Table 5: Results of the regression analysis of fiscal capacity index using the three principal components and the Tokyo dummy variable

Fiscal capacity indicator =	0.468 (0.71)	+	0.496 (PC1) (9.67)	+	0.117 (PC2) (3.22)	−	0.015 (PC3) (-0.21)	−	2.20 Tokyo dummy (-2.42)
Loans =	-0.99 (-5.68)	+	0.137 (PC1) (10.09)	+	0.079 (PC2) (8.23)	+	0.073 (PC2) (3.81)	+	4.66 Tokyo dummy (19.37)
Deposits =	-0.82 (-3.56)	+	0.184 (PC1) (10.27)	+	0.106 (PC2) (8.32)	+	0.085 (PC2) (3.38)	+	3.86 Tokyo dummy (12.14)

	Modified R^2
PC 1 = Prefectural strength (industrial productivity)	fiscal capacity indicator: 0.81
PC 2 = the proportion of earnings from the services industry, not manufacturing	loans: 0.99
PC 3 = employment absorption capacity	deposits: 0.98

We compare the degree of similarity between prefectures by "clustering" prefectures using the variables employed in the above principal component analysis. When we prepare a dendogram (Figure 11) by a cluster analysis using the Ward's linkage method, prefectures are classified into four major clusters, not including Tokyo. First is prefectures with strong secondary sector. Second is prefectures with economic strength and population inflow. Third is prefectures with an aging population and a low fiscal capacity index. And the fourth cluster is an intermediate group. On the right hand side of Figure 11 are, data on fiscal capacity, the attractiveness index of the surrounding prefectures calculated above, and the loan to deposit ratios.



	fiscal capacity	attractiveness of nearby prefectures	loans to depsit ratio
Hokkaido	C	0.41	60%
Miyagi	B2	8.53	62%
Hyogo	B2	25.84	42%
Fukuoka	B2	2.73	76%
Nara	C	208.71	38%
Kyoto	B2	94.60	43%
Saitama	B1	142.01	48%
Chiba	B1	46.17	46%
Kanagawa	B1	48.05	42%
Osaka	B1	10.86	54%
Okinawa	D	0.75	76%
Aomori	D	5.07	59%
Kochi	E	27.23	56%
Nagasaki	D	10.66	53%
Kagoshima	D	4.68	74%
Akita	D	10.16	51%
Tottori	E	46.16	58%
Ehime	C	15.13	83%
Kumamoto	C	10.27	64%
Miyazaki	D	9.18	72%
Iwate	D	6.85	51%
Saga	D	52.37	47%
Yamanashi	C	74.77	40%
Wakayama	D	75.21	40%
Oita	D	12.46	58%
Tokushima	D	42.59	44%
Yamagata	D	28.78	53%
Niigata	C	7.56	51%
Gifu	B2	78.11	39%
Fukushima	B2	12.56	46%
Toyama	C	23.00	56%
Nagano	B2	15.12	42%
Fukui	C	37.46	51%
Shimane	E	21.01	49%
Kagawa	C	39.37	50%
Ishikawa	B2	21.95	56%
Okayama	B2	14.74	62%
Hiroshima	B2	5.07	73%
Yamaguchi	C	9.21	52%
Ibaraki	B2	17.87	46%
Gunma	B2	29.82	50%
Tochigi	B2	29.73	55%
Shizuoka	B1	8.97	63%
Mie	B2	32.32	43%
Aichi	B1	5.49	55%
Shiga	B2	196.58	57%
Tokyo	F	12.41	72%

Figure 11: Dendrogram based on prefectural clustering and indicators

5. Improving the Situation by Promoting Digitalization

As mentioned above, rural areas experience large outflow of population when people reach the age of entering higher education and employment. Since the inflow and outflow of population relate to primary components of a prefecture's economic strength, it is important to consider ways to curb outflow of population.

In regions where population are decreasing, a negative cycle is happening where depopulation leads to further depopulation (Figure 12). This problem could be solved by promoting digitalization (Figure 13).

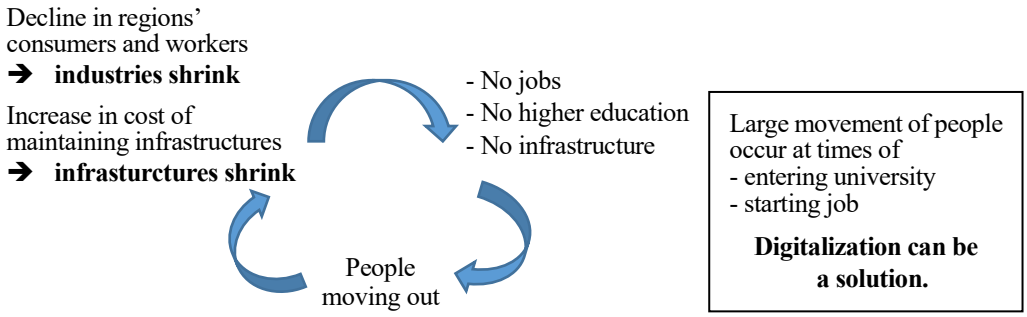


Figure 12: A negative cycle of declining population

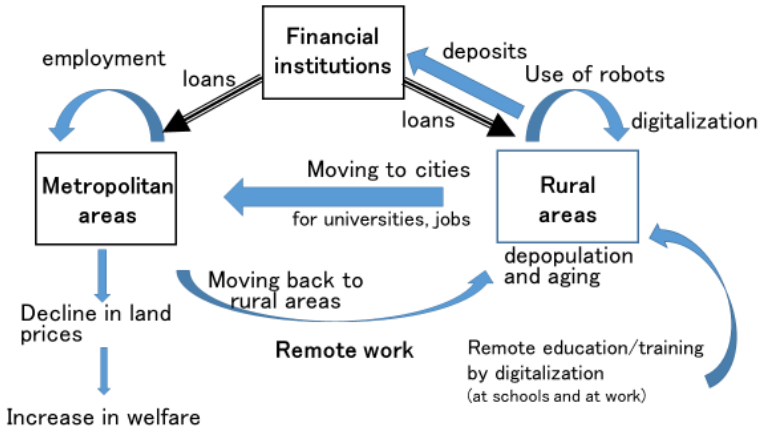


Figure 13: Solutions through promotion of digitalization

5.1 Digitalization of education

Promoting digitalization of education is an effective way to curb population outflow at the time people move to higher education.

First of all, for junior and senior high school education, if students can take class taught by top-level teachers in the region or the country, regardless of where they live, via on-demand access or online, this could eliminate educational disparity between regions and schools due to differences in the competence of teachers and educational environment such as the number of tutoring schools. By doing so, the quality of education can be secured in rural areas where educational resources are constrained due to declining

population, and younger generations with children can return or move to rural regions without worrying about educational disparity. This will create a good cycle for regional population growth. In addition, teachers at each school will be pressed for time less and will be able to prepare and give carefully planned class in person. Teaching can be provided by combining online and face-to-face method. Considering declining population in Japan in the future, it is crucial to create an environment where each child throughout the country can develop competency to the best of his/her ability without being constrained by where he/she grows up and the level of educational services available to them, thereby improving the country's human capital on the whole.

We looked how the situation is in terms of the environment necessary to realize digitalization of education (Figure 14). In elementary and junior high schools, every student in Japan now has access to a personal computer and/or tablet as such terminals had been rapidly installed due to the outbreak of Covid-19 pandemic. As of March 2022, the number of students per educational computer was 0.9, meaning there are more terminals than the number of students. As for internet connectivity, fast internet communication has been realized, with 98.8% of schools having established telecommunications lines with speeds of 30 Mbps or faster, and 95.2% with those of 100 Mbps or faster. At high schools, the situation varies from prefectures to prefectures in terms of available terminals (Figure 15). Installation of terminals is still midway, but every student will have one terminal by the end of fiscal 2024.

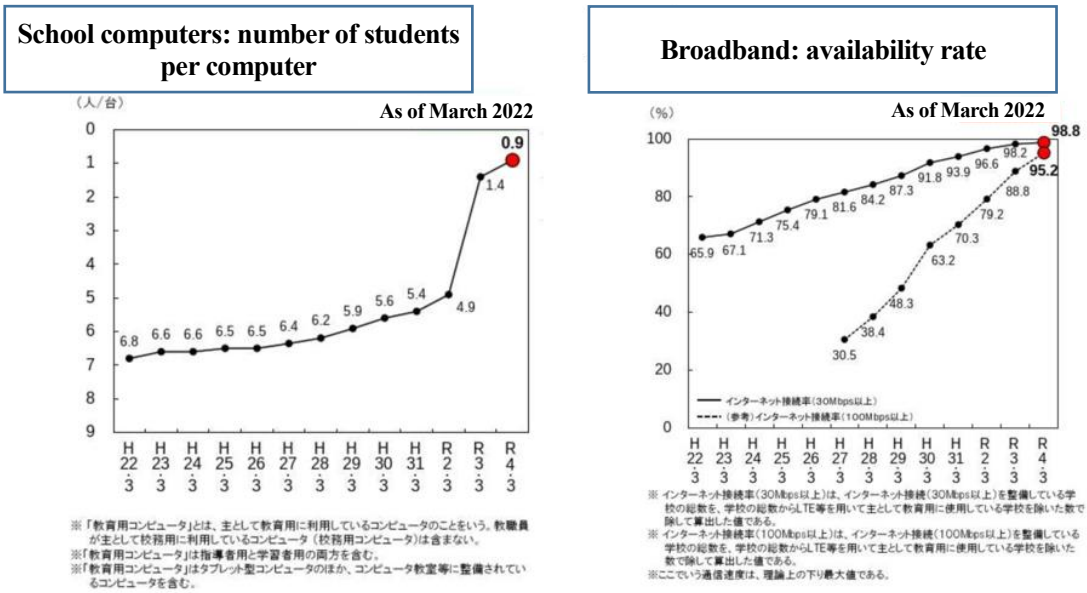


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Figure 14. Availability of computers/tablets and broadband access at elementary and junior high schools

(Source) Ministry of Education, Culture, Sports, Science and Technology, "2021 Survey Results on the use of information technology at schools (summary)" (available in Japanese only)

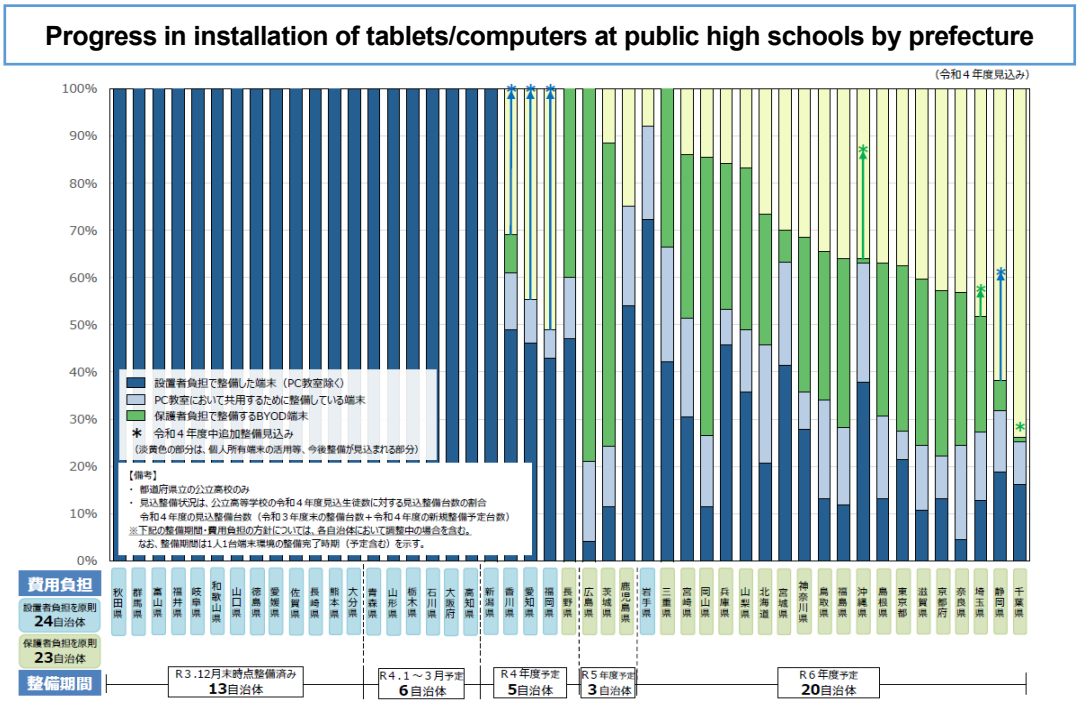

Figure 15: Availability of computers/tablets at public high schools

(Source) Ministry of Education, Culture, Sports, Science and Technology, "Computers for students at public senior high schools (estimate for FY 2022)"

Considering that internet access is essential for learning using computers at home, the level of optical fiber deployment rate, which indicates the availability of broadband access not only at schools but also in the communities, is an important indicator to follow. Although this rate is as high as 99.72% at the national level, there are regional differences due to the difficulty of deployment owing to factors such as landscape (Figure 16).

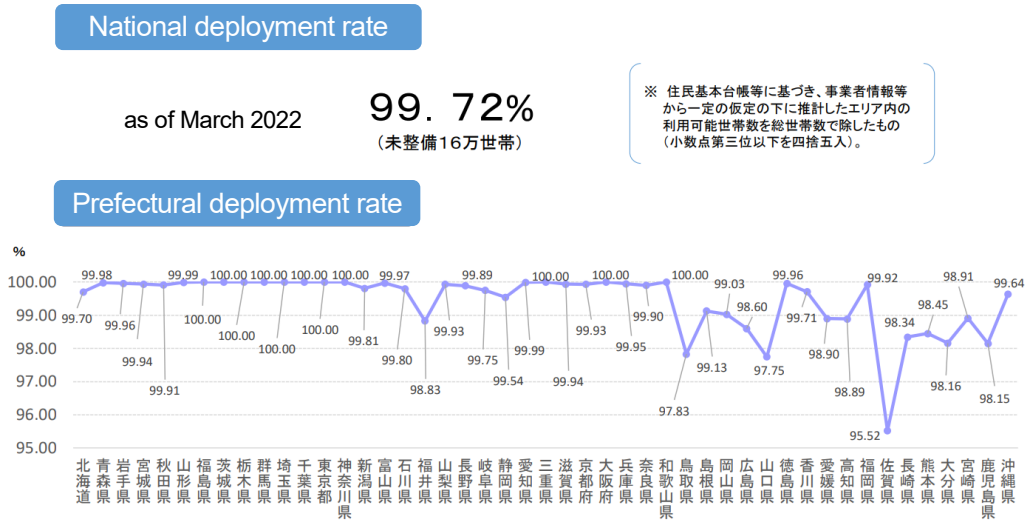

Figure 16: Optical fiber deployment rate of prefectures and the national level (as of the end-March 2022)

(Source) Results of the Ministry of Internal Affairs and Communications' survey on broadband infrastructure deployment rate at the end of fiscal 2021

Since it may take time and cost to install broadband to every corner of the country, it would be an idea to ensure broadband access at least at key locations such as community centers and libraries so that these locations function as study stations for children in the community.

As for education at universities, similarly, by promoting collaboration and partnerships between universities, students will be able to take classes of other universities remotely. This could improve the situation where students need to relocate to go to universities in metropolitan areas for education they want to pursue. Remote education can be a solution, but compared to education up to high school, learning at universities require in-person educational experience such as group discussion and individual or small-group study guidance, so more detailed planning of classes and courses is necessary. In this regard, universities and colleges across the country have experience and skill about remote education they had tried and implemented during the Covid-19 pandemic. Good examples should be taken up and shared by universities for effective implementation of remote education.

We need to take note that people move to metropolitan areas at time of advancing to universities, not only for academic reasons but also, or rather, for the pleasure of living there because metropolitan areas are appealing. From this viewpoint, it is difficult to control the population outflow at the time of entering higher education by means of digitalizing education only. What is important is to create an environment where those who have left for higher education return to their communities after they finished universities or colleges. To this end, we need to have more employment in rural areas.

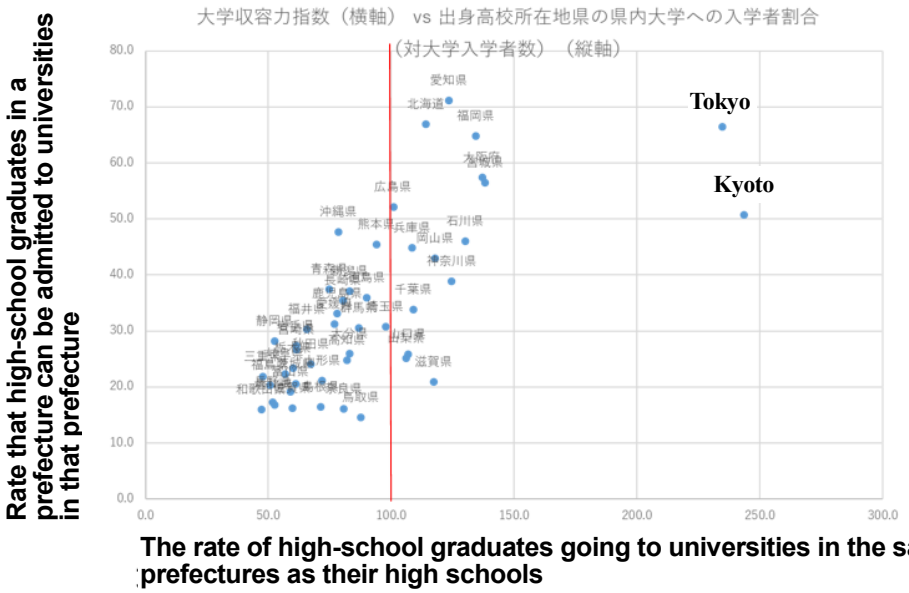

Figure 17: University Capacity and Prefectural High School Enrollment Rate

(Source) Compiled based on the "School Basic Survey," the Ministry of Education, Culture, Sports, Science and Technology.

When we look at "university enrollment capacity index," which is obtained by dividing admission capacity of universities in each prefecture by the number of high school graduates in the prefecture going on to universities (right axis in Figure 17), we find that indicators of many prefectures fall below 100; for example, Wakayama and Mie prefectures. This means that there is not enough admission capacity within a prefecture and that students have to move to other prefectures to go to universities.

The geographical distribution of students advancing to selected national universities is shown in Figure 18s, and comparing them reveals that Tohoku University has a large number of students from regions other than Tohoku, while Kyushu University has a large number of students from within Kyushu. It is necessary to be aware of these differences from the viewpoint of thriving the community.

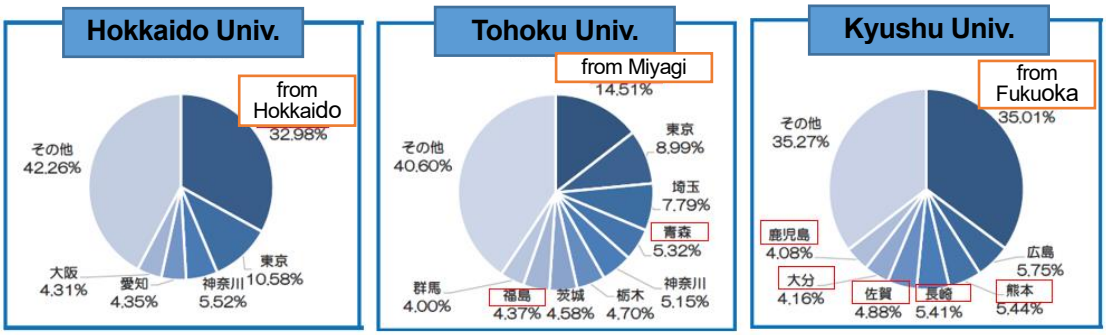

Figure 18: Percentage of university entrants by prefectures of students' high schools

(Source) "Basic information on Japan's national universities," The Japan Association of National Universities. March 29, 2021.

5.2 Digitalization of employment (promoting remote work)

In order to realize population inflow to rural areas, it is important to create jobs in rural areas. However, it is not easy to create jobs, all of a sudden. Therefore, the first step would be to create a category of people who work remotely for companies in metropolitan areas from rural areas.

People who have jobs in metropolitan areas are increasingly working remotely following the outbreak of the Covid-19 pandemic. In some industries, it has become possible for employees to commute only once a week and work from home for the rest of the week. In fact, remote work implementation rates have increased in the wake of the pandemic. A survey on remote work rate by companies in Tokyo (Figure 19) shows that, only 24% of firms had implemented remote work in March 2020, but it jumped to 51.6% in March 2023, and the rate remained 46.7% in April 2023, showing a significant increase. Also, regarding the number of days of remote work, 41.5% of them do it more than three days a week (Figure 20). This is higher than the national implementation rate of 22.7%.

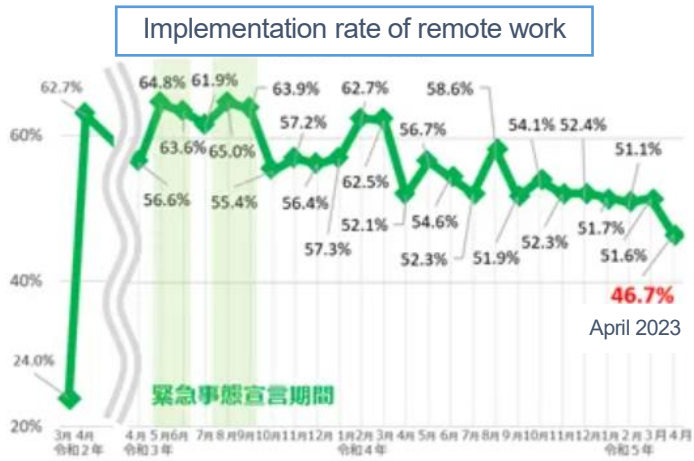

Figure 19: Trends in remote work implementation rate at enterprises in Tokyo

(Source) Bureau of Industrial and Labor Affairs, Tokyo Metropolitan Government, Telework Implementation Rate Survey Results April 2023.

Figure 20: Number of days remote work are implemented at companies in Tokyo

(Source) Bureau of Industrial and Labor Affairs, Tokyo Metropolitan Government, Telework Implementation Rate Survey Results April 2023.

Among those currently working remotely and who wish to relocate, 49.2% of them consider "working mainly from home" a preferred style of working after relocation (Figure 21). This suggests that there are strong preference for "relocation and remote working." In addition, some of the primary reasons for relocation (Figure 22) include "to live in spacious house" and "to hold down the cost of living," which can be motives for moving to rural areas.

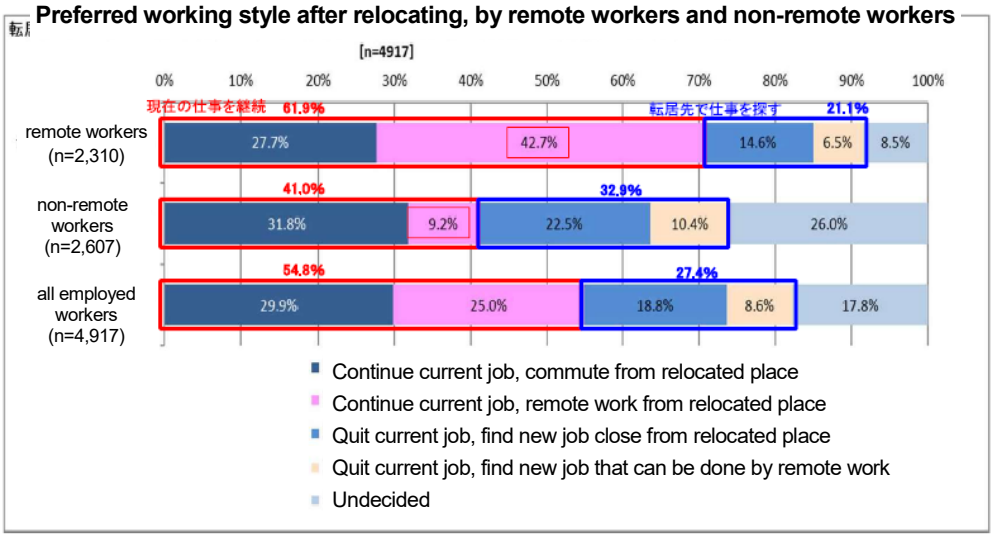

Figure 21: Preferred working style after relocating

Source: "2021 Telework Population Survey: Survey Results," Ministry of Land, Infrastructure, Transport and Tourism

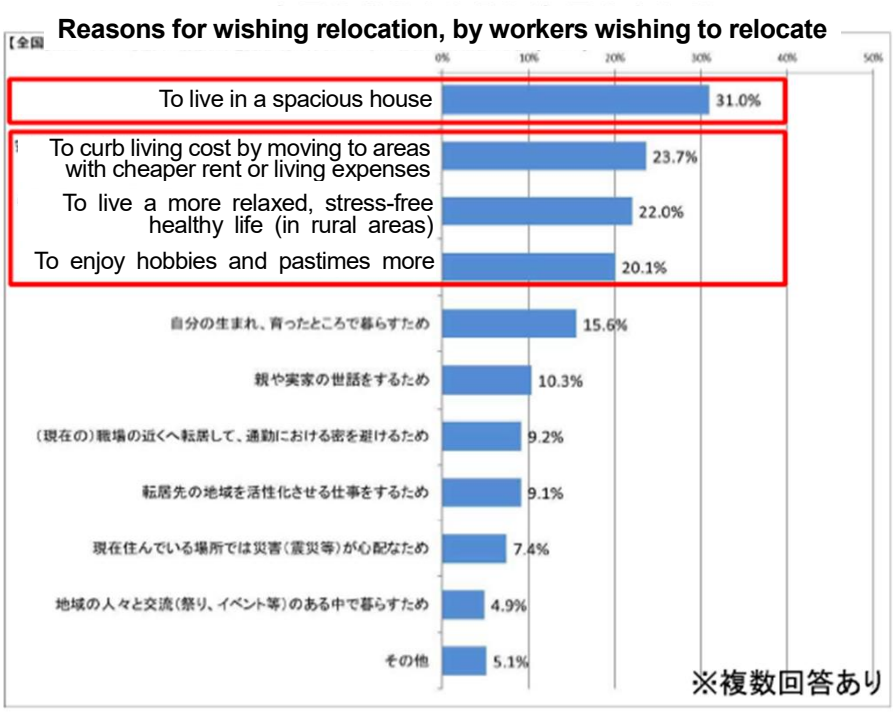

Figure 22: Reasons for relocation

Source: "2021 Telework Population Survey: Survey Results," Ministry of Land, Infrastructure, Transport and Tourism

The promotion of remote work would also be a great benefit for women's further participation in labor force. In Japan, the percentage of women in "non-participation in labor force who want to work" is higher than in other countries (Figure 23). The main reasons why such women do not want to work are (i)

job mismatch and (ii) childbirth, childcare and nursing care (Figure 24). Regarding (i) mismatch, if remote work enables job at distant companies, this could be eliminated. Regarding (ii) care giving, if more flexible working styles become possible through remote work, this would allow labor participation even for a very short time, and enable women to maintain connections with communities. Trends in the labor force participation rate by age group for men and women from 1970 to 2019 (Figure 25) shows that, the so-called "M-curve" in women's labor participation has been easing, but this trend can be further promoted.

The Covid-19 pandemic has led to developing systems that enable people to actively participate in communities while maintaining a work-life balance. This positive trend should not be hindered. If unnecessary face-to-face working arrangement is reduced and mechanisms to promote efficient labor participation are further implemented, it will be quite possible to increase the number of people living in rural areas.

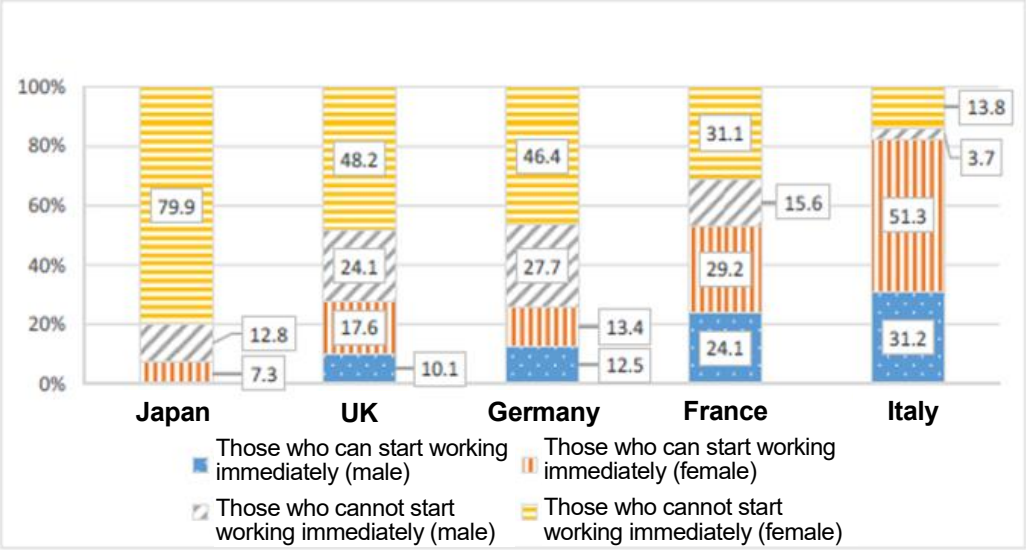

Figure 23: Breakdown of the non-labor force population wishing to work (aged 25 to 54)

(Source) Statistics Bureau, Ministry of Internal Affairs and Communications, "International Comparison of Underutilized Labor Indicators" (published on August 31, 2018)

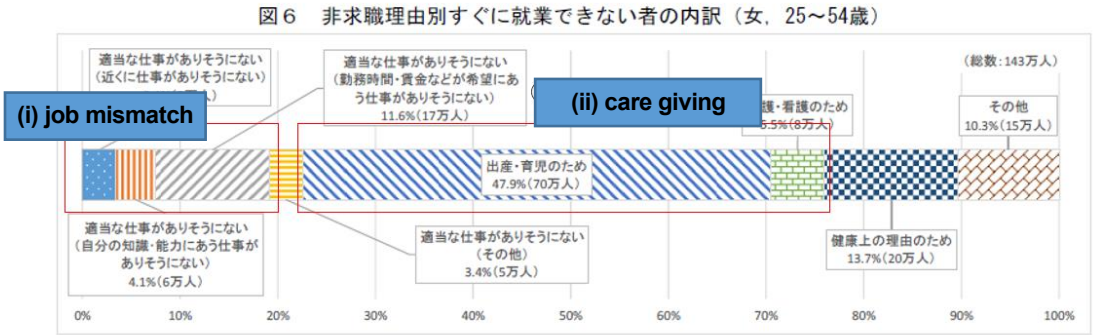

Figure 24: Reasons given by women who are unable to work immediately (aged 25−54 years)

(Source) Statistics Bureau, Ministry of Internal Affairs and Communications, "International Comparison of Underutilized Labor Indicators" (published on August 31, 2018)

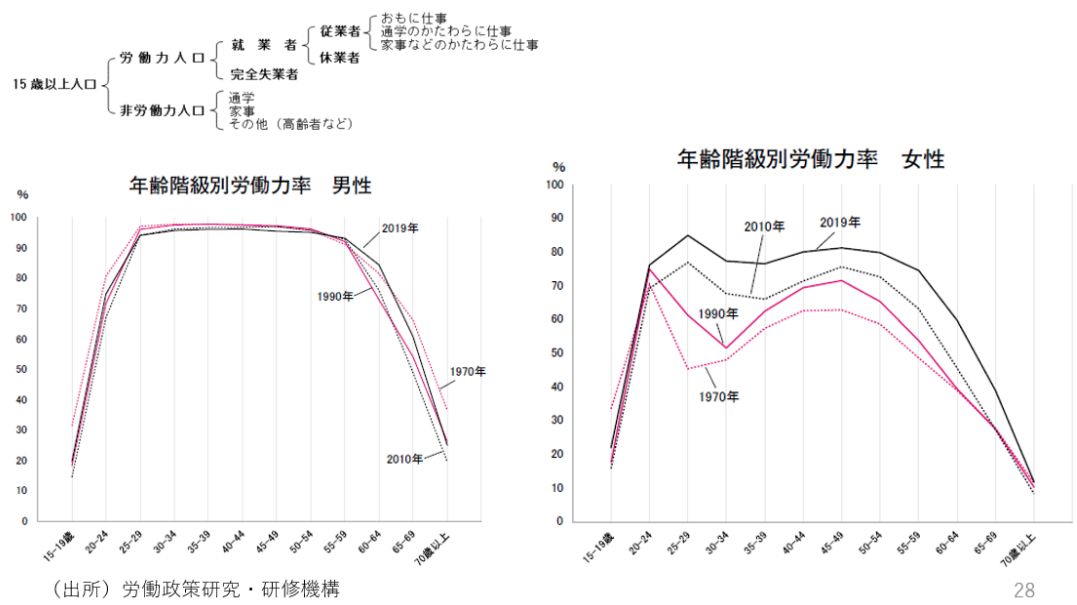

Figure 25: Labor force participation rates for men and women (1970-2019)

(Source) Japan Institute for Labour Policy and Training, *Business Labor Trends*, May 2020.

○職業別雇用者数の全体に占める割合（2021年）

Women are employed in office work, for which job offers are limited in rural areas.

	総数	管理的職業従事者	専門的・技術的職業従事者	**Office worker**	販売従事者	サービス職業従事者	保安職業従事者	農林漁業従事者	生産工程従事者	輸送・機械運転従事者	建設・採掘従事者	運搬・清掃・包装等従事者	分類不能の職業
Male	100	3	18	17	13	6	4	1	17	6	6	8	1
Female	100	1	21	**30**	13	18	0	1	9	0	0	7	1

Figure 26: Number of employees by occupation as a percentage of total employees (by gender)

(Source) Statistics Bureau, Ministry of Internal Affairs and Communications, "2021 Labour Force Survey Annual Report (basic tabulation)"

○2022年４月の「事務的職業」の求職、求人バランスの例

	job offers	job seekers	Ratio of jobs to seekers	Wage (min) JPY	Wage (max) JPY
Osaka	16,644	42,631	0.39	197,604	248,771
Kochi	666	1,308	0.51	163,162	205,647

Osaka offers more jobs, at higher wages.

Figure 27: Example of the balance between job offers and job applications for clerical work

Source: Osaka Labour Bureau, Kochi Labour Bureau, "job offers and job applications, wage information."

However, in promoting remote work, we need to note that there are differences in feasibility of implementation depending on the type of job. According to a survey by the Ministry of Land, Infrastructure, Transport and Tourism (Figure 28), remote work implementation rate for jobs such as research and professional/technical positions is close to 50% or more, whereas for sales positions, for example, it is only 4.7%. Looking at the reasons for not implementing remote work in the type of jobs with low remote work implementation rates (Figure 29), over 50% of respondents answered "job is not suited to remote work." When we look at the reasons why certain jobs are not suitable to remote work (Figure 30), the necessity of working onsite and in person accounts for large part (87.4%). This point is not easy to resolve.

In terms of the policy to promote remote work, for the time being, it would be realistic to increase further the remote work rate in jobs with high remote work rates.

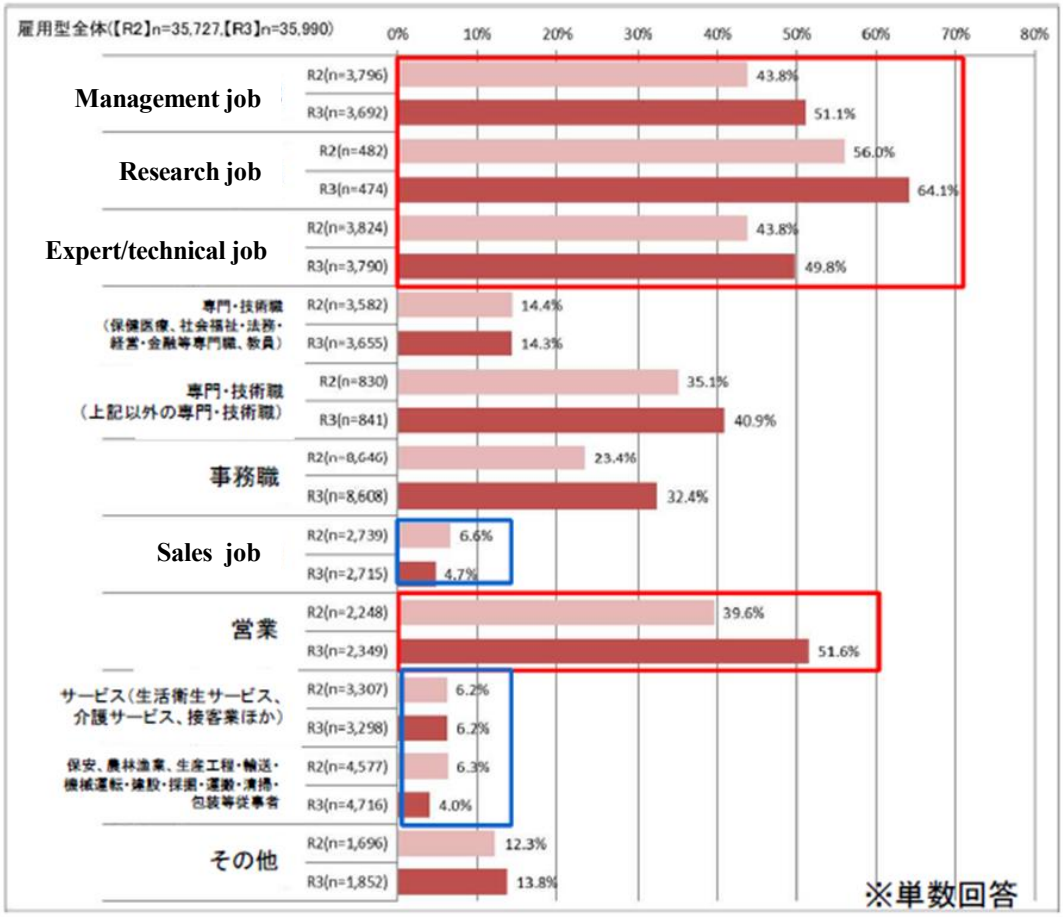

Figure 28: The rate of remote work by type of jobs

Source: "2021 Telework Population Survey: Survey Results," Ministry of Land, Infrastructure, Transport and Tourism.

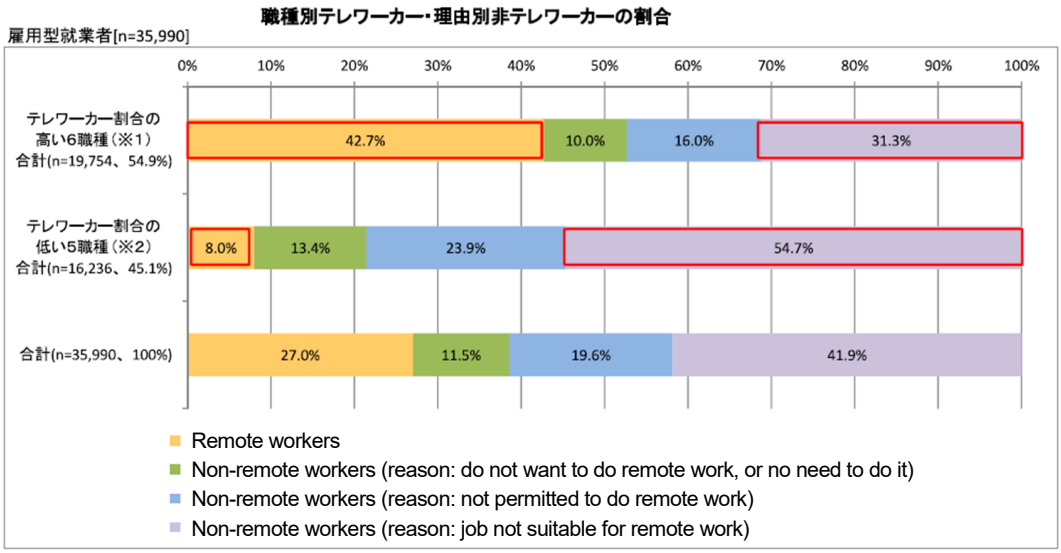

Figure 29: The rate of remote work and reasons for not doing remote work

Source: "2021 Telework Population Survey: Survey Results," Ministry of Land, Infrastructure, Transport and Tourism.

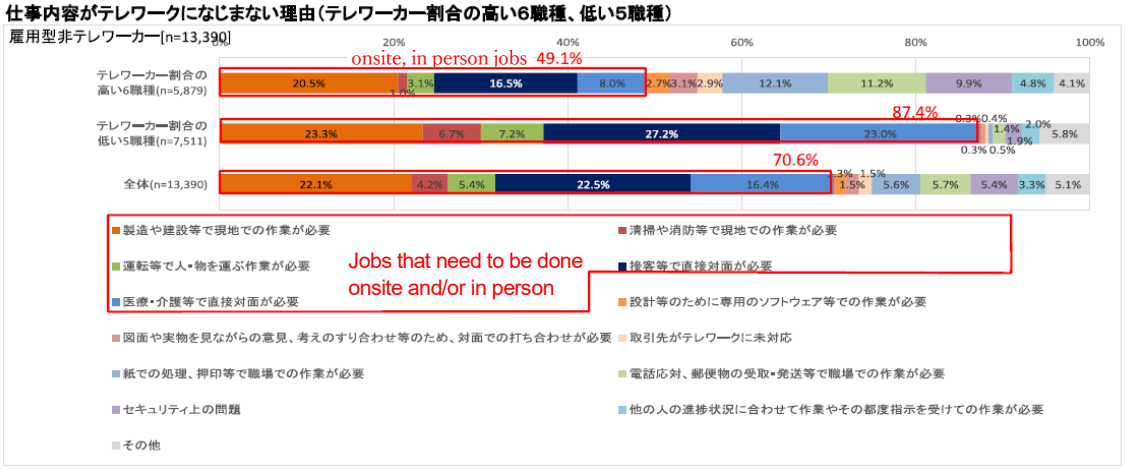

Figure 30: Reasons why jobs are not suited to remote work

Source: "2021 Telework Population Survey: Survey Results," Ministry of Land, Infrastructure, Transport and Tourism.

5.3 Maintaining financial functions as an infrastructure

As shown in Figure 31, depopulation and aging are in progress simultaneously in Japan. In regions where depopulation is progressing so rapidly, maintaining financial functions as the regions' infrastructure becomes so crucial. To this end, we need to promote digitalization of payment in a way that does not leave elderly people behind. In addition, in order to maintain the financial infrastructure, it might be an idea to operate automatic teller machines (ATMs) jointly with other non-financial sector by shared vehicles. Ultimately, such projects could be supported by public funds.

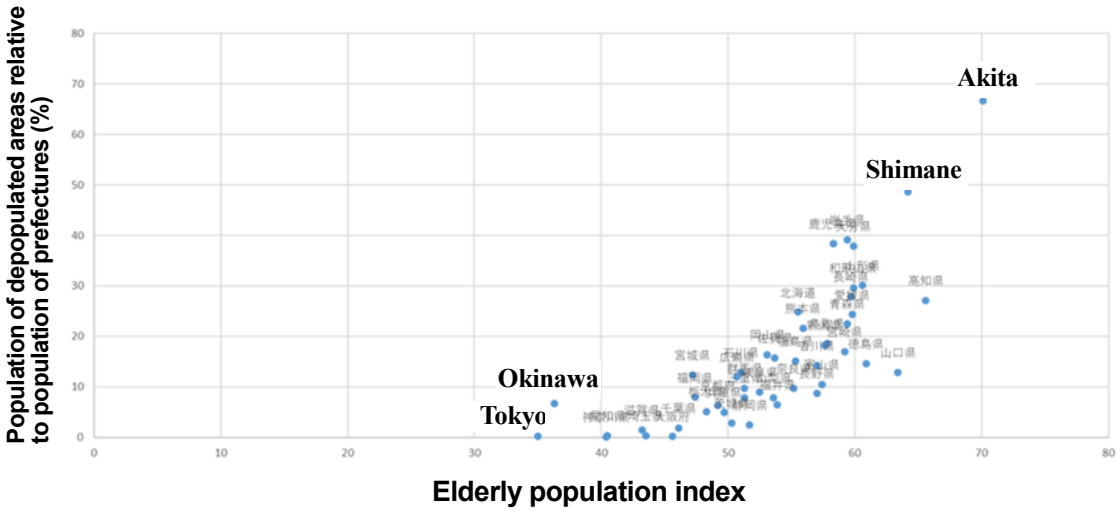

Figure 31: Depopulation and Aging

(Source) Compiled based on Demographic Statistics (2022), The National Institute of Population and Social Security Research.

6. Theoretical Model Classifying Prefectures into Three Categories

In this section, we conduct economic analysis by classifying 47 prefectures into three types and constructing economic models appropriate to the groups. The three types are as follows: (i) prefectures situated where residents can work remotely and occasionally commute to companies in metropolitan areas; (ii) prefectures that can foster unique industries distinctive from those in other prefectures taking advantage of geographical benefits, and (iii) prefectures where regional economy needs to be operated with public financial support due to depopulation and aging.

6.1 Prefectures where remote work is possible

Here, we explain the impact of remote education and remote work on the economy using production functions on urban and rural economies. Equation (1) represents a production function on urban areas (U = urban), and Equation (2) represents a production function on rural areas (R = rural). $\boldsymbol{L_{U1}}$ is the type of jobs that is done in urban areas but if remote work is possible, workers would want to work from rural areas. $\boldsymbol{L_{U2}}$ is the type of jobs that need to be done in person in urban areas and that do not allow remote work. $\boldsymbol{L_{R1}}$ is the type of jobs for which remote work in rural areas possible, and $\boldsymbol{L_{R2}}$ is one that only allows face-to-face work in rural areas.

$$\boldsymbol{Y_U(t_0) = K_U{}^{\alpha}(A_{U1}L_{U1})^{b}(A_{U2}L_{U2})^{c}} \quad \textbf{(1)}$$

$$\boldsymbol{Y_R(t_0) = K_R{}^{\alpha}(A_{R1}L_{R1})^{\beta}(A_{R2}L_{R2})^{\gamma}} \quad \textbf{(2)}$$

Where:

$\boldsymbol{Y_U}$: Urban output (t_0 as base year)
$\boldsymbol{Y_R}$: Rural production (t_0 as base year)
$\boldsymbol{K_U}$: Urban capital stock
$\boldsymbol{K_R}$: Rural capital stock
$\boldsymbol{L_{U1}}$: Workers in urban areas with jobs that can be performed remotely
$\boldsymbol{L_{U2}}$: Workers in urban areas with jobs that can only be performed in person
$\boldsymbol{L_{R1}}$: Workers in rural areas with jobs that can be performed remotely
$\boldsymbol{L_{R2}}$: Workers in rural areas with jobs that can only be performed in person
$\boldsymbol{A_{U1}}$: Quality of personnel in urban areas with jobs that can be performed remotely
$\boldsymbol{A_{U2}}$: Quality of personnel in urban areas with jobs that can only be performed in person
$\boldsymbol{A_{R1}}$: Quality of personnel in rural areas with jobs that can be performed remotely
$\boldsymbol{A_{R2}}$: Quality of personnel in rural areas with jobs that can only be performed in person
a, b, c, α, β, γ: coefficients of Cobb-Douglas production function

Aggregate consumption (= aggregate demand) in urban and rural areas is expressed as Equation (3) and (4). Consumption is expressed simply as a function of working hours, and we presume the type of workers based on the amount of wage income.

$$\boldsymbol{C_U(t_0) = C_U[L_{U1}(t_0), L_{U2}(t_0)]} \quad \textbf{(3)}$$

$$\boldsymbol{C_R(t_0) = C_R[L_{R1}(t_0), L_{R2}(t_0)]} \quad \textbf{(4)}$$

Equation (3) represents aggregate consumption (= aggregate demand) in urban areas, and we assume that it depends on the number of working hours by workers in urban areas with jobs that can be done remotely and on the number of working hours by workers in urban areas with jobs that can only be done in person. Equation (4) represents aggregate consumption (= aggregate demand) in rural areas, and likewise we assume that it depends on the number of hours worked by workers in rural areas with jobs that can be done remotely and those who can only work in person.

6.1.1. Economic model without remote work

The left side of Equation (5) represents the urban production function, and the right side represents urban aggregate consumption (= aggregate demand). We assume $\tilde{\boldsymbol{L}}_{\boldsymbol{R1}}$ as workers who have jobs in urban areas and work remotely living in rural areas, and commute once a week or so to urban areas. In the world where

there is no remote work, the right side of equation (5) means that $\tilde{L}_{R1}$ live and work in urban areas, so aggregate consumption in urban areas (= aggregate demand) depends on the working hours of workers who live in urban areas $L_{U1}(t_0) + \tilde{L}_{R1}(t_0)$ and on the working hours of workers who live in urban areas and work in jobs that do not allow remote work $L_{u2}(t_0)$.

$$Y_U(t_0) = \tilde{C}_U[L_{U1}(t_0) + \tilde{L}_{R1}(t_0), L_{u2}(t_0)] \quad (5)$$

The left side of Equation (6) is the aggregate production in rural areas $(Y_R(t_0))$. The right side of Equation (6) is aggregate consumption (= aggregate demand) in rural areas, and depends on the working hours of those who live in rural areas and have jobs that can be performed remotely $L_{R1}(t_0)$ and those who live in rural areas and work in jobs that can only be done in person $L_{R2}(t_0)$.

$$Y_R(t_0) = C_R[L_{R1}(t_0), L_{R2}(t_0)] \quad (6)$$

6.1.2 Economic model with remote work

When remote work becomes possible, $\tilde{L}_{R1}$ is the working hours of workers who live in rural areas and commute to urban areas around once a week. As shown in Equation (7), workers in the urban production function are $\{(L_{U1})(t_1) + \tilde{L}_{R1}(t_1)\}$, which includes workers who live in rural areas and participate in urban production, namely $\{\tilde{L}_{R1}(t_1)\}$.

$$Y_U(t_1) = K_U{}^{a}[A_{U1}\{(L_{U1})(t_1) + \tilde{L}_{R1}(t_1)\}]^{b}\,[(A_{U2}L_{U2}(t_1)]^{c} \quad (7)$$

The production function of rural areas is as shown in Equation (8), and we assume that it depends on the working hours of workers who live in rural areas and do jobs that can be performed remotely (L_{R1}) and of those who do jobs that cannot be done remotely (L_{R2}).

$$Y_R(t_1) = K_R{}^{\alpha}[(A_{R1}L_{R1})(t_1)]^{\beta}\,[(A_{R2}L_{R2}(t_1)]^{\gamma} \quad (8)$$

We assume that the aggregate production functions in Equations (7) and (8) are affected by the quality of human capital: (A_{U1}, A_{U2}, A_{R1}, A_{R1}).

Aggregate consumption (= aggregate demand) in urban areas after remote work has become possible is expressed as the sum of working hours of those who live in urban areas and can work remotely and those who can only work in person in urban areas, as shown in Equation (9). Aggregate consumption (= aggregate demand) in rural areas is expressed as Equation (10), and depends on the sum of working hours of workers who have been living in rural areas and of those who have moved from urban areas and

work remotely $[L_{R1}(\mathrm{t}_1) + \tilde{L}_{R1}(\mathrm{t}_1)]$ and the working hours of those who can only work in person in rural areas $L_{R2}(\mathrm{t}_1)$.

$$\tilde{\boldsymbol{C}}_{\boldsymbol{U}}(\mathbf{t_1}) = \tilde{\boldsymbol{C}}_{\boldsymbol{U}}[\boldsymbol{L}_{\boldsymbol{U1}}(\mathbf{t_1}), \boldsymbol{L}_{\boldsymbol{U2}}(\mathbf{t_1})] \quad \textbf{(9)}$$

$$\tilde{\boldsymbol{C}}_{\boldsymbol{R}}(\mathbf{t_1}) = \tilde{\boldsymbol{C}}_{\boldsymbol{R}}[\boldsymbol{L}_{\boldsymbol{R2}}(\mathbf{t_1}) + \tilde{\boldsymbol{L}}_{\boldsymbol{R1}}(\mathbf{t_1}), \boldsymbol{L}_{\boldsymbol{R1}}(\mathbf{t_1})] \quad \textbf{(10)}$$

When we compare aggregate supply $Y_U(\mathrm{t}_0)$ in urban areas and aggregate consumption in urban areas (= aggregate demand) $\tilde{C}_U[L_{U1}(\mathrm{t}_1), L_{U2}(\mathrm{t}_1)]$ after remote work has become possible, aggregate supply exceeds aggregate consumption. This is because aggregate consumption declines for the amount equivalent to working hours of workers who live in (or have moved to) rural areas and can work remotely $\tilde{L}_{R1}(\mathrm{t}_1)$, as shown in Equation (11).

$$\boldsymbol{Y}_{\boldsymbol{U}}(\mathbf{t_0}) > \tilde{\boldsymbol{C}}_{\boldsymbol{U}}[\boldsymbol{L}_{\boldsymbol{U1}}(\mathbf{t_1}), \boldsymbol{L}_{\boldsymbol{U2}}\ (\mathbf{t_1})] \quad \textbf{(11)}$$

On the other hand, in rural areas, aggregate consumption (= aggregate demand) increases more than the aggregate supply $Y_R(t_0)$ by the amount equivalent to the working hours of workers who have moved to rural areas from urban areas and work remotely $\tilde{L}_{R1}(t_1)$. Therefore, as shown in Equation (12), aggregate consumption on the right side exceeds aggregate supply on the left side.

$$\boldsymbol{Y}_{\boldsymbol{R}}(\boldsymbol{t_0}) < \tilde{\boldsymbol{C}}_{\boldsymbol{R}}[\boldsymbol{L}_{\boldsymbol{R1}}(\boldsymbol{t_1}) + \tilde{\boldsymbol{L}}_{\boldsymbol{R1}}(\boldsymbol{t_1}), \boldsymbol{L}_{\boldsymbol{R2}}(\boldsymbol{t_1})] \quad \textbf{(12)}$$

Hence, in urban areas, aggregate production exceeds aggregate consumption (= aggregate demand), and creates excess supply. As a result, prices in urban areas fall as shown in Equation (13). In rural areas, aggregate consumption (= aggregate demand) increases more than aggregate production, and so prices in rural areas rise as shown in Equation (14).

$$\frac{\boldsymbol{dP_U}}{\boldsymbol{d\mathrm{t}}} = \boldsymbol{\delta_U}[\tilde{\boldsymbol{C}}_{\boldsymbol{U}}(\boldsymbol{L_{U1}}, \boldsymbol{L_{U2}}) - \boldsymbol{Y_U}(\mathbf{t_0})] \quad \textbf{(13)}$$

$$\frac{\boldsymbol{dP_R}}{\boldsymbol{d\mathrm{t}}} = \boldsymbol{\delta_R}[\tilde{\boldsymbol{C}}_{\boldsymbol{R}}(\boldsymbol{L_{R1}} + \tilde{\boldsymbol{L}}_{\boldsymbol{R1}}, \boldsymbol{L_{U2}}) - \boldsymbol{Y_R}(\mathbf{t_0})] \quad \textbf{(14)}$$

δ_U and δ_R in Equations (13) and (14) represent the rate of price adjustment. To make adjustment for the excess supply in urban areas and the excess demand in rural areas, production in urban areas will decrease and production in rural areas will increase. $-\Delta Y_U$ in Equation (15) represents a decrease in production in rural areas and $+\Delta Y_R$ in Equation (16) represents an increase in production in rural areas. This continues until aggregate supply and aggregate demand in urban areas and rural areas balance as in Equations (15) and (16), respectively, and so production decreases in urban areas, while production increases in rural areas.

$$\boldsymbol{Y_U(t_1) = Y_U(t_0) - \Delta Y_U \quad = C_U[L_{U1}(t_1), L_{U2}(t_1)]} \tag{15}$$

$$\boldsymbol{Y_R(t_1) = Y_R(t_0) + \Delta Y_R = \tilde{C}_R[L_{R1}(t_1) + \tilde{L}_{R1}(t_1), L_{U2}(t_1)]} \tag{16}$$

With the prevalence of remote work for research jobs and other white-collar workers, the number of people who live in rural areas and working in urban companies are increasing. This could lead to an increase in production in rural areas and a decrease in production in urban areas. Here, we assume that prices of goods change gradually as shown in Equations (13) and (14).

However, one of the obstacles to working from home in rural areas is a concern about children's education and educational environment, and inability to have job training. If remote education is provided on a school basis and remote job training is achieved, people would be able to receive classes taught by skilled teachers for all the subjects regardless of where they live in Japan. Further, if remote training is provided for a wide range of job categories free of charge, 365 days a year, this would improve the quality of human capital represented by (A_{U1}, A_{U2}, A_{R1}, A_{R2}). These measures will enable both urban and rural areas to achieve output growth, which will help lower prices and promote economic growth.

This theoretical model shows that encouraging remote work and promoting remote education would increase Japan's output, marginal productivity of labor, and wages, thereby improve economic welfare.

Looking at the impact of remote work on savings, savings in rural areas will increase relative to urban areas as people move in from urban areas. Such an increase in savings will be channeled through local financial institutions to financing and capital activities in rural areas (K_R), and would fund those returning to rural areas to start new businesses, as well as existing firms in rural areas for capital investment to increase production to meet the growing local consumption. Deposits that have increased in rural areas owing to remote work would finance firms in rural areas through local financial institutions. Such an ideal circulation of funds plays a similarly important role as the flow of people to rural areas. In rural areas, population is aging and local financial institutions are downsizing their branches. As remote work enables people to return to rural areas, it has the potential to thrive rural areas in terms of the flow of funds too.

6.2 Prefectures with production structures distinctive from other prefectures owing to geographical benefits

$$Y_U = K_U{}^{a}(A_{U1}L_{U1})^{b}(A_{U2}L_{U2})^{c} \quad (17)$$

$$Y_R = K_R{}^{\alpha}(A_{R1}L_{R1})^{\beta}(A_{R2}L_{R2})^{\gamma} \quad (18)$$

Above equations show production functions of urban and rural areas. Here, if a local government implements policy measures taking advantage of its local features, say for example, building offshore power generation. This increases capital stock $K_R{}^{\alpha}$ in rural areas, and as indicated by Equations (19) and (20) below, higher output is achieved, employment opportunities in the region increase, local consumption increases (Equations (21) and (22)), and well-being in the region increases.

(1) construction of offshore power generation or other policy measures.

$$\frac{dY_R}{dK_R} > 0 \quad (19)$$

(2) creation of new jobs and consequent increase in Y

$$\frac{dY_R}{dL_{R1}} > 0,\ \frac{dY_R}{dL_{R2}} > 0 \quad (20)$$

(3) increase in consumption in rural areas

$$C_R = C_R[L_{R1}, L_{R2}] \quad (21)$$

$$\frac{dC_R}{dL_{R1}} > 0,\ \frac{dC_R}{dL_{R2}} > 0 \quad (22)$$

Therefore, well-being in rural areas is increased.

Regions in this category are those that can increase production and consumption in the regions and their economic well-being by creating industries unique to them.

6.3 Prefectures in need of public assistance due to depopulation and aging

The third category of prefectures is those that are, due to depopulation and aging, difficult to establish unique, distinctive industries, and those difficult to conduct remote work because they are physically distant from economically thriving areas. There exist regions that require services like trucks selling groceries and ATM trucks for cash withdrawal. In such regions, public assistance is indispensable to maintain the

minimum level of services in the communities. As shown in the following equation, in order to maintain the certain level of sales (economic activities), it is essential to maintain the consumption level of the residents and secure the sales amount by running a bus with public subsidies, selling food and providing financial services for the local residents. Local sales activities and levels of consumption can be maintained with public funds G, which is the amount of public assistance by the government.

$$Y_R = \text{Sales value}$$

$$Y_R = F_R\left(K_R, A_1\, L_{R1}, A_{R2} L_{R2}, G\uparrow\right)$$

$$\frac{\partial Y_R}{\partial G} > 0$$

$$C_R = C_R(Y_R)\; G\uparrow) = \quad C\;[L_{R1}, L_{R2}, G\uparrow]$$

$$\frac{\partial C_R}{\partial G} > 0$$

$$Y_R = F_R(K_R, A_1 L_{R1}, A_{R2} L_{R2}, G) \tag{23}$$

$$\mathrm{Y_R} = \textbf{Sales value}$$

$$\frac{\partial Y_R}{\partial G} > 0 \tag{24}$$

$$C_R = C_R(Y_R, G) \tag{25}$$

$$\frac{\partial C_R}{\partial G} > 0 \tag{26}$$

As we have seen in this section, we can categorize 47 prefectures in Japan into three groups.

7. Possible roles of regional financial institutions

7.1 Promoting corporate digitalization

Financial institutions can play a role in supporting firms' digitalization, including the development of remote work environment. To this end, financial institutions themselves need to promote their own digitalization. This would also be helpful in maintaining financial infrastructures in depopulated areas. Through financial institutions' support of local businesses by, for example, securing sales channels for local products, this could reduce bankruptcies and encourage growth, and also help to maintain or increase the number of local borrowers in the future.

7.2 Job creation

It is important for regional financial institutions to extend loans that will lead to job creation in the regions. For example, offshore wind power generation in Akita prefecture is a good example of lending to

businesses that bring out the unique quality of the region. In Aomori prefecture, Shinkansen is used for freight services conveying fresh vegetables and seafood speedily to metropolitan areas, boosting demand. It would be desirable for financial institutions to provide funds smoothly to encourage innovative initiatives.

In addition, in order to support venture firms to which normal loans are difficult to provide from a credit risk perspective, local financial institutions can provide funds to such firms with promising businesses in collaboration with crowdfunding services, raising funds from the private sector, and create a flow of funds to startups. Such initiatives are expected to help create jobs and thrive local firms. Furthermore, it is also desirable from a long-term perspective to support local firms to start operating businesses related to human resources management and accounting, so as to foster consulting companies that understand local customs and culture.

As shown in Figure 32, there are broadly two types of borrowers among those whose businesses are currently stagnant. One is companies who are stagnant temporarily, and the other is companies whose businesses are not expected recover due to structural reasons. For the former type of companies, when they encounter temporal slack in business, financial institutions should perform a consulting function and provide support to the management, not limited to financial assistance, thereby helping their business performance to recover. On the other hand, for the latter, financial institutions should consider proposing change of business to clients and providing loans to that end.

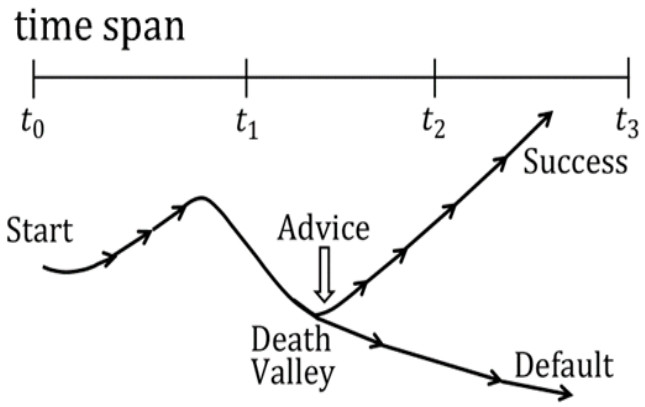

Figure 32: Two types of stagnant firms

References

Financial Services Agency (2022). "The role of regional finance for regional revitalization," SUM× Nikkei Forum for Regional Revitalization (February 2022, materials in Japanese for the event, https://www.fsa.go.jp/common/conference/danwa/20220316O2.pdf.

Ministry of Internal Affairs and Communications (2023). *Statistical Observations of Prefectures 2023*" (in Japanese).

Development Bank of Japan, DBJ Data Platform (National & Global Data, Regional Data) https://www.dbj.jp/investigate/dataplatform/ (in Japanese).

Naoyuki Yoshino, Hideki Nagai (2021). "Comparison of Japan-U.S. Real Estate and Housing Price Trends and Analysis of the Current Situation under the COVID-19 Pandemic" (in Japanese), *Housing and Land Economics*, Fall 2021, pp. 2-7.

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