How Different Are the Regional Factors of High-tech and Low-tech Start-ups? Evidence from Japanese Manufacturing Industries

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Abstract

This paper analyzes regional determinants of the start-up ratio in the Japanese manufacturing sector. A major contribution of this study is the comparison between high-tech and low-tech industries. The empirical results using a sample of 253 industrial districts suggest that business density, weight of the manufacturing sector, and the average business size significantly influence the start-up ratio in both high-tech and low-tech industries. Distinct differences between these industries were found with regard to the effects of human capital, research institutes, and the weight of high-tech industries.

Keywords: Start-up Ratio, High-tech Industries, Low-tech Industries, Manufacturing, Industrial Districts, Japan

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Business start-ups play an important role in promoting competition and innovation and in creating employment. The contributions of the start-up activity are essential also from the viewpoint of regional economies. In Japan, however, a continuous stagnation of the start-up ratio has been observed since the beginning of the 1990s, unlike in other developed countries. Thus far, various public efforts to promote the start-up activity have been largely futile.

The stagnation of the start-up activity in Japan is particularly serious in the manufacturing sector, which is regarded as a major source of innovation. According to the estimation by the Small and Medium Enterprise Agency (2006) based on the "Establishment and Enterprise Census" of the Ministry of Internal Affairs and Communications, the gross start-up ratio in the manufacturing sector has continuously decreased from 6.0% in the latter half of the 1960s to less than 2% in the latter half of the 1990s (Figure 1)[1]. Moreover, the closure ratio has exceeded the start-up ratio since the beginning of the 1990s; thus, we experience a continuous decrease in the number of manufacturing plants. Several industrial districts that have supported the industrial development of Japan for decades currently face a serious crisis. Therefore, it is essential to promote business start-ups in the Japanese manufacturing sector, especially in high-tech industries.

Insert Figure 1 about here

However, despite a distinct variation in the start-up ratio across regions, few empirical studies have thus far been conducted on the regional determinants of the start-up ratio in Japanese manufacturing industries. Moreover, most studies, including the Japanese ones, do not distinguish technology-intensive start-ups from the others, although high-tech start-ups deserve special attention for their contribution to innovation.

Thus, this paper analyzes the regional determinants of the start-up ratio of Japanese manufacturing establishments, with emphasis on the differences between high-tech and low-tech industries. This analysis is based on the micro data from the "Census of Manufactures" of the Ministry of Economy, Trade and Industry (METI). Using micro data, we can obtain the gross number of new establishments in each municipality, industry, and size class; however, information cannot be obtained on the innovativeness of each start-up. Thus, instead of a direct estimation of the regional determinants of innovative start-ups, we estimate those of technology-intensive (high-tech) industries and compare the results with those of the other (low-tech) industries.

The remainder of this paper is organized as follows. The next section provides a survey of previous studies on the regional determinants of the start-up ratio. The third section explains analytical models and presents the hypotheses. The fourth section describes the data and discusses their limitations. The fifth section demonstrates the empirical results that compare high-tech and low-tech industries. The last section concludes this paper, discussing its contributions and limitations.

Literature Review

While studies on the regional variations of the start-up ratio became popular in Western countries in the 1990s, few studies have been conducted in Japan thus far. Summarizing the models of previous studies, regional determinants of the start-up ratio can be categorized into demand (profit), cost, human resource, research base, industry agglomeration and structure, and other factors.

The factors of expected demand and profit, such as growth in population and price-cost margin, have been regarded as the most direct determinants of the regional start-up ratio in most studies including Audretsch & Fritsch (1994a), Guesnier (1994), Keeble & Walker (1994), and Reynolds (1994), although this hypothesis was not always supported for the manufacturing sector. With regard to cost factors, previous studies focus on the wage level and show that it has a negative impact on the start-up ratio (Gerlach & Wagner, 1994; Audretsch & Vivarelli, 1996; Okamuro & Kobayashi, 2006).

The qualitative composition of the regional population or labor force has attracted considerable attention from the viewpoint of human capital. Several studies indicate that the larger the share of university graduates in the local population or labor force, the higher is the start-up ratio (Guesnier, 1994; Armington & Acs, 2002; Acs & Armington, 2004; Okamuro & Kobayashi, 2006).

The effect of unemployment ratio as one of the human resource factors has often been discussed. Some argue that a high unemployment ratio drives the unemployed to self-employment, thereby increasing the start-up ratio (push hypothesis) (Evans & Leighton, 1990), while others demonstrate that a high unemployment ratio signals poor business opportunity, thereby lowering the incentive to start new businesses (pull hypothesis) (Reynolds, Miller & Maki, 1995).

Further, German studies find that R&D input by universities, public research institutes, and private firms in the region, measured by the number of research staff, has a positive impact on the regional start-up ratio because of the spillover effect, especially in research-intensive industries (Berger & Nerlinger, 1997; Felder, Fier & Nerlinger, 1997; Nerlinger, 1998; Steil, 1999).

Regarding industry agglomeration and structure, several studies demonstrate that the variables of agglomeration, such as population density and business density, have positive impacts on the start-up ratio (Audretsch & Fritsch, 1994a; Guesnier, 1994; Keeble & Walker, 1994; Armington & Acs, 2002; Okamuro & Kobayashi, 2006).

Among other factors of the regional start-up ratio, the average business size is the one that has most often been considered in the literature. Several studies find that the smaller the average business size or the larger the weight of small businesses, the higher is the start-up ratio (Audretsch & Fritsch, 1994a; Gerlach & Wagner, 1994; Hart & Gudgin, 1994; Keeble & Walker, 1994; Reynolds, 1994; Audretsch & Vivarelli, 1996). They argue that such regions provide favorable business environments for small businesses, thereby promoting the start-up of new businesses.

Several studies compare the regional determinants of the start-up ratio between the manufacturing and service sectors (Audretsch & Fritsch, 1994a, 1994b; Hart & Gudgin, 1994; Keeble & Walker, 1994; Reynolds, 1994; Audretsch & Vivarelli, 1996); however, none conduct such comparisons across industries within either sector. The exceptions are Felder et al. (1997) and Nerlinger (1998) based on the micro data of start-up firms in East and West Germany, respectively. They classify various manufacturing industries into three groups based on the R&D intensity (the industry-average ratio of R&D expenditure to sales) and compare them with each other and with technology-intensive service industries by estimating the impacts of regional factors on the start-up ratio using the same model.

This paper classifies various Japanese manufacturing industries as "high-tech" and "low-tech" based on the R&D intensity, with some modifications to the classification criteria; it subsequently examines the similarities and differences in the regional determinants of the start-up ratio between the categories. In this manner, we expect to obtain suggestions for the promotion of high-tech start-ups at the regional level.

Analytical Method and Hypotheses

Models and Variables

We regress the gross start-up ratio of manufacturing plants (with 4–19 persons engaged) from 1998 to 2000 on various regional factors. The sample comprises 253 industrial districts as of 1998. We will discuss these regional units in more detail in the next section. OLS is employed as the analytical method.

The dependent variable is the number of start-ups per 10,000 labor force (START). Distinguishing the start-up ratios in high-tech and low-tech industries (START_H and START_L), we compare the impacts of regional factors between these groups. The distinction between these industries is based on the R&D intensity (the ratio of R&D expenditure to sales), as we explain later in more detail.

Previous studies on the regional differences in the start-up ratio in Japan standardize this ratio by the number of existing establishments. This approach measures the increase in establishments relative to the stock of establishments and is termed as the "ecological approach" (Audretsch & Fritsch, 1994a, 1994b) or the "business stock model" (Keeble & Walker, 1994). This approach is mainly used in the studies on industry-specific factors of start-ups and the simultaneous analysis of entry and exit.

Unlike previous studies in Japan, we standardize the start-up ratio by the size of the labor force. This approach indicates how many people in the region who are potential founders of new businesses indeed started new businesses. This approach is termed as the "labor market approach" (Audretsch & Fritsch, 1994a, 1994b) or the "labor force model" (Keeble & Walker, 1994) and is employed in most of the previous studies on the regional determinants of start-ups in Western countries. It implicitly assumes that local inhabitants start their businesses in the region they live, an assumption supported by several studies.

A distinct advantage of the latter approach is its clear theoretical background that the working population has the choice of starting new businesses and they decide to do this when expected benefit from the start-up is larger than expected cost (Audretsch & Fritsch, 1994a, 1994b). Due to this advantage and the comparability with major previous studies in Western countries, this paper adopts the labor market approach and uses the start-up ratio standardized by labor force as the dependent variable.

Following the analytical framework of several previous studies, the following basic model is presented for the empirical analysis in this paper.

Start-up Ratio = f (Expected Profit Factors, Cost Factors, Human Resource Factors, *Research Infrastructure Factors, Industry Agglomeration and Structure Factors)*

We assume linear relations between the start-up ratio and these factors, specify 4 models with different sets of independent variables considering the correlations among them, and run OLS estimations considering the possibility of heteroskedasticity. We summarize the definitions of the variables in Table 1.

Insert Table 1 about here

As variables of expected profit, we use the gross profit ratio (price-cost margin) (PCM) and the growth of total shipment (GRSALES) of the manufacturing sector. Variables of cost factors are the average wage of the manufacturing sector (WAGE) and the unit land price in industrial estates (LNLANDP). Variables of human resource factors are the unemployment ratio (UNEMPL) and the ratio of university graduates to the population (UNIV). The proxy for research infrastructure is the number of research institutes, both public and private, relative to the number of manufacturing plants (INST).

Moreover, business density (DENS), the degree of industrial specialization

(SPEC), the ratio of manufacturing industries (MRATIO), and the ratio of high-tech industries (HITECH) are used as the variables of industry structure and agglomeration. Finally, we focus on the average size (number of employees) of existing establishments (AVESIZE).

Hypotheses

We expect the start-up ratio to be affected by various regional factors in both high-tech and low-tech industries; however, the impacts of regional factors are partially different between them. More concretely, we present the following hypotheses. The related variables and expected signs of regression coefficients are given in parentheses.

First, we expect that the higher the expected profit from start-up, the more likely are potential founders to start new businesses. Thus, coefficients of the variables PCM and GRSALES are expected to have positive signs. We assume that there are no distinct differences between high-tech and low-tech industries with regard to this factor.

Hypothesis 1: Start-up ratio is higher in districts where a higher profit is expected

(PCM +, GRSALES +).

Second, we expect that the higher the related costs, less motivated are the potential founders to start new businesses. Thus, coefficients of the variables WAGE and LNLANDP are expected to have negative signs.

Hypothesis 2: Start-up ratio is higher in districts with lower costs for start-up and operations (WAGE –, LNLANDP –).

Assuming that firms in low-tech industries find it increasingly difficult to add value to their products and therefore are more sensitive to the wage level, the negative effect of WAGE is expected to be stronger in low-tech industries. However, if the level of human capital is reflected in average wage, WAGE is expected to have a positive effect on the start-up ratio and this effect may be stronger in high-tech industries.

Third, according to previous studies, the effect of UNEMPL can be positive (push hypothesis) or negative (pull hypothesis). If the unemployed are driven to self-employment, the expected sign of the coefficient of UNEMPL is positive (Evans & Leighton, 1990). However, if a high unemployment ratio signals poor business opportunity and thus makes potential founders more pessimistic and risk-averse, UNEMPL would have a negative coefficient (Reynolds et al., 1995). Therefore, we present two contrasting hypotheses regarding the effects of the unemployment ratio.

Hypothesis 3a: Start-up ratio is higher in districts with a higher unemployment ratio (UNEMPL +).

Hypothesis 3b: Start-up ratio is lower in districts with a higher unemployment ratio (UNEMPL –).

Here, we assume that the push hypothesis is more likely to be supported in low-tech industries. This is because the start-up as an escape from the unemployment is easier in low-tech than in high-tech industries, assuming that the latter requires comparatively better knowledge, higher ability, and a more thoughtful preparation.

Fourth, assuming that educational background can be regarded as a proxy for personal capability, a higher value of UNIV indicates a higher level of human capital. We can expect such regions to be populated by relatively many people who have sufficient capability as entrepreneurs and who can support them successfully. Based on this argument, UNIV is expected to have a positive effect on the start-up ratio (Guesnier, 1994; Acs & Armington, 2002). However, highly educated people tend to be highly paid employees occupying favorable positions, and thus, they have higher opportunity costs of start-up than those with a lower level of education (Small and Medium Enterprise Agency, 2002). If so, university graduates will be comparatively less motivated to start new businesses. Therefore, we also present two contrasting hypotheses regarding this variable.

Hypothesis 4a: Start-up ratio is higher in districts with a higher ratio of university graduates in the population (UNIV +).

Hypothesis 4b: Start-up ratio is lower in districts with a higher ratio of university graduates in the population (UNIV –).

If the level of business risk is the same between high-tech and low-tech industries, the positive effect of UNIV is expected to be stronger in high-tech industries, where more competent human capital is needed (such as engineers with a Ph.D.). However, if the level of business risk is higher in high-tech industries due to higher dependence on R&D, the negative effect of UNIV is possibly stronger in these industries.

Fifth, a better knowledge infrastructure represented by INST promotes technological spillover and thus stimulates start-ups, especially in high-tech industries (Felder et al., 1997; Berger & Nerlinger, 1997; Nerlinger, 1998). Moreover, the possibility of spin-offs from local research institutes would be higher in the regions with higher level of INST. Therefore, the expected coefficient of INST is positive and its effect is expected to be higher in high-tech industries.

Hypothesis 5: Start-up ratio is higher in districts with a higher ratio of research institutes to manufacturing plants (INST +).

Sixth, the variables of industry agglomeration—DENS, SPEC, and MRATIO—are expected to have positive effects on the start-up ratio of manufacturing plants (Keeble & Walker, 1994). This is because industry agglomeration plays an important role in the seedbed of new businesses through intense information exchange and efficient division of labor both within the same industry and between related industries (Krugman, 1991). Regarding these variables, we do not assume significant differences between high-tech and low-tech industries.

Hypothesis 6: Start-up ratio is higher in districts with a higher business density, a higher degree of industrial specialization, and a higher ratio of employees in the manufacturing sector (DENS +, SPEC +, MRATIO +).

Seventh, AVESIZE is expected to have a negative effect on the start-up ratio because regions having many small firms are supposed to provide favorable business environments for small businesses. Several studies support this argument (Audretsch & Fritsch, 1994a; Keeble & Walker, 1994; Reynolds, 1994; Audretsch & Vivarelli, 1996).

Regarding this variable, we do not assume significant differences between high-tech and low-tech industries.

Hypothesis 7: Start-up ratio is higher in districts with a smaller average size of manufacturing plants (AVESIZE –).

The remaining variable HITECH is one of the proxies for industry agglomeration; however, we regard it as a control variable. Although we do not explicitly present a hypothesis related to this variable, we can expect that the higher the ratio of existing plants in high-tech industries, the higher is the start-up ratio in high-tech industries. This is because the agglomeration of high-tech firms can create new high-tech plants.

Data and Sample

The empirical analysis in this paper uses the micro data of the “Census of Manufactures” by METI in 1998 and 2000 and the aggregated regional data from several public statistics.

The gross numbers of start-up establishments in each region were calculated from the obtained micro data. The establishments that did not exist in the 1998 survey and were confirmed in the 2000 survey are regarded as start-ups (new establishments).

Then, the number of start-ups was calculated in each municipality and aggregated to the level of industrial district, according to the regional classification in the "1998 Census of Manufactures."

We use a sample of 253 industrial districts. They do not necessarily correspond to the local market areas, but many of them roughly correspond to traditional industry agglomeration. This paper regards these districts as an appropriate level of regional aggregation for the following analysis: On one hand, there exist large regional differences within each prefecture in relation to several regional factors. On the other hand, municipalities may be too narrow to be considered as regional analytical units.

In this paper, special attention is paid to the differences between technology-intensive and other start-ups. However, information on R&D and innovation of each start-up is not available; thus, this paper focuses on the differences between small start-ups in "high-tech" and "low-tech" industries, with the assumption that the former are, on average, more innovative than the latter. The distinction between these industries is based on the R&D intensity (the ratio of R&D expenditure to sales) according to Felder et al. (1997) and Nerlinger (1998).

The R&D intensity data for each 3-digit manufacturing industry were obtained from the "Basic Survey of Japanese Business Structure and Activities" by METI. Finally, we classified 26 industries whose R&D intensity exceeded the mean value of all manufacturing industries (1.29%) as high-tech and the rest (32 industries) as low-tech industries.

The method used in this paper to distinguish between high-tech and low-tech industries differs from that of the German studies in several points. First, while they use absolute criteria to classify industries[2], this paper employs a relative criterion. Second, while they use R&D intensity data for a certain year, this paper uses an average of three years, 1998, 1999, and 2000 in order to capture a stable pattern of innovativeness in each industry. Third, while they use the industry-average value of R&D intensity, this paper focuses on the data of the smallest firm size class available from public statistics. This is a critical point because we are interested in small, innovative start-ups. We can more appropriately regard the R&D intensity of the smallest firm size class of a certain industry—rather than the average R&D intensity of this industry—as a proxy for the expected innovativeness of small start-ups in this industry.

Some limitations of the data should also be mentioned. The obtained micro data do not comprise all plants, but are limited to those with 4 or more persons engaged (employers and employees). Therefore, the start-up ratio in our sample is vastly underestimated[3]. Moreover, relocation of existing establishments cannot be distinguished from real start-ups. Finally, we cannot distinguish new branches of existing firms from independent start-ups. In order to cope with these problems, the sample was limited to small establishments with less than 20 persons engaged in 2000. Assuming that large start-ups include many cases of relocation and new branches, it is expected that one can exclude to some extent from the sample those establishments that are not real start-ups[4].

Moreover, our estimation models include the unit price of industrial estates and the business density (the number of establishments per square kilometer). These elements control for the effect on relocation of existing establishments. According to a public survey (METI, 2000), the availability of large industrial estates and low land price are major reasons for the relocation of factories. Thus, the regions where large industrial estates are available at relatively low prices tend to attract the relocation of factories existing in other regions. Therefore, the effect of relocation can be controlled for by including the variables of business density and the price of industrial estates.

As explained in the previous section, the start-up ratio is defined in this paper as the number of start-up establishments relative to 10,000 labor force. The average start-up ratio of all industrial districts for 2 years from 1998 to 2000 is 2.51. Assuming that all founders of new manufacturing plants come from the labor force of the same region, about 2.5 persons of 10,000 labor force started new plants (with 4 or more persons engaged) during this period. The average start-up ratios in high-tech and low-tech industries are 0.83 and 1.69, respectively. Descriptive statistics of the dependent and independent variables are presented in Table 2.

Insert Table 2 about here

Estimation Results and Discussion

Estimation Results for the Entire Manufacturing Sector

Table 3 presents the estimation results of the determinants of the regional start-up ratio for the entire manufacturing sector. We estimate 4 models with different combinations of variables, considering the correlation among them. Since the correlation between WAGE and UNIV and the correlation between LNLANDP, WAGE, UNIV, and DENS is especially high, these variables were interchangeably used in the models.

Insert Table 3 about here

Variables of expected profit do not reveal positive effects in all the models. WAGE has a strong negative effect in Model 3, but this effect disappears when we control for the average size (Model 2). The coefficient of LNLANDP is not statistically significant. UNEMPL reveals positive and significant effects in Models 1, 2, and 4. The effect of UNIV is negative and significant. INST shows positive and significant effects in Models 1 and 2. The coefficients of DENS and MRATIO have positive and significant signs in all the models, while the effect of SPEC is never significant. In all the models, the effect of AVESIZE is negative and significant, while the effect of HITECH is positive and significant.

Summarizing the above results, the start-up ratio of manufacturing plants is significantly higher in regions characterized by a low ratio of university graduates, high unemployment ratio, high business density, high ratio of employees in the manufacturing sector, and small average business size. However, significant effects of expected profit, land price, and industry specialization were not found. The effect of average wage is not robust.

Subsequently, the robustness of the above results was checked in several ways. First, we confirmed that the existence of a few outliers in the dependent variable does not essentially affect the results. Second, regarding variables of expected profit, significant results were not obtained even when PCM and GRSALES were used interchangeably and when another proxy (labor productivity) was used. Third, the relationship between the industrial districts is especially strong in the metropolitan areas; therefore, the influence of regional factors of a certain region on the start-up ratio of neighboring regions is also strong. To mitigate this problem, some metropolitan districts were excluded from the sample and the same models were estimated; however, there was no considerable change in the results.

Moreover, considering that research institutes influence a wider area than the industrial district, the definition of INST was changed to include those at the prefecture level and the estimation was carried out. Consequently, the significance of the coefficient of this variable decreased considerably. This result suggests that the positive effect of research institutes on the start-up in high-tech industries is especially strong in the direct vicinity.

The start-up ratio in a region is also affected by the industry structure of this region. Thus far, we used HITECH as a control variable of industry structure. We also tried an alternative estimation that considers the industrial characteristics of each region more directly by including industry dummies for food, textile, and electrical machinery instead of HITECH[5]; however, we found no considerable changes in the estimation results.

Comparison between High-tech and Low-tech Industries

Tables 4 and 5 demonstrate the results regarding high-tech and low-tech industries, respectively. Regarding both these industries, variables of expected profit do not show significant effect in any models. The significant effect of WAGE in Model 3 disappears when it is controlled for with AVESIZE (Model 2). LNLANDP and SPEC never show any significant effect. The coefficients of UNEMPL are positive and significant in most models of low-tech industries. The effect of UNIV is negative and significant only in low-tech industries. The effect of INST is positive and significant only in high-tech industries. DENS and MRATIO reveal positive and significant effects in both industries. AVESIZE reveals negative and significant effect in both groups. Finally, the coefficient of HITECH is positive and significant in high-tech industries and negative and significant in low-tech industries.

Insert Tables 4 and 5 about here

Summarizing the above results, we can conclude that distinct differences in the regional factors of the start-up ratio between high-tech and low-tech industries were found in the effects of the unemployment ratio, the ratio of university graduates, the ratio of research institutes, and the ratio of high-tech industries. The higher the unemployment ratio and the lower the ratio of university graduates, the higher is the start-up ratio in low-tech industries; however, this is not the case in high-tech industries. The higher the ratio of research institutes and the share of high-tech industries, the higher is the start-up ratio in high-tech industries; however, this does not apply to low-tech industries. The robustness of the results was confirmed with regard to high-tech and low-tech industries using the same method that was used for the entire manufacturing sector.

Discussion

The result that variables of expected profit have no significant effects at all is contrary to our expectation and does not support Hypothesis 1. However, this result is robust and is also supported by a very low correlation with the dependent variables. In fact, few previous studies on the manufacturing sector in Western countries found positive and significant effects of the variables of expected profit. This may be due to the fact that the variables such as price-cost margin and the growth of sales are not appropriate measures of expected profit from a start-up in each region.

The average wage shows a strong negative effect in Model 3. However, considering that the wage level differs across firm size, industry, and the quality of human capital, the fact that this negative effect disappears after controlling for the average business size and other factors suggests that the decision to start new businesses is not strongly affected by the local wage level. Moreover, the price level of industrial estates has no significant impact. Therefore, Hypothesis 2 was not supported.

With regard to the unemployment ratio, Hypothesis 3a (push hypothesis) was supported for the entire manufacturing sector and for low-tech industries. The finding that the effect of unemployment ratio is contrastive between high-tech and low-tech industries is important. This result differs from that of the German study (Nerlinger, 1998), which shows negative and significant effects of the unemployment ratio in both high-tech and low-tech industries. Our results suggest that the start-ups in low-tech industries include, to some extent, self-employment in an attempt to escape from unemployment.

With regard to the impact of human capital, the results indicate negative and significant effects of the ratio of university graduates on the start-up ratio in the entire manufacturing sector and in low-tech industries. Thus, Hypothesis 4b was supported. This result is different from the results of previous studies conducted in Western countries (Guesnier, 1994; Armington & Acs, 2002; Acs & Armington, 2004); however, it is consistent with that of the Small and Medium Enterprise Agency (2002)[6]. This negative impact of the ratio of university graduates can be explained with the opportunity cost of start-up, as previously mentioned. This result and explanation are not consistent with Okamuro and Kobayashi (2006), but the analysis in this paper is different from theirs in that it focuses on the manufacturing sector and standardizes the start-up ratio with the number of existing establishments.

The ratio of research institutes has positive and significant impacts only on the start-up ratio in high-tech industries. This result supports Hypothesis 5 with regard to high-tech industries and is consistent with the previous studies conducted in Germany (Felder et al., 1997; Nerlinger, 1998).

It was also found that the business density and the weight of the manufacturing sector have a positive impact on the start-up ratio in both high-tech and low-tech industries. These results are highly significant and robust and support Hypothesis 6, although the effect of industry specialization was not found. Thus, the seedbed function of industry agglomeration in the sense that the agglomeration of manufacturing plants promotes the start-up of new plants was verified both in high-tech and low-tech industries, although we found no effects of industrial specialization.

The result that the start-up ratio of manufacturing plants is higher in the regions where the average size of manufacturing plants is small corresponds to that of most previous studies and supports Hypothesis 7[7].

Finally, the ratio of high-tech industries has positive (negative) and significant effects on the start-up ratio in the high-tech (low-tech) industries. This result suggests that potential founders in the regions with a high ratio of high-tech industries tend to start new businesses in high-tech industries. This trend can be intuitively understood, considering the importance of job experience prior to start-up and of business networks in the same and related industries after the start-up.

As a whole, the above results support Hypotheses 3a, 4b, 5, 6, and 7; however, they do not support Hypotheses 1, 2, 3b, and 4a. Summarizing these results, it can be concluded that the overall start-up ratio in the manufacturing sector is higher in the regions with a higher unemployment ratio, a lower ratio of university graduates, a higher ratio of research institutes, a higher business density, a higher weight of manufacturing industries, a higher weight of high-tech industries, and a smaller average business size. Moreover, unlike low-tech industries, the start-up ratio in high-tech industries is not affected by the unemployment ratio and the ratio of university graduates, but is positively and significantly affected by the ratio of research institutes and the weight of high-tech industries.

All the models in this analysis include the variables of business density or the price of industrial estates. As discussed before, it is assumed that these variables control for the possibility of the relocation of existing establishments to some extent because the availability of large industrial estates at low prices mainly attracts the relocation. Therefore, the results of this paper with regard to all the variables except for

DENS and LNLANDP explain the determinants of new start-ups rather than those of relocations.

From the empirical results of our analysis, some policy implications can be derived for the promotion of start-ups in the manufacturing sector, especially in high-tech industries. First, our results demonstrate the seedbed function of industry agglomeration. Therefore, the policy measures to maintain and to develop the existing industry agglomeration are also important in order to promote innovative start-ups. Second, for the promotion of start-ups in high-tech industries, it is useful to attract and support research institutes and build intellectual infrastructure in the region.

Conclusion

The start-up of new businesses contributes to the vitalization of the economy through competition, innovation, and job creation. In particular, the promotion of innovative start-ups is an important policy matter also from the viewpoint of regional economies. Nevertheless, few empirical studies have thus far focused on the regional determinants of innovative start-ups. In this paper, we tried to fill this gap by comparing the impacts of regional factors on the start-up ratio between high-tech and low-tech industries. This point is a major contribution of this paper.

This paper analyzed the regional determinants of the start-up ratio in the Japanese manufacturing sector during the period between 1998 and 2000. This period marked the peak of the continuous stagnation of start-up activity in Japan, which has the lowest level of start-up activity among the advanced economies. The stagnation of start-up activity in Japan is particularly serious in the manufacturing sector, which is the major source of innovation. However, few in-depth empirical studies have been conducted thus far with regard to the regional start-up ratio in the Japanese manufacturing sector. Thus, another contribution of this paper is that it provides evidence from Japanese manufacturing industries for international comparison.

The results of OLS estimation with a sample of 253 industrial districts suggest that the business density, the share of the manufacturing sector, and the average business size significantly affect the start-up ratio (the number of start-ups per 10,000 labor force) both in high-tech and low-tech industries; however, we could not find significant effects of the expected profit and cost of start-up. Distinct differences in the regional determinants of the start-up ratio between high-tech and low-tech industries could be found with regard to the unemployment ratio, the ratio of university graduates, the ratio of research institutes, and the share of high-tech industries. As a whole, these results imply the importance of human capital, industry agglomeration especially of high-tech industries, and research infrastructure in the region in creating innovative start-ups.

Despite some original contributions to the research of entrepreneurship and regional innovation, this study possesses certain shortcomings due to the limitations of data. One important shortcoming is that we cannot precisely distinguish between real start-ups and relocations of existing establishments. Another and more serious problem is that our data do not consider start-ups with less than 4 persons engaged (employers and employees). Therefore, in generalizing our results, we have to implicitly assume that there exist no differences between start-ups with less than 4 persons engaged and the larger ones with regard to the effects of regional factors.

Another problem is the interdependence between the regions. Industrial districts as defined in the "Census of Manufactures" may not necessarily be the optimal units of regional analysis. In other words, the decision to start a new manufacturing plant in a region may be influenced not only by the characteristics of this region but also by those of the regions around it (Anselin, 1988). Therefore, future researches should explicitly consider the possible influence of the factors of neighboring regions.

Notes

1 The start-up ratio is calculated here as the number of new establishments (annual average during the period) divided by the number of establishments at the beginning of the period. Note that this definition of the start-up ratio is different from that used in this paper, as described later in more detail.

2 For example, "state-of-the-art technology industries" are those with an average R&D intensity higher than 8.5%.

3 Such an underestimation can be slightly modified since these “start-ups” include incumbent establishments whose number of persons engaged was less than 4 in 1998 but increased to 4 or more in 2000.

4 With the same purpose, Felder et al. (1997) limit the objects of their research to the start-up firms with 20 or less employees. According to the Research Institute of the National Life Finance Corporation (2001), only 3% of their sample firms in the manufacturing sector had 20 or more employees at the beginning. These data provide

support to our approach of focusing on the new plants with less than 20 persons engaged.

5 For example, the food industry dummy takes on the value of 1 for the region where this industry has the largest share with regard to the number of establishments, and 0 otherwise.

6 They estimated the start-up ratio of male employees in their thirties using micro data from the "1997 Employment Status Survey" and demonstrated that university graduates are significantly less likely to start new businesses.

7 This result is contrary to that of Okamuro & Kobayashi (2006). However, while they employ the start-up ratio standardized by the number of existing establishments (ecological approach), this paper employs the start-up ratio standardized by the size of labor force (labor market approach). Several studies (Audretsch & Fritsch, 1994a, 1994b; Keeble & Walker, 1994) show that the average business size has a positive effect on the start-up ratio defined by the ecological approach, but has a negative effect on that defined by the labor market approach. They argue that in regions with a large average business size, the number of existing plants is relatively small as compared with the number of employees and thus with the number of potential founders of new

businesses. Therefore, when we use the number of existing establishments as the denominator of the start-up ratio, the larger the average business size, the higher is the value of the dependent variable. However, this does not indicate a causal relation.

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FIGURE 1
Start-up and Closure Ratio in the Japanese Manufacturing Sector (Establishment Level)

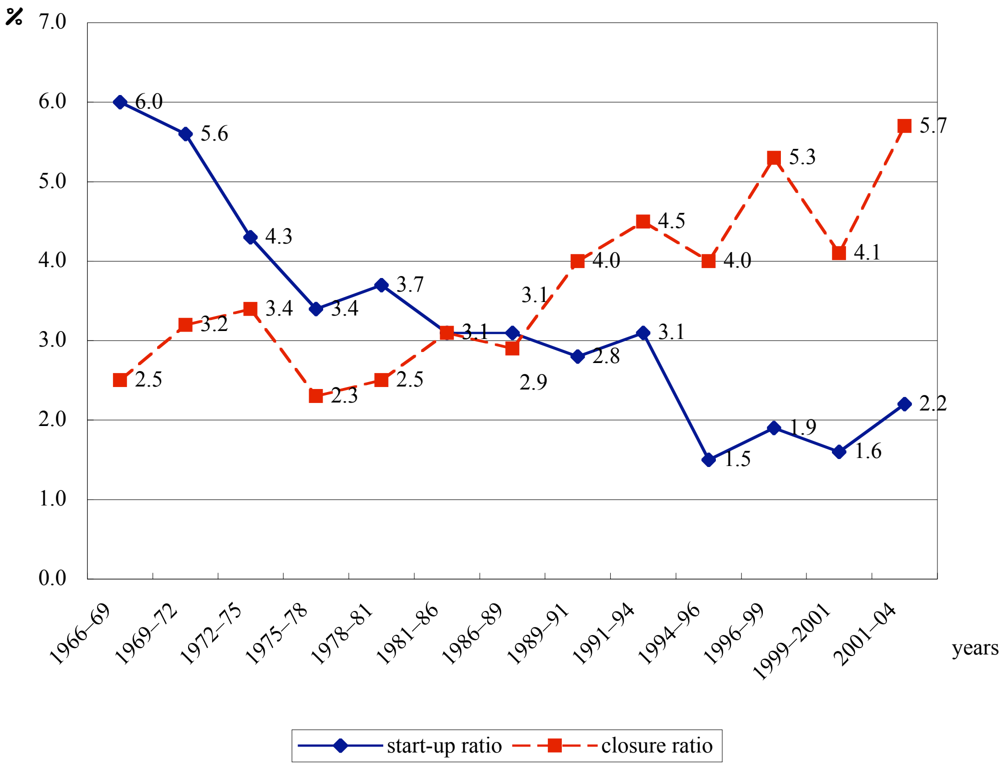

TABLE 1

Definitions of Variables

Variables	Meaning	Definition	Year/Period	Original Data Sources
START	Start-up Ratio	# of gross start-ups in manufacturing industries per 10,000 labor force	1998–2000	Micro data of the Census of Manufactures
START_H	High-tech Start-up Ratio	# of gross start-ups in high-tech manufacturing industries per 10,000 labor force	1998–2000	Micro data of the Census of Manufactures
START_L	Low-tech Start-up Ratio	# of gross start-ups in low-tech manufacturing industries per 10,000 labor force	1998–2000	Micro data of the Census of Manufactures
PCM	Gross Profit Ratio	(Value added–wages) / shipment in the manufacturing sector	1998	Census of Manufactures
GRSALES	Sales Growth	(Shipment of the manufacturing sector in 1998 / shipment of the manufacturing sector in 1995) –1	1995–98	Census of Manufactures
WAGE	Average Wage	Average annual wage in the manufacturing sector in 10,000 Yen	1998	Census of Manufactures
LNLANDP	Average Land Price	Average price of industrial estates per square meter in 100 Yen in logarithm	1998	Land Price Survey in Prefectures
UNEMPL	Unemployment Ratio	# of unemployed / size of labor force	1995	Population Census
UNIV	Ratio of University Graduates	# of university graduates / size of population (15 years and older)	2000	Population Census
INST	Ratio of Research Institutes	# of research institutes and laboratories / # of manufacturing plants	1995/96	Establishment and Enterprise Census
DENS	Business Density	# of manufacturing plants per square kilometer	1995/96	Establishment and Enterprise Census
SPEC	Industry Specialization	Sum of the squared shares of 2-digit manufacturing industries measured by # of establishments	1998	Census of Manufactures
MRATIO	Manufacturing Ratio	# of employees in manufacturing / # of employees in the non-primary sector	1996	Establishment and Enterprise Census
HITECH	High-tech Ratio	Ratio of plants in high-tech industries to the total number of manufacturing plants	1998	Micro data of the Census of Manufactures
AVESIZE	Average Size	Average # of employees in manufacturing plants	1996	Establishment and Enterprise Census

a) In calculating the start-up ratio, start-ups with 20 or more employees in 2000 are excluded.

TABLE 2

Sample Statistics

Variables	Mean	Median	Std. Div.	Min.	Max.	# of obs.
START	2.51	2.20	1.40	0.516	12.88	253
START_H	0.83	0.66	0.65	0	4.22	253
START_L	1.69	1.48	0.92	0.32	8.66	253
PCM	0.216	0.215	0.046	0.055	0.344	253
GRSALES	0.009	–0.003	0.084	–0.230	0.361	252
WAGE	392.9	386.4	81.2	228.6	653.0	253
LNLANDP	6.082	5.981	0.802	3.807	8.098	194
UNEMPL	0.037	0.037	0.012	0.015	0.118	253
UNIV	0.093	0.087	0.035	0.038	0.222	253
INST	0.004	0.003	0.005	0	0.029	253
DENS	8.19	4.09	17.6	0.33	167.3	253
SPEC	0.117	0.105	0.042	0.070	0.374	253
MRATIO	0.238	0.233	0.082	0.076	0.486	253
HITECH	0.293	0.296	0.099	0.060	0.640	253
AVESIZE	19.0	18.8	6.4	4.5	49.4	253

TABLE 3

Estimation Results for the Entire Manufacturing Sector

OLS; Dependent variable = START

Variables/Models	1	2	3	4
Constant	1.53 (3.34)***	1.44 (3.04)**	0.945 (1.79)	0.720 (1.18)
PCM	–0.796 (–0.716)	–0.999 (–0.888)	–0.551 (–0.459)	–0.288 (–0.219)
GSALES	0.0893 (0.128)	0.143 (0.204)	–0.794 (–1.09)	0.0865 (0.0881)
WAGE		–0.000619 (–0.678)	–0.00373 (–3.76)***	
LNLANDP				0.0110 (0.124)
UNEMPL	8.71 (2.07)*	7.11 (1.66)	5.95 (1.16)	15.0 (2.00)*
UNIV	–4.47 (–2.41)*			
INST	25.4 (2.44)*	18.1 (1.71)		13.5 (1.22)
DENS	0.0180 (3.86)***	0.0157 (5.02)***	0.0271 (3.79)***	
SPEC	–1.44 (–1.02)	–0.921 (–0.634)	0.0965 (0.0598)	
MRATIO	8.65 (9.72)***	8.85 (9.48)***	8.23 (8.73)***	9.38 (9.41)***
AVESIZE	–0.0798 (–9.28)***	–0.0770 (–8.09)***		–0.0843 (–9.36)***
HITECH	1.99 (2.69)**	1.65 (2.18)*	2.41 (2.89)**	1.80 (2.22)*
adj. R2	0.559	0.550	0.457	0.552
F value	32.6***	31.4***	27.2***	30.4***
# of obs.	250	250	250	192

a) Three districts in which the start-up ratio exceeds the mean value of all the districts plus three times the standard deviation were excluded from the sample as outliers.

b) Heteroskedasticity-consistent t values in parentheses.

c) Levels of Significance: * $p < .05$

** $p < .01$

*** $p < .001$

TABLE 4

Estimation Results for High-tech Industries

OLS; Dependent variable = START_H

Variables/Models	1	2	3	4
Constant	–0.200 (–0.958)	–0.233 (–1.10)	–0.372 (–1.71)	–0.179 (–0.693)
PCM	–0.237 (–0.539)	–0.293 (–0.672)	–0.157 (–0.341)	–0.0902 (–0.190)
GRSALES	–0.165 (–0.616)	–0.145 (–0.538)	–0.440 (–1.54)	–0.465 (–1.46)
WAGE		–0.0000986 (–0.277)	–0.000879 (–2.43)*	
LNLANDP				–0.00787 (–0.229)
UNEMPL	0.626 (0.339)	0.153 (0.0824)	–0.138 (–0.0649)	2.79 (0.967)
UNIV	–1.15 (–1.49)			
INST	14.8 (3.11)**	12.7 (2.62)**		10.3 (2.09)*
DENS	0.00544 (4.37)***	0.00477 (4.26)***	0.00790 (3.90)***	
SPEC	0.315 (0.420)	0.477 (0.644)	0.832 (1.17)	
MRATIO	2.51 (5.63)***	2.55 (5.59)***	2.13 (5.19)***	2.63 (5.48)***
AVESIZE	–0.0244 (–6.24)***	–0.0239 (–6.02)***		–0.0278 (–6.56)***
HITECH	2.90 (9.74)***	2.80 (9.40)***	3.01 (9.35)***	2.77 (8.86)***
adj. R2	0.613	0.609	0.567	0.618
F value	39.9***	39.4***	41.2***	39.4***
# of obs.	247	247	247	191

a) Six districts in which the start-up ratio exceeds the mean value of all the districts plus three times the standart deviation were excluded from the sample as outliers.

b) Heteroskedasticity-consistent t values in parentheses.

c) Levels of Significance: * $p < .05$

** $p < .01$

*** $p < .001$

TABLE 5

Estimation Results for Low-tech Industries

OLS; Dependent variable = START_L

Variables/Models	1	2	3	4
Constant	1.75 (4.91)***	1.68 (4.50)***	1.33 (3.25)**	0.938 (2.17)*
PCM	–0.373 (–0.415)	–0.510 (–0.557)	–0.193 (–0.206)	0.149 (0.156)
GRSALES	0.115 (0.243)	0.155 (0.325)	–0.435 (–0.913)	0.216 (0.330)
WAGE		–0.000310 (–0.454)	–0.00256 (–3.60)***	
LNLANDP				0.0155 (0.270)
UNEMPL	7.77 (2.42)*	6.67 (2.05)*	5.94 (1.60)	11.5 (2.25)*
UNIV	–2.81 (–2.22)*			
INST	6.17 (0.801)	1.34 (0.176)		2.25 (0.288)
DENS	0.0117 (4.24)***	0.0101 (5.61)***	0.0179 (4.15)***	
SPEC	–1.78 (–1.62)	–1.42 (–1.25)	–0.829 (–0.627)	
MRATIO	5.85 (9.21)***	5.96 (9.30)***	5.89 (8.92)***	6.80 (9.83)***
AVESIZE	–0.0510 (–7.98)***	–0.0495 (–6.69)***		–0.0562 (–8.48)***
HITECH	–1.28 (–2.39)*	–1.51 (–2.73)***	–1.02 (–1.72)	–1.27 (–2.08)*
adj. R2	0.431	0.422	0.322	0.473
F value	19.9***	19.2***	15.8***	22.4***
# of obs.	250	250	250	192

a) Six districts in which the start-up ratio exceeds the mean value of all the districts plus three times the standard deviation were excluded from the sample as outliers.

b) Heteroskedasticity-consistent t values in parentheses.

c) Levels of Significance: * p < .05

** p < .01

*** p < .001