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An Empirical Study on the Relationship of Regional Entrepreneurial Activities and Utilization of Digital Technology in Knowledge-Intensive Business Services (KIBS)

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An Empirical Study on the Relationship of Regional Entrepreneurial Activities and Utilization of Digital Technology in Knowledge-Intensive Business Services (KIBS)

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Abstract

This paper presents an analysis of factors that promote and suppress the regional start-up activities of knowledge-intensive business services (KIBS) in Japan, based on the Digital Capability Index (DCI). The results showed that rapid progress in the digitization of public services and local residents' high ICT skills were factors that promoted KIBS start-ups. In addition, the results revealed that the establishment of a high-speed information and communication environment in the region has promoted T-KIBS startups, which utilize the Internet. Regarding factors not included in the DCI, the results showed a positive effect of the concentration of human resources and business establishments in metropolitan areas, which was in line with the findings of previous studies. In contrast, the start-up rates of T-KIBS were high in areas where the ratios of day and night populations were low. This finding suggests that although the main customers of T-KIBS are companies in metropolitan areas, such as Tokyo and Osaka, they locate their offices in the suburbs, where commercial rents are lower than in urban areas.

Key words: Knowledge Intensive Business Services (KIBS), Digital Capability Index (DCI), start-up activity

JEL classifications: L26, L84, L86, R30

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1. Introduction

In Japan's industrial society, there have been fewer new start-up activities than in Western countries. In recent years, the business start-up rate in Japan has been around 5%, which is far below that in the United States and Europe. Although it was among the numerical targets proposed under the Abe administration, which aims to raise this rate to about 10% per year, it has not yet been achieved. Moreover, regarding regional situations in Japan, there are clear differences in business start-up rates between regions. In general, areas with high entrepreneurship rates have continued to be high, and areas with low rates continue to be low. This tendency has become even more prominent in recent years as the service economy has progressed.

In response to this situation, empirical research on entrepreneurial activities in Japan has accumulated in recent years, although it has been slightly less than in Europe and the United States. The aim of many previous empirical studies has been to clarify ways to improve the environment to promote business start-ups. However, only a few studies have been performed on knowledge-intensive business services (KIBS) as part of the recently developing service economy. Currently, about 40% of employees in KIBS-related industries are concentrated in Tokyo, which is 10% of the total service population of the country, indicating that the service economy, especially in the knowledge-intensive business service sector, is progressing mainly in the regions of Japan.

The realization of a multipolar, decentralized national land structure is an important issue in maintaining an "ecosystem" of sustainable economic activities in Japan and improving the quality of life of each citizen. In recent years, with the development of a high-speed, large-capacity information and communication infrastructure, businesses have gradually begun to relocate to rural areas. In addition, in the context of the coronavirus pandemic, new ways of working and remote business locations are becoming not only possibilities but also social demands. In the post-pandemic society, it is feasible that new trends in business activities will emerge, and so-called "digital capitalism" will be linked to regional revitalization. To promote this feasibility, a concrete plan is required regarding the kinds of elements that should be available in regions, especially rural areas.

This study aims to clarify factors that would promote and hinder the activity of start-ups in KIBS-related industries in each Japanese region. We introduce Digital Capability Indices (DCI) as important in determining such factors. DCIs are applied to evaluate a region's potential to improve quality of life by utilizing digital technology. In addition to several factors, such as regional economic vitality, characteristics of industrial agglomeration, and quantitative and qualitative endowments of regional labor forces, we utilized DCI to identify elements that support start-up activities. The purpose of this study is to clarify the effects of the availability of local digital technology on business start-up behavior in KIBS.

2. Previous research

Empirical research on the regional agglomeration of the business service industry, especially KIBS, has been paid increasing attention since 1990, triggered by the global relocation of production bases and structural changes in tertiary industries in developed countries. Castells (1989) and Keeble et al. (1991) published early studies in this field. Castells' (1989) study was based on the idea that a spatial structure is closely linked to the dominant social organizational structure, and a new social structure gives rise to a fundamentally new logic of spatial structure. Furthermore, the development of information and communication technology (ICT) and its infrastructure changes the flow of communication and creates a multifunctional and multifaceted spatial structure. Castells pointed out that it does not create an indiscriminate space but a hierarchical and functional structure, predicting that it would widen spatial and social disparities. Keeble et al. (1991) observed the agglomeration situation of management consultants and market research companies in the United Kingdom, finding that they were the cause of the disparity between north and south in the country.

Based on these early studies, empirical research on the accumulation of KIBS has been conducted in Europe and the United States in recent years. We categorize this research into the following four subcategories: 1) empirical research on the effects of the accumulation of companies and human resources in the region on the location and productivity of KIBS; 2) the effects of the accumulation of KIBS on innovation inside and outside the region; 3) analyses of the relationship between the location of manufacturing industries and KIBS agglomeration; and 4) analyses of the effects of the development status of ICT infrastructure on KIBS agglomeration.

Regarding the study of the effects of regional agglomeration on KIBS, their location factors, which tend to be more concentrated in large cities than in other industries, have been analyzed from various perspectives. Rubiera-Morollon et al. (2005) compared the efficiencies of KIBS in urban and remote areas, finding inefficiencies in remote areas. Deza and López (2014) analyzed the status of KIBS agglomeration throughout Europe and found that KIBS tended to agglomerate in areas where, except for capital cities and their suburbs, per capita GDP was high, the population was large, research and development (R&D) concentration was high, and multiple transportation access conveniences were high. Skytt-Larsen and Winther (2015) identified that KIBS companies maintained their productivity by concentrating in urban areas that included formal and informal social networks, even if customers were located outside the region. Meliciani and Savona (2015) analyzed the determinants of KIBS agglomeration in the European Union (EU) and found that they included the economics of urbanization, the regional structure of interim transactions, and innovations centered in the ICT field. They rejected the hypothesis that KIBS are industries that can be located anywhere and showed that they would strengthen center–periphery heterogeneity. Wyszkowska-Kuna (2017) argued that the export competitiveness of KIBS is governed by the endowment of human capital, the concentration of KIBS in each country's economy, and fair labor costs.

The effects of KIBS on the regional growth and innovation of industries have also been analyzed. Among these studies, KIBS was found to act as a catalyst for innovation and business development. Aslesen (2004) analyzed the role of Norwegian consultants in the development of the local economy. This study found that KIBS injected new professional and technical expertise into client companies and that retaining clients in a geographical spread was the source of KIBS' function as a mechanism for connecting regional innovation systems in domestic and international innovation. Simmie and Strambach (2006) compared and analyzed the regional agglomeration of KIBS in the United Kingdom and Germany, demonstrating that the urban economy formed a path-dependent mutual learning system that developed independently. Their findings also showed that KIBS played a key role in transporting non-standardized knowledge between businesses within and between regions. Shearmur and Doloreux (2009) analyzed a situation in Canada to determine whether location influenced KIBS innovation trends. Contrary to the conventional image, they found that regarding KIBS in general, innovation became more active as the distance from central businee district (CBD) increased. In a recent study, Brunow et al. (2020) analyzed the innovation performances of KIBS and their relation to their size and distance from cities, finding significant distance-decay and city-size effects.

As described above, KIBS comprise an industry with a particularly strong tendency to be centered in large cities. It has been pointed out that this tendency has exacerbated the uneven development of regional economies. Based on this premise, research has been conducted on the possibility that KIBS contribute to the development of multipolar decentralized regions through collaboration with other industries, especially the manufacturing industry. Meliciani and Savona (2015) showed that KIBS were not only concentrated in metropolitan areas but also in high-tech manufacturing locations. In addition, Muller and Zenker (2001) focused on the interaction between SMEs and KIBS. They found that KIBS provided customer-specific solutions and expanded their own knowledge base by exchanging information with clients. Antonietti and Cainelli (2007) analyzed the major factors in the outsourcing of manufacturing companies to KIBS in Italy and found positive correlations with corporate size, ICT investment, and R&D investment. Wyrwich (2019) analyzed the effects of the location of the manufacturing industry on the location of KIBS in Germany and found that in the former East Germany region, where KIBS did not exist in the past, the location of the manufacturing industry triggered the location of KIBS. However, the phenomenon was not found in the former region of West Germany, where KIBS companies had already been established.

Research has also been conducted on the effects of KIBS on the performance of the manufacturing industry. Bengtsson and Dabhilkar (2009) analyzed changes in the innovation capacity of the assembling and processing manufacturing industry in Sweden according to the effects of outsourcing. They found that companies that outsourced design and production separately performed worse than companies that did both endogenously or companies that outsourced both of them. They pointed out that the proximity of interrelated processes was an important factor in improving performance. Shearmur and Doloreaux (2013) investigated the relationship between KIBS utilization and innovation in the Canadian manufacturing industry and found that KIBS contributed to innovation within client companies and that companies who utilized various KIBS were more innovative. Similar trends have been observed in developing countries. Arnold et al. (2016) conducted an empirical analysis of productivity in the manufacturing and services sectors of India, finding that policy reforms in the banking, telecommunications, insurance, and transportation sectors significantly increased the productivity of manufacturing companies.

To investigate the excessive disparities in industrial agglomeration, research has also been conducted on the effect of improving regional ICT environments. Sokol et al. (2008) analyzed the Dublin metropolitan area to validate an argument proposed by Castell (1989). They showed that the concentration of decision-making functions and the decentralization of each function did not occur at the same time, but there was a stronger tendency to concentrate to capital cities in Ireland. Mack and Rey (2014) analyzed the relationship between broadband development status and the agglomeration of knowledge-intensive industries in metropolitan areas of the United States, finding that the development of broadband affected the agglomeration of knowledge-intensive companies. Tranos and Mack (2016) used the Granger causality test to determine whether the broadband Internet environment in the United States was an incentive for KIBS locations, demonstrating that the government's investment in Internet infrastructure in the early stages had played a role in attracting KIBS to several regions.

Next, we will provide an overview of previous research on the establishment of new KIBS in regions. Andersson and Hellerstedt (2009) analyzed the effects of regional characteristics in Sweden on KIBS entrepreneurial efforts. They found that start-up activities in KIBS were stimulated in regions where there were both large markets and resources suitable for creating and disseminating new ideas. Jacobs et al. (2016) analyzed the effects of the location of multinational companies on KIBS start-ups and found that many successful KIBS founders had experience working in multinational companies in the same industry. They also found that customers were the most important source of information for KIBS entrepreneurs, and they rarely utilized universities as information sources. Lafuente et al. (2017) that in Spain, KIBS start-ups and new manufacturers were linked by the activities of existing manufacturers, and these linkages created virtuous cycles. Horváth and Rabetino (2019) analyzed the effects of manufacturing characteristics (specialization and scale) in each region of Europe on the rate of new establishments of KIBS. Their findings showed that the entrepreneurial ecosystem in regions with stable industrial structures played an important role in increasing the rates of KIBS start-ups, while the existence of attractive neighbors had negative effects.

Based on this review of the literature, the following points were recognized as common trends in the location and agglomeration of KIBS:

1. There has been a strong tendency to concentrate on metropolitan areas, especially the capital.
2. The knowledge and expertise gained from past work experience and human networks have been major determinants in choosing a place to start a business.
3. There has been a virtuous cycle involving the accumulation of KIBS and the location and productivity of the manufacturing industry.
4. The development of ICT infrastructure, such as broadband Internet connections, has affected the concentration of knowledge-intensive industries.

There is no doubt that a large city with a large market and abundant supply of highly skilled human resources is the most important incentive for the entrepreneurship and agglomeration of KIBS.

However, it has also been suggested that the location of the manufacturing industry, which is sometimes outside the metropolitan area, and the development of ICT infrastructure may negatively affect the attraction of KIBS to rural areas.

3. Analytical method and model

3.1 KIBS industries

Previous studies have provided various definitions of KIBS. In the present study, although we referred to previous research, we identified KIBS industries based on the following two criteria:

1. Industries in which more than two-thirds of income was derived from companies, organizations, and government offices (not individuals), which were recorded in the Economic Census Activity Survey (2016).
2. Industries with a high proportion of employees engaged in highly specialized occupations, namely, occupation B professional and technical workers, which were recorded in the Census (2015).

Table 1 shows the KIBS industries examined in this study. Among them are industries that provide services by making full use of ICT and industries that provide services utilizing specialized knowledge and expertise. We identified the former as technical KIBS (T-KIBS) and the latter as professional KIBS (P-KIBS). We conducted a separate analysis of factors in regional business start-up rates.

Table 1. KIBS Industries Examined in This Study

Classification		Code	Industry	Professional workers(%)[b]	Sales ratio to businesses (%)
KIBS	T-KIBS	391	Computer Programming and Other Software Services	72.2	91.6
		392	Data Processing and Information Services	31.8	98
		401	Services Incidental to Internet	50.2	76.7
	P-KIBS	711	Research Institutes for Natural Sciences [a]	56.5	95.9
		712	Research Institutes for Humanities and Social Sciences [a]		
		724	Certified Public Accountants ' and Certified Tax Accountants' Offices	39.9	81.7
		726	Design Services	77.7	94.8
		731	Advertising	41.8	93.8
		742	Engineering and Architectural Services	14.9	98.1
		743	Mechanical Design Services	47.9	93.1
		744	Commodity Inspection and Non-Destructive Testing Services	11.3	99.4
		912	Worker Dispatching Services	8.9	98.5

(a) Data from 711 Research Institute for Natural Sciences and 712 Research Institute for Humanities and Social Sciences are integrated, as in 71 Academic and Development Research Institutions in the 2015 National Census.

(b) The average ratio of professional workers in all industries was 7.27%.

Table 2. Definitions of T-KIBS and P-KIBS Used in This Study

Classification	Definition
T-KIBS	Abbreviation of technical KIBS. KIBS that utilize information- and communication-related technologies and expertise
P-KIBS	Abbreviation of professional KIBS. KIBS that provide services based on specialized knowledge and expertise

3.2 Calculation of KIBS start-up rates by prefecture

In this study, the dependent variable was the average annual start-up rate of KIBS by prefecture from 2016–2019. Specifically, we calculated the ratio of new establishments to the number of establishments in the first year and determined the annual average. It should be noted that the definition of new establishments was broader than in the previous survey, as the "corporate number" was used in the 2019 Economic Census Basic Survey. Moreover, some newly identified establishments were not captured in the previous survey even though they existed in 2016. The following formula shows the start-up rates of KIBS in each prefecture.

$$SR_i = \sqrt[3]{\frac{NKIBS_i}{IKIBS_i} + 1} - 1$$

where SR_i is the start-up rate of KIBS in each prefecture, $NKIBS_i$ is the number of KIBS establishments newly identified in each prefecture during the study period (2016-2019), and $IKIBS_i$ indicates the number of KIBS establishments in each prefecture in the first year of the study period (2016).

3.3 Calculation of Digital Capability Index (DCI)

As discussed in the introduction, one of the main aims of this research was to clarify the effects of the possibility of utilizing local digital technology on the start-up activities of KIBS. To measure these effects, we utilized the Digital Capability Index (DCI). A DCI score is an indicator of "the potential of citizens to utilize digital technology to achieve a better life." This indicator is based on the Digital Economy and Society Index (DESI), which the European Commission (EU) prepares and publishes for member countries every year. DESI ranks the digital degree of member countries from 0 to 100 according to five perspectives: connectivity, human capital, Internet use, digital technology utilization, and digital public services. Based on the DESI, the DCI was created by the Nomura Research Institute, Ltd., focusing on citizens' utilization of digital technology to index the progress of digitalization in each prefecture in Japan. This index consists of the four components shown in Table 3.

Table 3. DCI Components

Components	Definition	Indicators
Network Utilization	An index showing the extent to which local residents use various Internet services, such as sending and receiving e-mails, online shopping, and watching free videos.	21 items such as Internet usage frequency, SNS user ratio, Email, online banking, Internet shopping and free video viewing, etc.
Digital Public Services	Indicators of the online status of various public services and the use of those services by citizens.	18 items such as online administrative procedures, shared use and optimization of inter-municipal systems, information security, business contingency plan and citizens' use of various digital public services, etc.
Connectivity	An index showing the diffusion status of infrastructure such as broadband, and the household ownership and diffusion status of ICT terminals.	10 items such as household ownership rate of smartphones, tablets, and PCs, owning an ICT terminal that one can freely use, optical fiber communication and regional broadband wireless access penetration rate, etc.
Human Resource	An index showing the extent to which local residents have ICT skills	15 items such as number of people who passed the information processing test (per prefectural population), citizen's basic ICT skills and number of PCs per students, etc.

We utilized various information sources to obtain these indicators. Some indicators were statistics published by government agencies, but several items were difficult to obtain from public sources. For this reason, we used data from the Consumer Questionnaire on Daily Life, which was conducted by the Nomura Research Institute, to survey citizens nationwide. Questionnaires are conducted irregularly, but the prefecture-specific DCI scores used in this study were based on data collected in a questionnaire survey that was conducted online in July 2020. In each prefecture, the number of samples was 200, ranging from respondents in their teens to those in their 60s. The data were collated according to the gender and generation in each region. Regarding the responses, there was a slight bias in the age group. All respondents were Internet users, but there was almost no bias between regions. Therefore, we think that objectivity could be guaranteed in terms of relative evaluations between regions.

Next, we will describe the calculation method used in the DCI. The index is based on the Consumer Questionnaire on Daily Life, which is frequently used to calculate each item on the DCI. The method has many points in common with the European Commission's DESI estimation method.[1]

(1) Calculate the average value and standard deviation from the response rate for each prefecture to the question item.

[1] See the European Commission (2019) for DESI estimation procedures.

$$average_a = \sum_{i=1}^{47} rate_{i,a}/47$$

$$SD_a = \sqrt{\frac{1}{47}\sum_{i=1}^{47}(rate_{i,a} - average_a)^2}$$

where $average_a$ is the average value of the response ratio of each prefecture to question a, $rate_{i,a}$ is the response ratio of each prefecture to question a, and SD_a is standard deviation of the response ratio to question a.

(2) Calculate the maximum value (Max_a) and minimum value (Min_a) on the setting.

As shown in the formula below, the maximum and minimum values for each prefecture were set at an average value of ± 3 standard deviations. If the minimum setting value was less than zero, $Min_a =$ 0.

$$Max_a = Average_a + 3SD_a \qquad Min_a = Average_a - 3SD_a$$

(3) The original data on each prefecture were indexed at the minimum value of 0 and the maximum value of 100.

$$DCI_{i,a} = \frac{rate_{i,a} - Min_a}{Max_a - Min_a} \times 100$$

where $DCI_{i,a}$ is DCI score of each prefecture on question a.

We set the average value of each item at 50, normalized the standard deviation at 16.7, and calculated the DCI for each item in each prefecture. The prefecture closest to the maximum in the setting took a value closest to 100, and the prefecture closest to the minimum took a value closest to 0.

(4) Aggregation by four components.

The DCI of the individual items calculated above was aggregated for each of the four components. For example, in the case of DCI related to Internet use, a simple average value for each prefecture was calculated from the 21 items:

$$DCI_{i,util} = \frac{\sum_{a=1}^{21} DCI_{i,a}}{21} \quad DCI_{i,public} = \frac{\sum_{a=22}^{39} DCI_{i,a}}{18} \quad DCI_{i,connect} = \frac{\sum_{a=40}^{49} DCI_{i,a}}{10} \quad DCI_{i,human} = \frac{\sum_{a=50}^{64} DCI_{i,a}}{15}$$

where $DCI_{i,util}$ is the DCI (network utilization), $DCI_{i,public}$ is DCI (digital public services), $DCI_{i,connect}$ represents DCI (connectivity), and $DCI_{i,human}$ represents DCI (human capital) in each prefecture[2].

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[2] The importance of all items was assumed to be the same at this time, which is shown in the simple averaging of the constituent items for each item.

3.4 Hypotheses regarding DCI

In this study, we hypothesized that a high DCI score level was a factor that promoted the start-up activities of KIBS in the region. Therefore, the following sub-hypotheses are stated:

H0-1: The more actively that local residents use the Internet service, the more KIBS start-up activities will be promoted (DCI (Network Utilization): +).

H0-2: The more digitalization of local public services and their use by residents, the more KIBS start-ups will be promoted (DCI (Digital Public Service): +).

H0-3: The more that the local high-speed, large-capacity ICT environment is set up and its utilization progresses, the more that KIBS start-ups will be promoted (DCI (Connectivity): +).

H0-4: Higher ICT skills of the local residents promote higher KIBS start-up activity (DCI (Human Resources) : +).

3.5 Setting and calculation of other explanatory variables

Several factors were considered to affect the start-up of KIBS in each region, and they were not only defined by DCI. However, it was impossible to include all the many possible factors in the model. Therefore, referring to previous research, we set and calculated explanatory variables that were thought to affect the start-up activity of KIBS.

1) Population factors

(1) Day to night population ratio

Previous research has shown that KIBS tend to be more prominent in metropolitan areas, especially in central business districts (CBD), than in the traditional service industry. In areas with a large population, such as the Tokyo metropolitan area and the Kansai area, many people commute to work in the CBD, and their employment and residences are in different prefectures. If there is a movement to live in the suburbs and run KIBS-related businesses in CBDs, there may be a tendency toward many KIBS start-ups in areas where the ratios of day to night populations are high.

In recent years, broadband information and communication environments, such as optical fiber networks and Wi-Fi, have improved nationwide, and business models that utilize ICT networks have been expanding. Previous studies have also shown that KIBS tend to be located in areas where the ICT environment is better (Mack and Rey, 2014; Tranos and Mack, 2016). In Japan, there are cases in which businesses are operated in small offices or homes in the suburbs by utilizing the ICT environment. If such movements can be observed as a quantitative trend, there is a possibility that the day/night population ratio would be negative and significant.

In this study, we aimed to determine, which tendency, the strength of the CBD or the trend toward suburbanization, was the strongest.

H1-1: In areas with a high day / night population ratio, KIBS start-up activity is promoted. (day / night population ratio: +)

H1-2: Reflecting the tendency of KIBS start-ups to locate in the suburbs of metropolitan areas, their activities are promoted in areas with a low day / night population ratio.
(day / night population ratio: -)

(2) Average age

T-KIBS provide many services that make full use of ICT technology and require cutting-edge skills in and knowledge of using the latest technology. Moreover, P-KIBS include many businesses in which specialized knowledge and work experience are indispensable. Therefore, in this study, we adopted the average age of each prefecture as a proxy variable for the length of work experience (or the ability to absorb cutting-edge knowledge) of its workers, and we examined its effects on the rate of KIBS start-ups.

H1-3: Start-up activities in KIBS are promoted in areas where the average age of local residents is low. (Average age: -)

H1-4: Start-up activities in KIBS are promoted in areas where the average age of local residents is high. (Average age: +)

2) Economic vitality factors

(1) Office density

Proximity to customers and subcontractors is a favorable business environment for KIBS operators because it increases business opportunities and allows them to specialize in their area of expertise. Therefore, the existence of many business establishments in proximity is expected to serve as a good environment for KIBS. In this analysis, we calculated the number of business establishments per 1 km^2 as the office density, and we assessed the effects of that number on the KIBS start-ups.

H2-1: KIBS start-up activities are promoted in areas where the office density is high.
(Business office density: +)

(2) Gross regional product increase rate

Because KIBS companies provide services for business establishments, it is expected that the demand for them is higher in areas where industrial activities are vigorous. Unlike traditional service industries (especially those for individuals), they can provide services to a wide area, so their business environment may not be affected by the vitality of the local economy. In this study, we adopted the gross regional product increase rate as an explanatory variable to analyze the effects of regional economic vitality.

H2-2: KIBS start-ups are promoted in areas where the gross regional product increase rate is high. (Gross regional product increase rate: +)

3) Human resources

Because KIBS companies provide services based on specialized knowledge and skills, the abundance of highly qualified human resources could be a factor that promotes start-up activities in such companies. In this study, we adopted two indices as proxy variables to measure the qualitative aspect of the labor force.

(1) University enrollment / high school graduate ratio

Universities, especially large-scale private universities, are concentrated in metropolitan areas such as the Tokyo metropolitan area and the Kinki (Osaka and Kyoto) area. Because of this distribution of higher education institutions, many students in Japan leave their hometowns when they graduate from high school and move to an area where universities are located. To examine the effects of the uneven regional distribution of university students on the trend toward KIBS start-ups, as an explanatory variable, we adopted the ratio of the number of university enrollments to high school graduates in each prefecture.

H3-1: In areas where the ratio of university enrollment to high school graduates is high, the rate of KIBS start-ups is promoted. (University enrollment / high school graduate ratio: +)

(2) University graduate ratio

Population influx in the metropolitan area and outflow from rural areas are particularly prevalent in young adults from the late teens to the early 20s. Many move to a metropolitan area when they go to university or begin employment. In contrast, in rural areas, some population inflow trends occur in and after middle age because of UJI turns and other reasons. Therefore, the university graduate ratio, which indicates the qualitative stock of the labor force of all generations, tends to be slightly different from the above-mentioned university enrollment / high school graduate ratio. To examine the effects of this difference on KIBS start-ups, we adopted the ratio of university graduates to the population as an explanatory variable.

H3-2: In areas where university graduates account for a large percentage of the population, the rate of KIBS start-up is promoted. (University graduate ratio: +)

4) Employment environment

The effects of abundant regional employment opportunities on new start-ups have been controversial in previous studies. The first view is that if there are abundant employment opportunities in the region, the incentive to start a business will decrease, and conversely, if the employment environment is poor, they will start their own business and create jobs (Hudson, 1987, 1989; Evans and Leighton,1990). Previous studies have also shown that a poor employment situation in a region reflects poor economic vitality, which suppresses the business start-up rate (Reynolds et al., 1995; Carree, 2002).

In this study, we examined the effects of the local employment environment on business start-ups by using two explanatory variables: the unemployment rate in the region and the ratio of non-regular employees to the labor force in the region.

H4-1: A poor employment environment in the region encourages entrepreneurial behavior and has a positive effect on the start-up rate of KIBS. (Regional unemployment rate: + non-regular employee ratio: +)

H4-2: A poor employment environment in the region reflects the poor economic situation in the region, and it acts as a restraint on KIBS start-ups.
(Regional unemployment rate: -Ratio of non-regular employees:-)

5) Effect of the Kumamoto earthquake

In April 2016, immediately prior to the study period, the Kumamoto earthquake, with a magnitude of 7.3, caused great damage to the area. It has been considered that it had a significantly negative effect on industrial activities in the Kumamoto area. as a shock factor other than the various explanatory factors mentioned above. In this study, to verify the effects of the Kumamoto earthquake on the rate of KIBS start-ups in the area, we used a dummy variable (Kumamoto prefecture: 1, other prefectures: 0) is set.

H5: The Kumamoto earthquake negatively affected the opening rate of the prefecture. (Kumamoto dummy: -)

3.6 Analytical model

The main aim of this research is to clarify the effects of digitization in each region (i.e., Internet usage, the spread of digitized public services, ease of connectivity through information infrastructure development, existence of human resources that handle digitalization, etc.) on business start-up activities, in addition to various regional factors that have been analyzed in past studies. The analytical model was formulated as follows:

$$SR_i = const. + \sum_{k=1}^{4} a_k\, DCI_i + \sum_{k=1}^{2} b_k\, Pop_i + \sum_{k=1}^{3} c_k\, Econ_i + \sum_{k=1}^{2} d_k\, HR_i + \sum_{k=1}^{2} e_k\, Emp_i + fKDummy + \varepsilon$$

where $const.$ is a constant term, DCI_i is a sectoral DCI score for each region, Pop_i is a population factor, $Econ_i$ is an economic vitality factor, HR_i is a human capital factor, Emp_i is the employment environment factor, $KDummy$ is the Kumamoto dummy, and ε is the error term.

There has been a large difference in the number of KIBS in each prefecture.[3] Since the business

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[3] The total number of KIBS establishments in Tokyo was 36,983 as of 2016, while in Tottori prefecture, which had the

start-up rate in local governments where the number of KIBS is small in the first year of the term changed significantly with only a slight increase or decrease in the number of establishments, we assumed that the variance of the error term was uneven. Therefore, in this study, instead of the ordinary least squares (OLS) method, the weighted least squares method (WLS) was used. The percentage of KIBS establishments in each prefecture compared with all nations was used as a weighting parameter.

4. Descriptive statistics

4.1 KIBS start-up rate

Table 4 shows the average annual start-up rates of all industries and KIBS. The average nationwide rate of KIBS start-ups during the study period was 5.15%, which was considerably higher than the rate of all industries (2.64%). When KIBS was divided into T-KIBS and P-KIBS, the start-up rate of the former was 8.59% and that of the latter was 4.36%. Therefore, T-KIBS recorded a much higher start-up rate compared with P-KIBS.

Regarding the KIBS start-up rates by prefecture, the prefectures with the highest rates were as follows: 1) Tokyo (12.43%); 2) Osaka (9.17%); 3) Kanagawa (8.99%); 4) Chiba (8.51%); and 5) Kyoto (7.50%). Thus, the rates were relatively higher in metropolitan areas, mainly in the Tokyo metropolitan area and the Kansai area. From 2014–2016, Miyagi prefecture and Iwate prefecture were ranked high, which indicated an increase in start-ups related to the earthquake reconstruction demand, but this trend ended in the period from 2016–2019.

4.2 T-KIBS start-up rate

The rates of five T-KIBS were as follows: 1) Tokyo (16.56%); 2) Chiba (16.02%); 3) Nara (15.51%); 4) Saitama (14.47%); and (5) Kanagawa (12.77%). These rates were similar to all KIBS, showing that the rates were high in metropolitan areas, with Tokyo as the highest, but municipalities located on the periphery of metropolitan areas, such as Chiba, Nara, Saitama, and Kanagawa prefectures, recorded relatively higher rates. Nonetheless, some rural areas, such as Aomori prefecture (10.50%, 9th place) and Kagoshima prefecture (10.25%, 11th place), recorded relatively high rates.

4.3 P-KIBS start-up rate

Regarding the rates of P-KIBS start-ups, Tokyo (9.97%) was the highest, followed by Osaka (8.07%), Kanagawa (7.46%), Fukuoka (6.52%), and Chiba prefectures (6.42%). Similar to T-KIBS, these results showed that the rates were higher in metropolitan areas. However, a slightly different tendency was that the central prefectures of each regional block (Hokkaido 9th, Miyagi 11th, Aichi 7th, Hiroshima 15th, and Fukuoka 4th) recorded relatively higher start-up rates compared with those of T-KIBS.

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smallest number, there were 662 KIBS establishments as of the same year.

Table 4. Annual Start-up Rates of KIBS Industries and All Industries by Prefecture (2016–2019)

No.	Prefecture	All Industries		KIBS		T-KIBS		P-KIBS	
		rate	rank	rate	rank	rate	rank	rate	rank
1	Hokkaido	2.92%	(13)	6.43%	(10)	8.99%	(14)	5.67%	(9)
2	Aomori	2.51%	(19)	4.80%	(20)	10.50%	(9)	3.70%	(30)
3	Iwate	2.22%	(35)	3.92%	(35)	6.92%	(36)	3.33%	(35)
4	Miyagi	3.18%	(8)	6.01%	(12)	8.33%	(19)	5.35%	(11)
5	Akita	1.96%	(44)	3.51%	(42)	5.00%	(46)	3.26%	(36)
6	Yamagata	1.95%	(45)	3.24%	(44)	5.60%	(43)	2.76%	(44)
7	Fukushima	2.36%	(30)	4.49%	(27)	6.23%	(39)	4.20%	(18)
8	Ibaraki	2.18%	(37)	4.45%	(28)	7.27%	(32)	3.83%	(26)
9	Tochigi	1.98%	(43)	3.50%	(43)	6.96%	(34)	2.93%	(42)
10	Gunma	2.26%	(33)	3.88%	(36)	6.44%	(38)	3.38%	(34)
11	Saitama	2.98%	(11)	7.23%	(8)	14.47%	(4)	5.48%	(10)
12	Chiba	3.32%	(5)	8.51%	(4)	16.02%	(2)	6.42%	(5)
13	Tokyo	5.77%	(1)	12.43%	(1)	16.56%	(1)	9.97%	(1)
14	Kanagawa	4.09%	(3)	8.99%	(3)	12.77%	(5)	7.46%	(3)
15	Niigata	1.88%	(46)	3.61%	(40)	5.88%	(42)	3.07%	(41)
16	Toyama	2.34%	(31)	4.79%	(21)	8.28%	(20)	4.06%	(23)
17	Ishikawa	2.30%	(32)	4.56%	(26)	7.66%	(26)	3.79%	(27)
18	Fukui	2.38%	(27)	4.37%	(30)	8.48%	(17)	3.44%	(32)
19	Yamanashi	2.45%	(24)	4.59%	(25)	6.82%	(37)	4.15%	(21)
20	Nagano	2.09%	(41)	4.02%	(34)	7.41%	(31)	3.26%	(36)
21	Gifu	2.16%	(38)	3.68%	(39)	7.48%	(29)	3.08%	(40)
22	Shizuoka	2.48%	(22)	4.67%	(23)	8.78%	(15)	3.85%	(25)
23	Aichi	3.31%	(6)	6.67%	(9)	10.02%	(12)	5.75%	(7)
24	Mie	2.21%	(36)	3.83%	(38)	7.95%	(25)	3.19%	(39)
25	Shiga	2.71%	(17)	4.65%	(24)	7.52%	(28)	4.17%	(19)
26	Kyoto	3.26%	(7)	7.50%	(5)	12.66%	(6)	6.24%	(6)
27	Osaka	4.12%	(2)	9.17%	(2)	12.14%	(7)	8.07%	(2)
28	Hyogo	2.87%	(16)	6.19%	(11)	9.74%	(13)	5.32%	(12)
29	Nara	3.13%	(9)	7.35%	(7)	15.51%	(3)	5.71%	(8)
30	Wakayama	2.90%	(15)	5.88%	(14)	10.89%	(8)	5.13%	(14)
31	Tottori	2.14%	(39)	3.22%	(45)	5.58%	(44)	2.62%	(46)
32	Shimane	2.25%	(34)	3.16%	(46)	5.93%	(41)	2.64%	(45)
33	Okayama	2.99%	(10)	5.92%	(13)	8.23%	(22)	5.29%	(13)
34	Hiroshima	2.92%	(13)	5.19%	(15)	7.43%	(30)	4.65%	(15)
35	Yamaguchi	2.37%	(28)	4.40%	(29)	8.08%	(23)	3.67%	(31)
36	Tokushima	2.69%	(18)	4.86%	(16)	8.28%	(20)	4.26%	(17)
37	Kagawa	2.49%	(21)	3.87%	(37)	6.95%	(35)	3.20%	(38)
38	Ehime	2.47%	(23)	4.82%	(19)	7.15%	(33)	4.31%	(16)
39	Kochi	2.14%	(39)	4.06%	(33)	5.49%	(45)	3.79%	(27)
40	Fukuoka	3.56%	(4)	7.49%	(6)	10.33%	(10)	6.52%	(4)
41	Saga	2.04%	(42)	3.59%	(41)	8.06%	(24)	2.82%	(43)
42	Nagasaki	2.51%	(19)	4.36%	(31)	6.10%	(40)	4.03%	(24)
43	Kumamoto	1.12%	(47)	1.58%	(47)	1.80%	(47)	1.51%	(47)
44	Oita	2.43%	(25)	4.84%	(18)	8.44%	(18)	4.15%	(21)
45	Miyazaki	2.37%	(28)	4.20%	(32)	8.62%	(16)	3.41%	(33)
46	Kagoshima	2.40%	(26)	4.75%	(22)	10.25%	(11)	3.76%	(29)
47	Okinawa	2.93%	(12)	4.86%	(16)	7.55%	(27)	4.16%	(20)
	average	2.64%		5.15%		8.59%		4.36%	
	std. division	0.73%		1.94%		2.97%		1.57%	

Source: Calculated by the author from the Economic Census (2016 and 2019)

4.4 Descriptive statistics of explanatory variables

Table 5 shows the descriptive statistics for explanatory variables. Items that had a discrepancy between the average value and the median (i.e., the distribution of data was slightly biased) were office density per square kilometers (average: 57.64 establishments / km^2, median: 37.07 establishments / km^2) and university enrollment / high school graduate ratio (average value: 78.18%, median value: 70.12%). Regarding the former, the values of some metropolitan areas, such as Tokyo and Osaka prefectures, and for the latter, the values for Tokyo and Kyoto prefecture, where many universities are concentrated, in terms of population ratio raised average values, the distribution of them were slightly biased.

Table 6 shows the correlation matrix of each explanatory variable. Because all the correlation coefficients were below 0.8 in absolute value, no two variables showed a significantly higher correlation. An unusual finding was that variables indicating the existence of highly educated human resources (i.e., university entrance / high school graduate ratio and university graduate ratio) had (i) high positive correlation ratios with items of DCI in general, (ii) high correlation ratios to office density, and (iii) high negative correlation ratios to the average age of the region. These correlations may indicate that young people flow into metropolitan areas when they enter university or begin employment. Hence, they form a highly educated human resources pool in the region and contribute to the reduction of the average age.

Table 5. Descriptive Statistics of Variables

Variable	*Mean*	*Std. Dev.*	*Max.*	*Min.*	*Median*
KIBS Start-up rate (%)	5.15	1.94	12.43	1.58	4.65
T-KIBS Start-up rate (%)	8.59	2.97	16.56	1.8	8.06
P-KIBS Start-up rate (%)	4.36	1.57	9.97	1.51	4.03
DCI (Network Utilization)	49.84	7.16	65.51	33.46	50.09
DCI(Digital Public Service)	46.16	9.16	70.02	28.15	45.22
DCI(Connectivity)	48.52	8.57	73.65	32.04	47.39
DCI(Human Resource)	45.76	8.06	66.2	33.28	44.26
Day / Night Population Ratio (%)	99.22	4.12	117.8	88.85	99.85
Average Age	53.06	1.59	56.32	49.37	53.2
Office Density (Offices / ㎢)	57.64	74.09	437.27	9.45	37.07
GRP Increase Rate (%)	2.02	0.97	4.71	-0.01	1.93
University enrollment / high school graduate ratio (%)	78.18	35.74	215.66	37.98	70.12
University graduate ratio (%)	51.12	6.59	66.5	39.2	50.6
Unemployment Ratio (%)	2.36	0.47	3.58	1.53	2.33
Ratio of Non-regular Employees (%)	37.55	2.56	43.07	32.56	37.48
Kumamoto Dummy	0.02	0.15	1	0	0

Table 6. Correlation Matrix of Each Explanatory Variable

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. DCI (Network Utilization)	1												
2. DCI(Digital Public Service)	0.15	1											
3. DCI(Connectivity)	0.38	0.59	1										
4. DCI(Human Resource)	0.34	0.46	0.55	1									
5. Day / Night Population Ratio (%)	0.19	-0.07	0.13	0.03	1								
6. Average Age	-0.34	-0.49	-0.63	-0.54	0	1							
7. Office Density (Offices / km²)	0.36	0.43	0.59	0.48	0.47	-0.59	1						
8. GRP Increase Rate (%)	0.1	-0.02	-0.05	0.13	-0.08	-0.18	-0.08	1					
9. University enrollment / High school graduate ratio (%)	0.13	0.29	0.47	0.56	0.35	-0.56	0.64	0.07	1				
10. University graduate ratio (%)	0.23	0.63	0.74	0.51	0.01	-0.6	0.63	-0.06	0.62	1			
11. Unemployment Ratio (%)	0.1	-0.08	-0.01	0.11	0.09	-0.36	0.31	0.12	0.39	0.03	1		
12. Ratio of Non-regular Employees (%)	0.3	0.19	0.18	0.18	-0.33	-0.52	0.14	0.34	0.22	0.27	0.36	1	
13. Kumamoto Dummy	0.17	0.12	0.03	0.15	0.01	0.06	-0.06	0.22	0.01	-0.11	0.17	-0.05	1

5. Results of the regression analysis

5.1 Basic model

Table 7 shows the results of the regression analysis. In addition to the WLS used in this analysis, the estimation results of the OLS are also shown for comparison. As shown in Table 7, the explanatory power of the model was greatly enhanced by using WLS.

Table 7. Results of Regression Analysis of Factors Determining KIBS Start-up Rate

	T-KIBS				P-KIBS			
	WLS		OLS		WLS		OLS	
explanatory variables	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
Constant	31.67	2.58**	38.8	1.84*	16.88	3.50***	14.15	1.84*
1. DCI (Network Utilization)	0.02	0.44	0.06	1.33	-0.02	-0.98	0.01	0.72
2. DCI(Digital Public Service)	0.09	3.96***	0.06	1.69	0.03	3.79***	0.02	1.44
3. DCI(Connectivity)	-0.14	-2.69**	-0.13	-2.62**	-0.05	-2.95***	-0.04	-2.29**
4. DCI(Human Resource)	0.13	3.22***	0.03	0.69	-0.02	-1.12	-0.02	-1.43
5. Day / Night Population Ratio (%)	-0.23	-3.03***	-0.31	-3.24***	-0.06	-2.37**	-0.07	-2.07**
6. Average Age	-0.09	-0.42	-0.15	-0.54	-0.12	-1.45	-0.11	-1.13
7. Office Density (Offices / km²)	0.02	4.90***	0.02	3.47***	0.01	7.75***	0.01	5.09***
8. GRP Increase Rate (%)	-1.42	-5.70***	-0.76	-2.67**	-0.08	-0.82	-0.26	-2.52**
9. University enrollment / High school graduate ratio (%)	0.04	3.40***	0.02	1.69	0.02	5.14***	0.01	3.19***
10. University graduate ratio (%)	-0.19	-3.63***	0.03	0.39	-0.01	-0.61	0.04	1.29
11. Unemployment Ratio (%)	-0.6	-0.83	0.03	0.04	0.66	2.55**	0.63	2.43**
12. Ratio of Non-regular Employees (%)	0.25	1.58	0.11	0.81	-0.004	-0.07	0.01	0.15
13. Kumamoto Dummy	-5.75	-6.58***	-5.72	-2.92***	-2.74	-7.23***	-2.24	-3.14
Adjusted R^2	0.988		0.714		0.99		0.864	
F value	291.0***		9.86***		361.5***		23.5***	

***Statistically significant at the 1% level **Statistically significant at the 5% level *Statistically significant at the 10% level

First, regarding the effects of DCI on KIBS start-ups, digital public service (DCI) was positive and significant for both T-KIBS and P-KIBS. These results suggest that advances in the use of digital technology in public services encourage the start-up activity of KIBS-related businesses in the region. It can be inferred that local governments could create a demand for local KIBS through the development of various systems, management, and operation outsourcing. In addition, DCI (human capital) was positively significant for the start-up rate of T-KIBS. It can be said that the existence of human resources with a certain level of IT skills and knowledge is a factor that promotes the start-up activities of T-KIBS-related industries in the region.

Second, regarding the effects of population factors on the start-up of KIBS, the effects of the day / night population ratio were significantly negative on both T-KIBS and P-KIBS. Therefore, regarding the influence of population factors, H1-2 (i.e., the tendency of KIBS to start-up in the suburbs of metropolitan areas and KIBS start-up activity will be promoted in areas with a low day / night population ratio) is supported.

Regarding average age, the coefficients were negative but insignificant. Although it is considered that young people have an advantage in responding to new technologies and expertise to utilize them in business, older entrepreneurs are presumed to have an advantage in terms of work experience, knowledge, human networks, and the financial resources necessary for opening a business. Both effects are required in KIBS, but the results suggest that they may cancel out each other.

Third, regarding the effects of economic vitality factors, the density of establishments showed strong positive significance, as hypothesized. Because KIBS provide specialized services for business establishments based on their own technology and expertise, the existence of abundant business establishments that are (potential) customers in the neighboring area is a factor for promoting a business. In contrast, the growth rate of GDP was negative and significant in T-KIBS; therefore, the hypothesis is not supported. In future quantitative and qualitative research, we will aim to find clear evidence that supports this hypothesis.

Fourth, regarding the effects of human resources factors, the ratio of university enrollment to high school graduates was positive and significant, which was hypothesized for both T-KIBS and P-KIBS. As shown in Figure 1, a percentage of the population in rural areas tended to move to metropolitan areas when they graduated from high school, entered university, or began employment. This population flow has created a concentration of young human resources who are highly educated and have the excellent ability to adapt to the latest technology. This population has formed a pool of human resources for supporting KIBS start-ups in urban areas.

Contrary to the hypothesis, the results showed that the proportion of university graduates in the population was negative and significant. A tentative hypothesis is that many potential employees who remain in the area where they were born, raised, and go to university will become successors to businesses run by their parents / relatives. Therefore, it is possible that the rate of starting a new business in a new industry such as KIBS would be suppressed.

Fifth, regarding the effects of the employment environment, the P-KIBS start-up rate tended to be high in areas where the unemployment rate was high. The results of previous studies on the effects of unemployment on regional business start-up activities have been inconsistent. In the present study, the results showed that a poor employment environment in a region promoted entrepreneurship, which supported the "unemployment push hypothesis," especially in P-KIBS industries. In addition, "912. Worker dispatching services" was included in P-KIBS target industries. of. This type of business may be activated in areas where there are many human resources who are unemployed because of few regular job opportunities.

Finally, the results regarding the effects of the Kumamoto earthquake were negative and significant for both T-KIBS and P-KIBS. These results showed that the Kumamoto earthquake, which occurred immediately prior to the study period, had a significant negative effect on the business activities of the region.

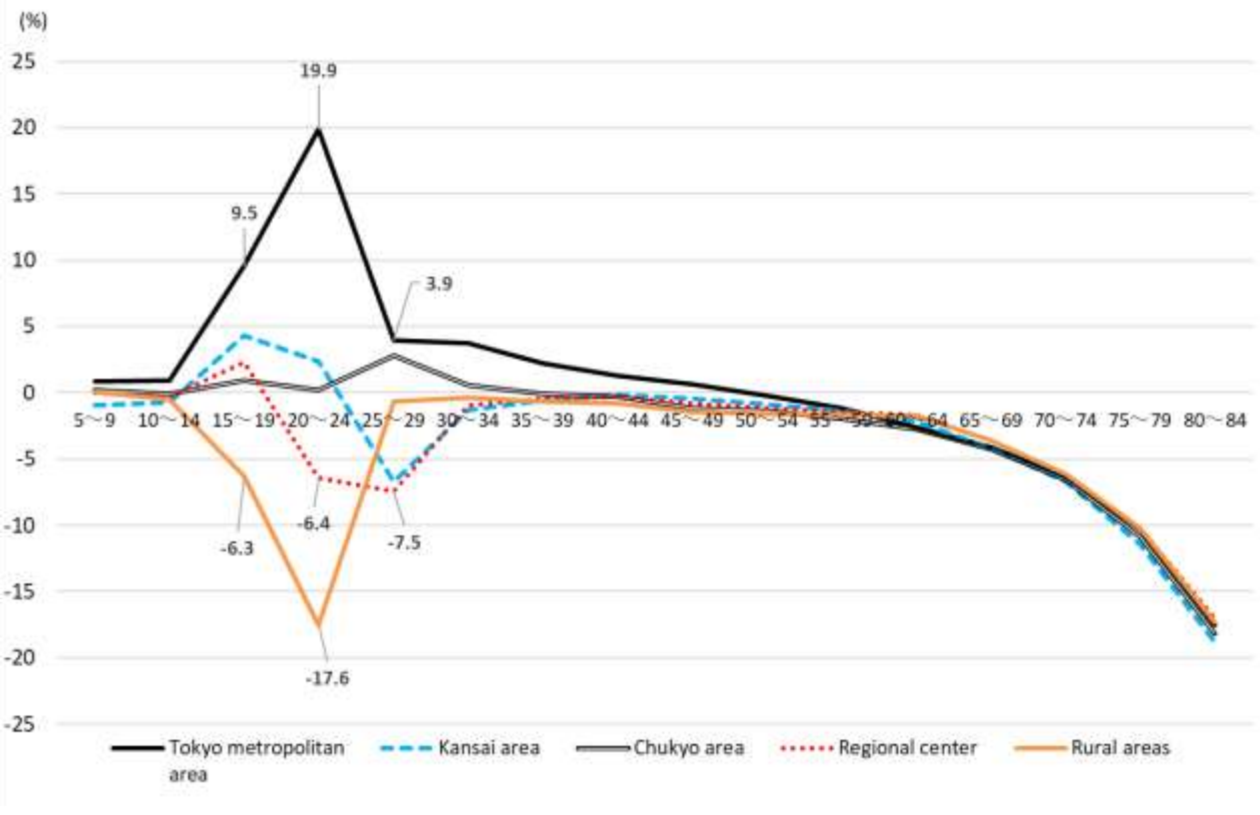

Figure 1. Comparison of population increase / decrease rates by five-year-old class by region in Japan

(1) Each area classification is as follows:
Tokyo metropolitan area: Tokyo, Kanagawa, Saitama, Chiba (Largest metropolitan area in Japan.)
Kansai area: Osaka, Kyoto, Hyogo, Nara (Second largest metropolitan area. Central city is Osaka.)
Chukyo area: Aichi, Gifu, Mie (Third largest metropolitan area. Central city is Nagoya.)
Regional center: Hokkaido, Miyagi, Hiroshima, Fukuoka (Prefectures where large cities with more than 1m people are located, except three areas above.)
Rural areas: Other prefectures

(2) For example, the rate of increase / decrease in the age group of 20 to 24 indicates the rate of increase / decrease from the population aged 15 to 19 in the census five years ago.

Source: Calculated by the author based on data from Census 2005 and Census 2010

5.2 DCI (Connectivity) reorganization model

The results of the model showed that DCI was positive and significant for both T-KIBS and P-KIBS, and DCI (human capital) was positive for T-KIBS, as hypothesized. However, the other items did not support the hypothesis, and the fact that DCI (connectivity) was negative and significant did not support the hypothesis. Hence, an additional analysis was performed to clarify the reason for this result.

Table 8 shows the individual items of DCI (Connectivity). As Table 8 shows, two types of indicators were included: 1) the environment of communication and service provision (FTTH, BWA diffusion status); and 2) the ratio of the ownership of various terminals at the consumer level. The former represented the high-speed communication environment in the region, and the latter represented the status of the possession of information and communication terminals that enhanced an individual's convenience. Therefore, we decided to divide DCI (Connectivity) into two items: 1) DCI (Network infrastructure); 2) DCI (Terminal ownership). We examined their effects on KIBS start-ups. The hypotheses to be tested were as follows:

H0-3.1: A regional high-speed and large-capacity communication environment promotes KIBS start-up activities. (DCI (Network infrastructure): +)

H0-3.2: The higher the ratio of local residents that own terminals, the greater the promotion of KIBS start-up activities. (DCI (Terminal ownership): +)

Table 8. Individual Items and Reorganization of DCI (Connectivity)

DCI (Connectivity) Individual Items		*Source*	*Reorganization*
FTTH household penetration rate		Ministry of Internal Affairs and Communications "Transition of number of contracts for broadband services, etc."	DCI (Network Infrastructure)
Number of BWA contracts per capita			
Smartphone ownership rate (2018, household)		Ministry of Internal Affairs and Communications "Communication Usage Trend Survey" (2019)	DCI (Terminal Ownership)
Tablet terminal ownership rate (2018, household)			
PC ownership rate (2018, household)			
Owned as free to use	Desktop personal computer	NRI "Questionnaire on Daily Life (2020.7)"	
	Laptop		
	Ordinary mobile phone (feature phone)		
	Smartphone (iPhone, etc.)		
	Tablet terminal (iPad, etc.)		
	Wearable device (Apple Watch, etc.)		
	E-book dedicated terminal (Kindle, etc.)		

Table 9 shows the results of the regression analysis after DCI (Connectivity) was divided into DCI (Network infrastructure) and DCI (Terminal Ownership) and added as explanatory variables. The results showed that the explanatory power of the model increased in T-KIBS in particular, which made heavy use of information and communication technology. The results showed the following two differences between the results of the basic model and the modified model.

First, the effects of DCI (network infrastructure) on the start-up activity of T-KIBS were clearly different from those shown in the analysis of DCI (connectivity). In other words, DCI (Network infrastructure) had a clear positive effect on T-KIBS start-ups, while DCI (Terminal ownership) had a negative effect. These results suggest that while a high-speed ICT environment is important in providing services for the start-up activities of these industries, personal terminals as users of services negatively affected start-ups in T-KIBS. In contrast, DCI (Network infrastructure) had no significant effect on the rate of P-KIBS start-ups.

Second, there was a change in the effect of average regional age on the start-up trend. In the basic model, the mean age did not show positive or negative effects. However, in the modified model, the effects were positive and significant for T-KIBS and slightly negative for P-KIBS.

Table 9. Results of Regression Analysis of Factors Affecting the KIBS Start-up Rate by Prefecture: DCI (Connectivity) Modified Model

	T-KIBS				P-KIBS			
	WLS		OLS		WLS		OLS	
explanatory variables	Coef.	t-value	Coef.	t-value	Coef.	t-value	Coef.	t-value
Constant	11.52	0.92	32.29	1.5	20.17	3.65***	12.66	1.56
1. DCI (Network Utilization)	0.06	1.4	0.05	1.25	-0.02	-1.3	0.01	0.58
2. DCI(Digital Public Service)	0.05	1.93*	0.06	1.43	0.04	3.57***	0.02	1.31
3.DCI(Network Infrastructure)	0.13	3.10***	0.01	0.16	-0.02	-1.29	-0.01	-0.36
4.DCI(Terminal Ownership)	-0.14	-3.82***	-0.12	-2.67**	-0.03	-2.26**	-0.03	-1.63
5.DCI(Human Resources)	0.08	2.04**	0.03	0.66	-0.01	-0.68	-0.02	-1.47
6. Day / Night Population Ratio (%)	-0.47	-4.97***	-0.33	-3.19***	-0.04	-1.02	-0.07	-1.86*
7. Average Age	0.63	2.22**	-0.01	-0.02	-0.21	-1.73*	-0.09	-0.76
8. Office Density (Offices / ㎢)	0.02	5.70***	0.02	3.73***	0.01	7.44***	0.01	5.05***
9. GRP Increase Rate (%)	-1.13	-4.93***	-0.68	-2.30**	-0.08	-0.8	-0.25	-2.25**
10. University enrollment / High school graduate ratio (%)	0.04	4.25***	0.02	1.54	0.02	5.00***	0.01	3.03***
11. University graduate ratio (%)	-0.21	-4.46***	0.01	0.11	-0.03	-1.34	0.03	0.98
12. Unemployment Ratio (%)	0.22	0.34	0.08	0.12	0.62	2.31**	0.67	2.48**
13. Ratio of Non-regular Employees (%)	0.24	1.73*	0.15	1.05	-0.01	-0.23	0.01	0.26
14. Kumamoto Dummy	-4.41	-5.16***	-5.11	-2.49**	-2.94	-6.84***	-2.22	-2.87***
Adjusted R^2	0.991		0.713		0.99		0.854	
F value	361.1***		9.17***		325.5***		20.2***	

***Statistically significant at the 1% level **Statistically significant at the 5% level *Statistically significant at the 10% level

6. Conclusion and future research

In this study, we analyzed regional factors that affected start-up activities in the knowledge-intensive business service industry (KIBS). The original contribution of our study to the literature is that, unlike previous studies on this topic, we analyzed the effects of DCI on regional start-up rates by evaluating "Potential for citizens to utilize digital technology to realize a better life." Table 10 lists the analysis results and the hypotheses.

First, we summarize the results regarding DCI. Among the DCI indices, DCI (Digital Public Service) was the most consistent with the hypothesis. This index contains items about the digitization of the local government and the utilization of public services through the Internet, such as the progress of various online administrative procedures, the sharing of systems between local governments, and the information security of local governments. The results suggest that local KIBS may be a catalyst for the smooth progress of these efforts. In other words, local governments could actively work on the digitalization of local administrative procedures to activate new start-up activities in KIBS-related industries in the region.

Next, it is worth noting that the high DCI (Human Capital) score indicated positive effects on the rate of T-KIBS start-ups. The high level of ICT skills of local residents indicates that, for example, public support for the acquisition of ICT skills by residents could promote start-up activities in T-KIBS.

An interesting result regarding the effects of DCI on start-up rate of KIBS was related to DCI (Connectivity). We hypothesized that DCI (Connectivity), which encompasses the diffusion status of infrastructure and the diffusion status of ICT terminals, is an element that promotes KIBS start-ups (especially T-KIBS). However, contrary to the hypothesis, the regression results showed that the index had a negative effect on business start-ups in both T-KIBS and P-KIBS.

Therefore, in an additional analysis, we divided the DCI (Connectivity) index into DCI (Net infrastructure), which represented the environment of high-speed ICT infrastructure in the region, and DCI (Terminal possession), which represented the ICT terminal ownership ratio of local residents, and verified the influence of the two indices. The results showed that DCI (Net infrastructure) had a significant positive effect on the rate of T-KIBS start-ups in the region. In contrast, DCI (Terminal possession) had negative effects on both T-KIBS and P-KIBS. These results indicated that the local high-speed ICT environment could promote start-up activities in T-KIBS, regardless of the ICT terminal ownership status of local residents.

Regarding factors other than DCI, the results showed that the concentration of human resources and business establishments in metropolitan areas had a positive effect on factors that influenced KIBS start-ups, which was in line with the findings of previous research. In particular, the density of local business establishments, which are indicators of customer access, and the ratio of university enrollments to high school graduates had strong positive effects on both T-KIBS and P-KIBS. These results indicated that these are reasons for the preference for metropolitan areas in the establishment of KIBS.

Table 10. List of Hypotheses and Results

Hypotheses	Basic Model		DCI reorg. model	
	T-KIBS	P-KIBS	T-KIBS	P-KIBS
H0-1: The more active the local residents use the Internet service, the more start-up activities of KIBS will be promoted. (DCI (Network Utilization): +)	－	－	－	－
H0-2: The more digitalization of local public services and the use by residents, the more start-up of KIBS will be promoted. (DCI (Digital Public Service): +)	◎	◎	○	◎
H0-3: The more the local high-speed, large-capacity ICT environment is set up and its utilization progresses, the more the start-up of KIBS will be promoted. (DCI (Connectivity): +)	×	×		
H0-3.1 ： Local high-speed and large-capacity communication environment promotes start-up activities of KIBS (DCI (Net Infrastructure): +)			◎	－
H0-3.2：The higher the percentage of local residents who own ICT terminals, the more the opening of KIBS will be promoted. (DCI (Terminal Possession): +)			×	×
H0-4: Higher ICT skills of the local residents promote start-up activity of KIBS. (DCI(Human Resources)：+)	◎	－	◎	－
H1-1: In areas with a high day / night population ratio, start-up activity of KIBS will be promoted. (Day / night population ratio: +)	×	×	×	×
H1-2: Reflecting the tendency of KIBS to start businesses in suburbs of metropolitan areas, start-up of KIBS will be promoted in areas with a low day / night population ratio (Day / night population ratio :-)	◎	○	◎	－
H1-3: Start-up of KIBS is promoted in areas where the average age of local residents is relatively low. (Average age:-)	－	－	×	○
H1-4：Start-up of KIBS is promoted in areas where the average age of local residents is relatively high. (Average age:+)	－	－	○	×
H2-1: Start-up of KIBS will be promoted in areas where the density of business establishments in the area is high. (Business office density: +)	◎	◎	◎	◎
H2-2: In areas where the growth rate of gross domestic product is high, start-up of KIBS will be promoted. (Gross domestic product increase rate: +)	×	－	×	－
H3-1: In areas where the ratio of university enrollment to high school graduates is high, start-up of KIBS will be promoted. (University enrollment / high school graduate ratio: +)	◎	◎	◎	◎
H3-2: In areas where university graduates account for a large proportion of the population, start-up of KIBS will be promoted. (University graduate ratio: +)	×	－	×	－
H4-1: Poor employment environment in the region encourages the behavior of starting a business by oneself and has a positive effect on start-up rate of KIBS. (Regional unemployment rate: + Non-regular employee ratio: +)	－	◎[4]	○[5]	◎[6]
H4-2: The poor employment environment in the region also acts in a restraining manner on start-up activities of KIBS. (Regional unemployment rate: -Ratio of non-regular employees:-)	－	×	－	×
H5: The Kumamoto earthquake had a negative effect on KIBS start-up rate in the prefecture. (Kumamoto dummy:-)	◎	◎	◎	◎

Note. ◎ Supports the hypothesis at the significance level of 5% or more

○: Supports the hypothesis at the significance level of 10%

×: Supports the opposite result to the hypothesis

-: The hypothesis is not verified

[4] Neither positive nor negative effects were found regarding the proportion of non-regular employees, but the unemployment rate had a positive effect at a 5%-significance level.

[5] Neither positive nor negative effects were found regarding the unemployment rate, but the percentage of non-regular employees had a positive effect at a 10%-significance level.

[6] The same as footnote 4.

However, some tendencies were slightly different from the merit of simple accumulation. The results showed that T-KIBS start-ups were particularly active in areas where the ratio of the day to night populations was low. Areas with a low day / night population ratio were prefectures surrounding the Tokyo area and the Kansai area, such as Saitama, Chiba, Kanagawa, Nara, and Hyogo. In these areas, while the main customer base is the concentration of companies in metropolitan areas centered on Tokyo and Osaka, KIBS entrepreneurs tended to be based in the suburbs, where office costs were low. These relocations may have become popular because of the development of a high-speed ICT environment.

Regarding the relationship between the employment environment and the activities of KIBS start-ups, the results supported the "unemployment push hypothesis," although there has been no definitive discussion. Regarding P-KIBS, the results showed a tendency to promote start-up activity in areas where the unemployment rate was high. This may suggest that "912. Worker dispatching business" in P-KIBS may find business opportunities in areas with potential labor pools.

Regarding the qualitative aspects of local human resources, which were approximated by the final academic background, the results showed that both T-KIBS and P-KIBS start-ups tended to be promoted in areas where the population was increased by the influx of students who were entering university. However, the results also showed that the proportion of university graduates in the local population had a negative effect on T-KIBS start-ups.

Finally, we recommend future research topics. First, in contrast to the hypothesis, the results showed that start-up activity was hindered in regions where the growth rate of total production in the region was high, especially regarding T-KIBS. No previous study has investigated this phenomenon. Second, regarding the qualitative study of human resources, the ratio of university enrollments to high school graduates was found to have a positive effect on the start-up activities of T-KIBS and P-KIBS, as hypothesized. However, the ratio of university graduates in the region did not support the hypothesis. A potential reason is the relationship between business succession and the tendency to enter higher education in the region.[7] In a future qualitative study, we aim to clarify these points by conducting interviews with the local community in addition to conducting a quantitative analysis.

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[7] The current hypothesis is that human resources who consider entering the business of parents or relatives have a strong incentive to maintain and develop a long-standing human network in the region, and they are likely to go on to local universities. In contrast, it has been speculated that human resources who do not have such connections tend to select other destinations, including those outside the region, and as a result, the number of those who move to areas with a large concentration of universities increases.

Appendix

Table A1: Components of DCI

DCI (Net Utilization): 21 items	Source
Frequency of Internet use on PCs	1
Frequency of Internet use on cell phones and smartphones	1
Facebook usage frequency	1
Twitter usage frequency	1
LINE usage frequency	1
Instagram usage frequency	1
Whether to use the Internet service: Sending and receiving e-mail	1
Whether to use the Internet service: Online banking	1
Whether to use the Internet service: Online trading of stocks	1
Whether to use the Internet service: Online shopping	1
Whether to use the Internet service: Paid video distribution service	1
Whether to use the Internet service: Paid video distribution service	1
Whether to use the Internet service: Net auction	1
Whether to use the Internet service: Question site (Yahoo Answers, etc.)	1
Whether to use the Internet service: Social-network games (free)	1
Whether to use the Internet service: Read other people's SNS posts	1
Whether to use the Internet service: Press "Like" on someone else's SNS	1
Whether to use the Internet service: Disseminate one's information on SNS	1
Whether to use the Internet service: Update one's homepage and blog	1
Whether to use the Internet service: Free voice call service	1
Whether to use the Internet service: Online health information search	1
DCI (Digital Public Service): 18 items	**Source**
Experience using digital services of national and local governments	1
Acquisition of individual number card	1
Whether to use e-Tax	1
Whether to view real estate registration information on the Internet	1
Experience in responding to surveys conducted by national and local governments online	1
Experience in searching and lending library books on the Internet	1
Whether to reserve public conference rooms and sports facilities online	1
Whether to apply for courses provided by local governments online	1
Whether to use an electronic prescription note / smartphone app	1
Whether to use a smartphone app that can manage and view personal health information	1
Applied for a special flat-rate benefit for COVID-19 online*	1
Applied for a sustainable benefit for COVID-19 online*	1
Online status of administrative procedures (prefecture level)	2
Online status of administrative procedures (municipal level)	2
Inter-municipal system shared use / optimization status (prefecture level)	2
Inter-municipal system shared use / optimization status (municipal level)	2
Information security and BCP status of local governments (prefecture level)	2
Information security and BCP status of local governments (municipal level)	2

Table A1: Components of DCI (Continued)

DCI (Connectivity): 10 items	Source
FTTH household penetration rate	3
Number of BWA contracts per capita	3
Smartphone ownership rate (per household)	4
Tablet device ownership rate (per household)	4
PC ownership rate (per household)	4
Ownership ratio of desktop PCs that can be used freely	1
Ownership ratio of laptop that can be used freely	1
Ownership ratio of smartphone that can be used freely	1
Ownership ratio of tablet device that can be used freely	1
Ownership ratio of wearable device that can be used freely	1
DCI (Human Resources): 15 items	**Source**
Percentage of people who can create spreadsheets and graphs using Excel etc.	1
Percentage of people who can create slides and materials using PowerPoint etc.	1
Percentage of people who can edit illustrations using Photoshop etc.	1
Percentage of people who can shoot / edit videos and post them on YouTube, etc.	1
Percentage of people who can create a website	1
Percentage of people who can make application software by programming	1
Percentage of people who can maintain servers and networks	1
Percentage of people who can analyze data using artificial intelligence (AI)	1
Percentage of people who can use 3D printers*	1
Percentage of people who have studied information and communication in faculties and departments at universities	1
Percentage of people who have studied information and communication at junior colleges and technical colleges	1
Number of people who passed the Information-Technology Engineers Examination per 10,000 people	5
Number of learning PCs per child	6
Human resource development for promoting the computerization of local government employees (prefecture level)	2
Human resource development for promoting computerization of local government employees (municipal level)	2

Sources:

1. Nomura Research Institute Questionnaire
2. Ministry of Internal Affairs and Communications, "Overview of Local Autonomy Information Management"
3. Ministry of Internal Affairs and Communications, "Transition of number of broadband service contracts"
4. Ministry of Internal Affairs and Communications, "Communication Usage Trend Survey"
5. Information-technology Promotion Agency, "Information-Technology Engineers Examination Statistics"
6. Ministry of Education, Culture, Sports, Science and Technology, "Survey on the actual situation of computerization of education in schools"

* Newly added question items in July 2020

Table A2: DCI by prefecture (July 2020)

ID	Prefecture	DCI (Network Utilization)	DCI (Digital Public Services)	DCI (Connectivity)	DCI (Human Resource)	DCI
1	Hokkaido	9.7	13.1	10.4	9.4	42.7
2	Aomori	9	10.8	8	9.2	36.9
3	Iwate	10.3	12.3	8.4	9.6	40.6
4	Miyagi	9.8	12.1	9	8.5	39.5
5	Akita	10.6	13.4	8.8	9.6	42.3
6	Yamagata	12.7	11.8	11	13.2	48.7
7	Fukushima	13.5	14.6	11.7	9	48.8
8	Ibaraki	12.1	16.9	14.8	13	56.8
9	Tochigi	14.5	12.8	13.7	8.7	49.7
10	Gunma	13.9	13.2	13	9.6	49.7
11	Saitama	13.1	17	13.3	12.4	55.8
12	Chiba	13.4	15.6	15.7	14.8	59.5
13	Tokyo	18.4	21.4	20.1	21.9	81.7
14	Kanagawa	16.3	17.8	15.1	13.7	62.8
15	Niigata	12.5	12.2	10.1	11.1	46
16	Toyama	13.5	12	14.2	13.2	52.9
17	Ishikawa	16	13.4	12.8	12.2	54.4
18	Fukui	16.2	15.9	15.4	13.7	61.2
19	Yamanashi	15.6	14.1	14.6	12.1	56.3
20	Nagano	13.7	12.1	12.8	10.6	49.1
21	Gifu	11.6	13	12	10.2	46.8
22	Shizuoka	16	17.6	14.4	13	60.9
23	Aichi	12.9	16.3	12.7	9.8	51.8
24	Mie	13	11.8	12.9	11.9	49.6
25	Shiga	14.6	15.4	14.7	11.8	56.5
26	Kyoto	16.8	17.5	14.8	12.5	61.6
27	Osaka	12.5	13.9	13.5	13	53
28	Hyogo	16.5	14	12	12.9	55.4
29	Nara	14.5	15.1	13.3	12	54.8
30	Wakayama	13.5	12.5	11.6	13.1	50.7
31	Tottori	16.7	14.3	11.6	10.7	53.3
32	Shimane	17.5	15.2	12.8	12.3	57.8
33	Okayama	15.2	14.8	14.4	13.3	57.7
34	Hiroshima	13.8	15.7	12.6	15.9	58
35	Yamaguchi	13.9	13	10	10.5	47.4
36	Tokushima	12.7	13.3	11.4	10.6	47.9
37	Kagawa	13.6	16	15	10.7	55.2
38	Ehime	13.8	12.5	10.9	12	49.1
39	Kochi	12.3	11.5	8.3	10.3	42.4
40	Fukuoka	17.5	14.5	13.1	13.3	58.4
41	Saga	14.1	15.4	12.5	13.4	55.3
42	Nagasaki	13.5	13	11	9.9	47.5
43	Kumamoto	15.5	15.3	11.8	11.4	54
44	Oita	14.6	13	10.1	11.4	49.1
45	Miyazaki	15.6	13.2	8.4	9.4	46.6
46	Kagoshima	14.9	12.7	9.2	10.5	47.3
47	Okinawa	16.8	14.5	12.3	11.9	55.5

Note. In calculating the DCI score (0–100), each of the four items was weighted by 0.25. Therefore, the magnitude of the numerical value differs from the descriptive statistics of DCI shown in Table 5.

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