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# Utilization of External and Internal Information as Key Drivers for Innovations in Regional High-tech SME's

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## Abstract

In this study, we analyzed contributions of external and internal information sources to the creation of various types of innovations in Japanese regional high-tech SMEs. According to the aggregation of questionnaire survey data in accordance with the Oslo Manual, it is shown that these SMEs are vigorously engaged in innovation creation activities utilizing multiple external information sources such as customers, universities and suppliers simultaneously. In addition, regression analysis shows that the contribution of each information source differs depending on the type of innovation. In fact, information from firm's internal resources contribute significantly to the realization of two types of product innovations and process innovations for business process. On the other hand, information obtained from suppliers plays significantly important roles in the product innovation based on imitation and process innovations concerning manufacturing or production method. As for regionality, firm's location in the suburbs of Tokyo where many information sources are concentrated, is not always advantageous to create innovations. It is confirmed that the effects of regionality also varies depending on the type of innovation.

*Keywords:* Innovation, SME, Knowledge Management, Information, Region.

## 1 Introduction

In recent years, unprecedented changes in the natural environment surrounding us greatly impact our business. In fact, the coronavirus outbreak has had a major impact on the retail and tourism sectors, while triggering a push for digitalization in many business areas. In addition, global warming is causing catastrophic disasters around the world, which drives efforts and investment to create new industries to decarbonize the world [1]. Furthermore, in new key industries such as EVs, the battle for supremacy is intensifying, involving not only traditional automobile manufacturers such as Volkswagen, BMW and Toyota, but also rapidly growing new entrants such as Tesla, BYD and SGMW. In a word, we are entering the age of VUCA [2].

Under such circumstance, innovation in corporate management is becoming increasingly important. Indeed, Barney, who is one of the most influential scholars in management study,

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pointed out that Schumpeterian competition based on innovation is most important among three types of competitions† when our business environment is full of uncertainty [3]. To realize innovations in a firm, there exists a consensus among scholars that ambidextrous management based on knowledge exploration and exploitation is crucial ([4], [5], [6]). In this context, it is inferred that external and internal information sources for knowledge acquisition is quite important in the process of innovation creation.

By the way, many innovation surveys in the world including Japan show that, in general, SMEs (Small and Medium sized Enterprises) are less innovative than large firms. For example, according to 4th Japanese national innovation survey, the percentage of large firms that achieved product innovation during last three years was 27%, while that of small firms with less than 50 employees was only 11% [7]. Since SMEs generate approximately 70% of employment in Japan [8], it is an urgent task to enhance their ability to innovate in today's uncertain business environment. Concerning the mechanism to realize innovation in SMEs, it is presumed that external knowledge acquisition is quite important since their management resources are limited in nature. In the present paper, we focus on high-tech SMEs to investigate what types of information sources are perceived to be important, and how these contribute to their innovations based on statistical analyses.

In Japan, SMEs with advanced technological capabilities are concentrated not only in metropolitan areas but also in local regions. For example, Hamamatsu City in Shizuoka prefecture is famous for the concentration of small manufacturing firms, while Sapporo City in Hokkaido prefecture is a well-known regional cluster of small ICT ones. From the perspective of regional revitalization, innovations created by regional SMEs are expected to form a solid basis for the development of local economy. Therefore, in the present study, in addition to the contributions of external and internal information sources, we also investigate the effects of regionality when SMEs try to realize innovations.

## 2 Former Studies and Research Objectives

Schumpeter, who coined the term "innovation", defined it as a new combination of existing knowledge [9]. To enhance organizational learning for innovation, prior managerial studies have demonstrated that ambidextrous management is quite effective ([4], [5], [6]). In this research context, it is presumed that external information sources are quite important in the process of knowledge exploration since it entails a shift from current knowledge base inside a firm [10].

Concerning external information sources, according to social network theory, actors who are in positions to fill the structure holes have an advantage in terms of innovation creation. In fact, various studies have shown that such actors have information and control advantages over others, which contribute to the creation of new ideas ([11], [12]). It is also known that a network with rich weak ties has high efficiency in knowledge transmission [13] which will also generate a solid basis for innovation. From the point of view of each SME, it is not easy to recognize their own position in their business network. However, at least, having contacts with various external organizations even without close business relationships will enhance their innovation capability.

By the way, manufacturing industries in Japan, including the automobile and home appliance industries, are supported by many SMEs which are collectively called "supporting industries" [14]. These SMEs are not just cost competitors but also innovators in their niche markets

† Three types are (i) IO competition based on industrial organization theory, (ii) Chamberlinian competition based on monopolistic competition model and (iii) Schumpeterian competition based on innovation [3].

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utilizing their own unique core technologies. Many empirical studies mention that such innovative SMEs actively collaborate with external organizations during the development of new products, compensating for their limited resources, knowledge and technologies ([15], [16]). The purpose of the present study is to clarify how high-tech SMEs perceive the importance of various information sources, and how this contributes to innovation creation, taking regional characteristics into account.

## 3 Data and Analysis

In the following analysis, we utilized the results of an innovation survey for high-tech SMEs conducted in 2012. Though the dataset is rather old, it is useful because the questionnaire is based on the Oslo Manual by OECD [17] which has been commonly used in many innovation surveys in the world. The target firms of this survey are SMEs approved for the subsidy of the "Strategic Support Project for Advancement of Core Manufacturing Technologies (Sapoin Project, in Japanese)" by the government [18] which is one of the largest supporting measures for high-tech SMEs in Japan. In this survey, 416 companies were responded.

In the present analysis, we focus on five specific types of innovations, i.e., two types of product innovations and three types of process innovations (Table 1). In line with former surveys, the questionnaire for this study asked whether the company had specifically created each type of innovation in the past four years. In other words, we analyzed binary data concerning realization of each specific type of innovation.

Table1: Innovations focused on in the present analysis:

| | Types of Innovation | Examples of Questions in the Survey Form |
|---|---|---|
| 1 | Product Innovation leading the Market | Have you sold any groundbreaking new products or services since 20XX that are ahead of your competitors ? |
| 2 | Product Innovation based on Imitation of Competitors | Have you sold a new product or service that your competitors were already offering but that was revolutionary for you since 20XX ? |
| 3 | Process Innovation in Manufacturing or Production Methods | Have you introduced any new or significantly improved manufacturing or production methods since 20XX ? |
| 4 | Process Innovation in Logistics and Delivery methods | Have you introduced any new or significantly improved logistics or delivery methods since 20XX ? |
| 5 | Process Innovation for Business Support | Have you implemented new or significantly improved methods in your business support processes, such as maintenance, purchasing/procurement, accounting, or human resource management since 20XX ? |

Concerning the information sources, in the questionnaire, we asked about the importance of them when a SME attempts to realize product and process innovations. More specifically, the respondents are asked to estimate the importance of following information sources, i.e., "customers", "suppliers", "competitors", "financial institutions/ consultants", "universities and other research institutions", "academic societies and associations", "exhibitions" and "internal resources in the firm" in four level scales, when they attempt to acquire the technology, knowledge and “awareness" (“Kizuki” in Japanese) for innovation.

## 4 Hypotheses

The hypotheses to be tested in this study are described as follows:

Hypothesis 1: When creating product innovation in domestic high-tech SMEs, external sources

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of information are important, especially, the importance of information from "customers" is high.

Hypothesis 2: Different types of innovations have different key sources of information that significantly contribute to their creation. Especially, importance of suppliers is significant for process innovations related to manufacturing or production method.

Hypothesis 3: For domestic high-tech SMEs locating in Tokyo and the Kanto region, where many information sources are aggregated, is advantageous for innovation creation.

We set hypothesis 1 above since most of the respondent firms are presumed to support domestic large manufacturing firms. Rather than utilizing technology to realize disruptive innovation which strongly affects our daily life, they are more likely to solve the problems of their important customers (e. g., large manufacturing firms) technologically.

However, when imitating other companies' products or improving their own internal manufacturing methods, the important information sources will probably differ. In this context, a part of regional high-tech SMEs in Japan forms strategic alliances to realize innovative products, compensating for their limited capabilities [19]. We deduce hypothesis 2 since each member firm would be a supplier for others in such a strategic SME alliance.

Hypothesis 3 means that firm location in Tokyo or its surrounding areas, where a wide variety of firms are concentrated, will contribute positively to innovation creation. Especially, in case of acquisition of tacit knowledge which transmits nonverbally, it would be advantageous to be located geographically near the source of information. In the following analysis, Japan is divided into eleven regions based on the electoral districts for proportional representation system in Japan [20].

# 5 Results of Analysis

In this section, firstly, we present the basic statistics concerning "innovation creation" and "importance of information sources" including the regional perspective. After that, results of the regression analysis are reviewed.

## 5.1 Innovations and Regional Characteristics

One of the key characteristics of the target companies in this study is the high creation rate of market-leading product innovation (Table 2). In the present dataset, about 44 per cent of the respondents have achieved this type of innovation, while past innovation surveys in Japan show that it is about 20 per cent in manufacturing industry[‡]. It is also worth noting that this percentage (44%) is higher than the creation rate of imitation-based innovation (30%) which is usually easier to realize. In a word, target SMEs in the present study are creators of truly innovative products and services.

Another characteristic of this dataset is the high rate of process innovations in manufacturing

[‡] According to the past innovation surveys, the percentage does not show large temporal fluctuation. From the result of 4th Japanese innovation survey, it is shown that 17 per cent of manufacturing firms had realized market-leading product innovation in the past three years, which corresponds to 22.8 per cent in the four years [7] .

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or production method. So far, this type of process innovation has traditionally been special forte in Japanese manufacturing firms, however, it is worth to mention that total average (57%) is more than two times higher than that (25.2% in four years) reported in previous survey [7].

Table 2: Realization Rate of Innovation Creation (Past Four Years)

| | Region | # of firms | Market-leading Product Innovation | Product Innovation based on Imitation | Process Innovation in Manufacturing or Production Method | Process Innovation in Logistics /Delivery Method | Process Innovation for Business Support |
|---|---|---|---|---|---|---|---|
| 1 | Hokkaido | 11 | 45%. | 27%. | 64%. | 0% | 27% |
| 2 | Tohoku | 30 | 23%. | 23%. | 57%. | 3% | 17% |
| 3 | North Kanto | 38 | 47%. | 26%. | 50%. | 11% | 24% |
| 4 | South Kanto | 29 | 59%. | 21%. | 41%. | 3% | 34% |
| 5 | Tokyo | 34 | 62%. | 38%. | 38%. | 12% | 21% |
| 6 | Hokuriku-Shinetsu | 39 | 26%. | 33%. | 76%. | 11% | 39% |
| 7 | Tokai | 84 | 49%. | 30%. | 63%. | 13% | 25% |
| 8 | Kinki | 95 | 44%. | 33%. | 52%. | 7% | 29% |
| 9 | Chugoku | 21 | 38%. | 29%. | 62%. | 19% | 19% |
| 10 | Shikoku | 13 | 31%. | 15%. | 46%. | 8% | 8% |
| 11 | Kyushu & Okinawa | 17 | 41%. | 47%. | 69%. | 12% | 35% |
| | Total | 410 | 44% | 30% | 57% | 10% | 27% |

As for regionality, concerning the creation of "market-leading product innovation", regions with high rates are (i) Tokyo (62%), (ii) South Kanto (59%) and (iii) Tokai (49%). As expected, the rate is high in Tokyo and its suburbs (Kanto regions) while it is below 30% in Tohoku (23%) and Hokuriku-Shinetsu (28%) region. On the other hand, concerning "product innovation based on imitation", the top ranks are quite different. Top four regions are (i) Kyushu-Okinawa (47%), (ii) Tokyo (38%), (iii) Hokuriku-Shinetsu (33%) and Kinki (33%).

These two types of product innovation are considered to have essentially different aspects. In fact, to realize market-leading product innovation, it is not enough to simply acquire information of other companies' advanced products or services; it is necessary to generate new ideas inside the firm and uniquely deepen accumulated knowledge and technological capabilities. On the other hand, to create imitation-based innovation, the firm has a clear goal to achieve. There is less necessity for idea creation and more emphasis is placed on knowledge exploitation. However, since imitation of other companies' products encourages organizational learning, it may help enhance firm's capability to create innovations including market-leading ones. Therefore, regions with high rates of imitation-based innovation could be viewed as being in the "preparation stage" of creating market-leading innovations.

As for the three types of process innovations, since they are essentially dissimilar, regional differences are evident. For example, concerning realization rate of "process innovation in manufacturing or production method", top three regions are (i) Hokuriku-Shinetsu (76%), (ii) Kyushu-Okinawa (69%) and (iii) Hokkaido (64%) while they are (i) Chugoku (19%), (ii) Kyushu-Okinawa (12%) and (ii) Tokyo (12%) for process innovation in logistics or delivery. The regional differences in various types of innovation mentioned above will be examined later in the regression analysis at the firm level.

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## 5.2 Importance, Multiplicity, and Regionality of Various Information Sources

Next, we show the summary table concerning the importance of various information sources for innovation creation (Table 3). In this study, the importance is rated on a four-point scale with higher numbers indicating greater importance. Specifically, numbers 1 and 2 basically correspond to the unimportant rating while numbers 3 and 4 to the important one.

Concerning the aggregated result of the entire data, the most important information source is "Customers and End Users" with a high average of 3.6. As mentioned earlier, companies in this dataset are SMEs in supporting industries. This result is not surprising because they are presumed to be creating innovations in a market-pull context rather than a technology-push one. The second most important factors are "Universities and Public Research Institutes" (3.0) and firm's "Internal Resources" (3.0). Among these, the former is likely to play an important role in the process of "knowledge exploration" while the latter forms the foundation of ambidextrous innovation management. Average scores of following "Suppliers" (2.9), "Competitors" (2.7) and "Exhibitions and Trade Fairs" (2.7) do not differ greatly, suggesting the utilization of multiple information sources.

Table 3: Importance and Multiplicity of Information Sources

| | Region | Importance of information Sources | | | | | | | | Multiplicity |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Internal Resources | Suppliers | Customers End Users | Competitors | Financial Institute, Consultant. | Universities, etc. | Academic Societies, etc. | Exhibitions, etc. | |
| 1 | Hokkaido | 2.8 | 2.4 | 3.0 | 2.3 | 2.1 | 3.0 | 2.6 | 2.8 | 6.0 |
| 2 | Tohoku | 3.0 | 3.1 | 3.6 | 2.9 | 2.0 | 3.4 | 2.4 | 2.7 | 6.5 |
| 3 | North Kanto | 2.9 | 3.0 | 3.6 | 2.7 | 1.8 | 3.1 | 2.3 | 2.8 | 6.1 |
| 4 | South Kanto | 3.1 | 2.8 | 3.4 | 2.7 | 2.1 | 3.1 | 2.3 | 3.0 | 5.9 |
| 5 | Tokyo | 2.9 | 2.6 | 3.5 | 2.4 | 1.6 | 3.1 | 2.6 | 2.8 | 6.2 |
| 6 | Hokuriku-Shinetsu | 3.0 | 2.7 | 3.7 | 2.7 | 1.9 | 2.8 | 2.1 | 2.6 | 6.2 |
| 7 | Tokai | 3.0 | 3.0 | 3.6 | 2.6 | 2.0 | 2.9 | 2.2 | 2.6 | 6.3 |
| 8 | Kinki | 3.2 | 3.0 | 3.6 | 2.7 | 1.9 | 2.9 | 2.3 | 2.7 | 6.3 |
| 9 | Chugoku | 2.8 | 2.7 | 3.6 | 2.5 | 2.2 | 2.6 | 2.3 | 2.9 | 6.5 |
| 10 | Shikoku | 2.6 | 2.7 | 3.8 | 2.9 | 1.7 | 2.7 | 2.5 | 2.8 | 6.4 |
| 11 | Kyushu & Okinawa | 3.1 | 3.0 | 3.5 | 2.8 | 1.9 | 3.3 | 2.7 | 2.8 | 6.4 |
| | TOTAL | 3.0 | 2.9 | 3.6 | 2.7 | 1.9 | 3.0 | 2.3 | 2.7 | 6.3 |

To quantify the utilization of multiple information sources, the data is binarized as follows:

(i) each information source rated as "important" (number 4 in a four-point scale) or "somewhat important" (number 3) is transformed to the value 1, respectively,

(ii) Each information source rated as "not very important" (number 2 in a four-point scale) or "not important at all (do not use)" (number 1) is transformed to 0, respectively.

Then, for each firm, we newly defined the "multiplicity" of information sources by adding these values. As shown in the bottom row in Table 3, total average score of "multiplicity" is 6.3. It is suggested that innovative high-tech SMEs in this dataset explore and exploit knowledge by utilizing about six information sources in parallel. However, we could not

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derive clear relationship between multiplicity in Table 3 and creation rate of various types of innovations in Table 1. As for the reason, it is possible that aggregation by region has rounded up the characteristics of individual firms. In the next subsection, we introduce regression models at the firm level to examine the relationships without collapsing the details of the dataset.

### 5.3 Regression Analysis

The basic model for the regression analysis in this study is described as follows:

Innovation (binary)
= *f*( Number of Employees （log）,
Independent Patent Application filed by a Single Firm (binary),
Joint Patent Application (binary), Multiplicity of Information Sources,
Importance of Information Sources, Technological dummies (binary),
Regional dummies (binary) )

The type and basic statistics of the dependent variables " Innovation (binary)" are shown in Table 2, where number of samples in each region is also described. As for "Importance” and “Multiplicity” of Information Sources, they are shown in Table 3. The list of other variables and their basic statistics are shown in Table 4(a) and Table 4(b).

Table 4 (a): Explanatory Variables

| | Explanatory Variables | # of Samples | Average | Std. Dev. | Min | Max |
|---|---|---|---|---|---|---|
| 1 | Number of Employees (log) | 412 | 3.66 | 1.39 | 0 | 6.76 |
| 2 | Independent Patent Application filed by a Single Firm (binary) | 416 | 0.35 | 0.48 | 0 | 1 |
| 3 | Joint Patent Applications (binary) | 416 | 0.33 | 0.47 | 0 | 1 |

Table 4 (b): Technological Dummies

| Technological Dummy | # of firms |
|---|---|
| ICT, Embedded Software, etc. | 65 |
| Chemistry | 7 |

Among these variables, “Independent Patent Application filed by a Single Firm” is a binary variable that measures whether or not patent applications had been filed in the past four years based on the respondent firm’s internal invention. It is adopted because it is considered to be an effective proxy variable measuring internal R&D capability of the firm. On the other hand, “Joint Patent Application” corresponds to a proxy variable for open R&D capability with other organizations.

In the present study, we utilized generalized linear model (GLM) because the dependent variable is binary [21]. The results of the probit regression analysis between the dependent variable for market-leading product innovation and above group of variables is shown in Table 5. Like many previous studies of R&D management in high-tech firms, variables related to patent applications, which can be regarded as proxies for R&D intensity, are significant in the present analysis. In fact, existence of “independent patent application" is significant at the 1% level while that of “joint patent application" is significant at the 5% level.

On the other hand, concerning the importance of information sources, only that of "internal resources" is significant at the 1% level. As for regional characteristics, "Tokyo" is

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significant at the 1% level while "North Kanto," "South Kanto," and "Tokai" are significant at the 5% level. The partial regression coefficients for these variables are all positive signed, indicating positive contributions to the creation of market-leading product innovations.

Among these coefficients, numerically largest one is that for "internal resources". In the context of open innovation, networks and connections with external organizations are presumed to be of great importance. However, the multiplicity is not insignificant in this result, which suggests that each excellent high-tech SMEs in our dataset already utilize their own extensive external networks, respectively. Furthermore, it is implied that no matter how much knowledge and insights they gather from external information sources, the power of internal resources is crucial to embody them within the firm and bring them to fruition as a groundbreaking new product. In other words, the present result reaffirms the importance of the absorptive capacity of the explored knowledge [22].

Table 5: Results of Probit Regression Analysis (Market-Leading Product Innovation)

| Dependent Variable: Market-Leading Product Innovation | | Coeff. | Std. Err. | P>z |
|---|---|---|---|---|
| | Number of Employees (log) | -0.01 | 0.06 | 0.88 |
| | Independent Patent Application filed by a Single Firm | 0.77 *** | 0.15 | 0.00 |
| | Joint Patent Application | 0.37 ** | 0.15 | 0.01 |
| | Multiplicity of Information Sources | -0.06 | 0.10 | 0.58 |
| Information Sources | Internal Resources | 1.30 *** | 0.36 | 0.00 |
| | Suppliers | -0.21 | 0.34 | 0.53 |
| | Customers, End Users | -0.01 | 0.43 | 0.98 |
| | Competitors | 0.06 | 0.31 | 0.86 |
| | Financial Institutions, Consultants, etc. | -0.37 | 0.33 | 0.26 |
| | Universities, Public Research Institutes, etc. | -0.04 | 0.36 | 0.90 |
| | Academic Societies and Associations | 0.31 | 0.36 | 0.38 |
| | Exhibitions and Trade Fairs | 0.13 | 0.36 | 0.71 |
| Technological Dummy | ICT, Embedded Software, etc. | -0.04 | 0.20 | 0.85 |
| | Chemistry | -0.70 | 0.63 | 0.27 |
| Regional Dummy | Hokkaido | 0.62 | 0.49 | 0.20 |
| | Tohoku | -0.09 | 0.37 | 0.82 |
| | Northern Kanto | 0.74 ** | 0.31 | 0.02 |
| | Tokyo | 0.96 *** | 0.34 | 0.01 |
| | Southern Kanto | 0.81 ** | 0.36 | 0.03 |
| | Tokai | 0.61 ** | 0.27 | 0.02 |
| | Kinki | 0.35 | 0.27 | 0.20 |
| | Chugoku | 0.61 | 0.38 | 0.10 |
| | Shikoku | 0.24 | 0.45 | 0.59 |
| | Kyushu and Okinawa | 0.51 | 0.40 | 0.20 |
| | Constant | -1.55 *** | 0.52 | 0.00 |
| Significance: *** 1%, ** 5%, * 10%. | | | | |
| Log Likelihood: -228.8, Pseudo R2: 0.153, Number of Obs.: 394 | | | | |

## 6 Summary and Discussions

In Table 6, the contribution of the importance of information sources and that of regionality to five types of innovations are summarized.

As described in the previous section, "internal resources" and the location of the firm in "Tokyo", "Northern Kanto", "Southern Kanto" and "Tokai" contribute significantly to the creation of market-leading product innovation. On the other hand, for product innovation based on imitation, key contributors are slightly different. In fact, as for the importance of information sources, both "internal resources" and "suppliers" are significant at the 5% level with positive

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coefficient. On the other hand, no significance is found for regional dummies. The result indicates that information from upstream in the supply chain is important for product innovations based on imitation since in supporting industry, it is presumed that introduction of new components or materials will enhance the creation of new products. It is also demonstrated that “internal resources” are critical to the creation of product innovation, regardless of their type.

Table 6: Summary of Probit Regression Analysis[§]

| | | Market-Leading Product Innovation | Product Innovation based on Imitation | Process Innovation (Manufacturing/ Production method) | Process Innovation (Logistics, Delivery) | Process Innovation (Business Support) |
|---|---|---|---|---|---|---|
| | Number of employees (log) | | | +++ | | ++ |
| | Independent Patent Application | +++ | +++ | | | |
| | Joint Patent Application | ++ | | | | |
| | Multiplicity of Info. Sources | | | | | -- |
| Information Sources | Internal Resources | +++ | ++ | | | +++ |
| | Suppliers | | ++ | +++ | | |
| | Customers, End Users | | | | | |
| | Competitors | | | | | |
| | Financial Inst., Consultants, etc. | | | | | ++ |
| | Universities, etc. | | | | | |
| | Academic Societies etc. | | | +++ | | |
| | Exhibitions, Trade Fairs | | | | | ++ |
| Tech. Dummy | ICT, Embedded Software | | | --- | | |
| | Chemistry | | | | | |
| Region | Hokkaido | | | | | |
| | Tohoku | | | | | |
| | Northern Kanto | ++ | | - | | |
| | Tokyo | +++ | | -- | | |
| | Southern Kanto | ++ | | -- | | |
| | Tokai | ++ | | | | |
| | Kinki | | | -- | | |
| | Chugoku | | | | | |
| | Shikoku | | | | | |
| | Kyushu and Okinawa | | | | | |
| | Num. of Obs. | 394 | 394 | 394 | 347 | 391 |
| | PseudoR2 | 0.15 | 0.09 | 0.12 | 0.10 | 0.11 |

On the other hand, key contributors for process innovations are different from those for product innovations. In fact, “internal resources” do not contribute significantly to two types of process innovations concerning “manufacturing or production methods” and “logistics”. Concerning the information from “suppliers”, it contributes significantly only to the process innovation related to “manufacturing or production methods”. In addition, regarding regionality, being located in the “Kanto” and “Kinki” regions contribute significantly with negative coefficients to this type of process innovation. The result indicates that the feasibility of this type of process

[§] Details of the regression analysis are described in Appendix.

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innovation increases when the firm is not located in a metropolitan area. In Japan, huge factories for mass production are often established in local areas where land cost is much lower than in metropolitan areas. One possibility is that the need for the process innovation concerning "manufacturing and production method" is greater for SMEs located around huge factories in local regions than those located in metropolitan areas.

Returning to the hypotheses in Section 3, Hypotheses 1 and 2 are confirmed while Hypothesis 3 is rejected. The advantage of locating in a metropolitan area is limited to "market-leading product innovations" but is rather negative for process innovation related to "manufacturing or production methods".

While this paper provides some new insights into innovation creation by high-tech SMEs in supporting industry, further research is needed to understand the detailed mechanisms. For example, we would better consider not only the importance of external information sources but also the strength of exploitation of them. In the near future, the authors plan to conduct additional survey to deepen the understanding of the detailed mechanisms of innovation creation in regional high-tech SMEs.

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**Appendix:** Probit Regression Analysis for Process Innovations and Product Innovation Based on Imitation.

| Dependent Variable | Product Innovation based on Imitation | | Process Innovation (Manufacturing/ Production method) | | Process Innovation (Logistics, Delivery) | | Process Innovation (Business Support) | |
|---|---|---|---|---|---|---|---|---|
| | Coefficient | S.E. | Coefficient | S.E. | Coefficient | S.E. | Coefficient | S.E. |
| Number of Employees (log) | 0.046 | 0.058 | 0.111 ** | 0.055 | 0.085 | 0.077 | 0.244 ** | 0.062 |
| Independent Patent Application filed by a Single Firm | 0.552*** | 0.155 | 0.106 | 0.155 | -0.064 | 0.219 | -0.104 | 0.164 |
| Joint Patent Application | 0.144 | 0.154 | 0.131 | 0.153 | 0.327 | 0.209 | -0.134 | 0.165 |
| Multiplicity of Info. Sources | -0.008 | 0.105 | -0.088 | 0.097 | -0.064 | 0.135 | -0.228 ** | 0.106 |
| Internal Resources | 0.770 ** | 0.368 | 0.465 | 0.358 | -0.715 | 0.516 | 1.503 *** | 0.394 |
| Suppliers | 0.708 ** | 0.352 | 1.065 *** | 0.340 | 0.650 | 0.482 | -0.126 | 0.358 |
| Customers, End Users | -0.335 | 0.447 | 0.307 | 0.413 | -0.423 | 0.594 | 0.430 | 0.457 |
| Competitors | -0.306 | 0.326 | 0.077 | 0.314 | -0.063 | 0.441 | 0.080 | 0.335 |
| Financial Inst., Consultants, etc. | -0.265 | 0.338 | -0.016 | 0.322 | 0.734 | 0.492 | 0.591 * | 0.348 |
| Universities, etc. | 0.137 | 0.365 | -0.206 | 0.355 | 0.410 | 0.515 | 0.221 | 0.380 |
| Academic Societies etc. | 0.280 | 0.367 | 0.970 *** | 0.360 | 0.231 | 0.532 | 0.595 | 0.383 |
| Exhibitions, Trade Fairs | 0.280 | 0.359 | -0.241 | 0.352 | 0.485 | 0.522 | 0.639 * | 0.377 |
| ICT, Embedded Software | -0.143 | 0.204 | -0.785 *** | 0.199 | -0.556 | 0.366 | -0.168 | 0.218 |
| Chemistry | -0.609 | 0.631 | -0.054 | 0.522 | 0.000 | (Omitted) | 0.243 | 0.564 |
| Hokkaido | -0.600 | 0.561 | -0.049 | 0.486 | 0.000 | (Omitted) | -0.116 | 0.496 |
| Tohoku | -0.383 | 0.357 | -0.114 | 0.338 | 0.000 | (Omitted) | -0.536 | 0.373 |
| Northern Kanto | -0.228 | 0.315 | -0.587 * | 0.305 | -0.119 | 0.399 | -0.409 | 0.321 |
| Tokyo | 0.122 | 0.331 | -0.709 ** | 0.325 | 0.084 | 0.421 | -0.440 | 0.351 |
| Southern Kanto | -0.543 | 0.373 | -0.704 ** | 0.357 | -0.725 | 0.583 | 0.105 | 0.362 |
| Tokai | -0.228 | 0.263 | -0.279 | 0.258 | 0.029 | 0.320 | -0.378 | 0.261 |
| Kinki | -0.233 | 0.266 | -0.520 ** | 0.260 | -0.302 | 0.352 | -0.217 | 0.261 |
| Chugoku | 0.021 | 0.373 | -0.124 | 0.374 | 0.407 | 0.440 | -0.460 | 0.401 |
| Shikoku | -0.557 | 0.502 | -0.524 | 0.428 | -0.248 | 0.629 | -0.899 | 0.570 |
| Kyushu and Okinawa | 0.144 | 0.398 | -0.139 | 0.422 | -0.170 | 0.514 | -0.134 | 0.394 |
| Const. | -1.619 *** | 0.561 | -0.948 * | 0.510 | -1.782 ** | 0.725 | -2.459 *** | 0.574 |
| Num. of Obs. | 394 | | 394 | | 347 | | 391 | |
| Log Likelihood | -217.9 | | -237.9 | | -108.2 | | -204.4 | |
| PseudoR2 | 0.09 | | 0.12 | | 0.10 | | 0.11 | |

(Significance: *** 1%, ** 5%, * 10%)

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