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Applicability of Marshall's Agglomeration Theory to Industrial Clustering in the Japanese Manufacturing Sector: An Exploratory Factor Analysis Approach

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Abstract. This study explores the results of a location survey of new Japanese manufacturing plants from 1997 to 2004 and reports an industrial cluster in Japan. More specifically, this study identifies an industrial cluster and specifies its advantages based on an exploratory factor analysis (EFA), which explores the spatial position of the cluster through spatial variation of factor scores. The major finding of this study is that there exists an industrial cluster factor containing most of the location advantages of a Marshallian industrial cluster, especially the secondary reason of the location choice. In addition, through the spatial analysis of the factor scores, this study identifies two prefectures—Nagano and Niigata—where Marshallian advantages are most effective in attracting plant locations.

1. Introduction

The concept of industrial clusters has attracted substantial research in the last three decades, particularly in the last half century (Cruz and Teixeira, 2010). While various cluster theories have highlighted the different roles and functions of industrial clusters, these theories stem from Marshall's concept of industrial clusters (Asheim, 2000).

Marshall's industrial cluster theory has been refined and rediscovered largely by economic geographers. Many modern location theories, symbolized by the so-called post-Fordist industry, are oriented much more towards non-economic factors such as localized learning (Piore and Sable, 1984; Lawson and Lorenz, 1999; Malmberg and Maskell, 2002), unique culture and institutions (Saxenian, 1994; Martine, 2000), industrial linkages and non-traded interdependencies (Piore and Sable, 1984; Scott, 1988a, 1988b; Storper, 1995), and policy support and regional infrastructure (Porter, 1990 and 2000). These theories are influenced to a certain degree by Marshall's agglomeration theory (Scott, 2000).

Moreover, there are many different perspectives describing the nature of industrial clusters and highlighting the various facets of Marshallian advantages. Examples in economic geography include evolutionary approaches to clusters (Boschma and Lambooy, 1999; Boschma and Frenken, 2006), regional development strategies (Sanz-Menendez and Cruz-Castro, 2005), the institutional approach (Asheim, 2000), the global production network (Young et al., 1994) and knowledge economics and learning (Malmberg and Maskell, 2002). Marshall's concepts were integrated and reinterpreted by recent economic geographers (Krugman, 1991a, b; Fujita et al., 1999; Fujita and Thisse, 2002). Krugman (1991b) noted that demand linkages among firms are the source of industry agglomeration. Fujita (1988) and Rivera-Batiz (1988) incorporated the role of non-traded intermediate inputs (Krugman and Venables,

1996; Puga and Venables, 1997; Venables, 1996a and b).

The importance of Marshall's cluster theory was rediscovered in modern production activities by Porter (1999, 1998, 2000). Unlike the cost advantages of clustering, Marshallian advantages concern the integrated functions of industrial clusters as a whole, and the theory does not treat a firm as an atomistic entity but as a mutually influencing node in a cluster network. This view has generated major location theories such as Porter's cluster theory based on the idea that Marshall's localized benefits lead firms and production activities to agglomerate, and a number of empirical studies (Hanson, 2001; Rosenthal and Strange, 2004, and reference therein) have examined these benefits.

In line with these theories, this study investigates whether such Marshallian location benefits affect the actual location behaviour of Japanese manufacturing plants. Marshall proposed four localized advantages residing in industrial agglomerations: knowledge spillover, a skilled labour pool, development of supporting industries, and shared input resources. These four advantages form the foundation of Marshall's industrial cluster theory. However, no study has confirmed the spatial concentration of these advantages, and therefore these advantages are dispersed across space in a manner that no single region has all advantages. In such a situation, the following questions arise: Are these four advantages localized in a region, collectively forming the industrial cluster advantage? If such a region exists, where is it located in Japan? This study investigates these issues through exploratory factor analysis (EFA). If all four advantages are merged and localized in a region, they should be summarized in a latent location factor. Thus, the objective of this study is to identify such a Marshallian location factor using exploratory factor analysis (EFA) and explore its spatial distribution to specify the location of an industrial cluster.

The inter-firm relationship in the Japanese manufacturing sector is often characterized by the stable supplier-buyer relationship between local small and medium enterprises (SMEs) and a large enterprise, many of which follow a form of keiretsu where they share a single founding entity and/or funding body (Braun, 2002). Many empirical studies on Japanese industrial clusters report that the formation of a local cluster is key to the success of Japanese regional economies. Yamawaki (2002) identifies four important benefits of clusters reported by small firms: specialization of their own production, ease of procurement, diffusion of technologies, and public policy support. However, access to skilled labour is not reported as a significant benefit. Kodama (2008) found an effective role of regional associations with experienced firms in local technology transfers through university-industry collaborations. Takada et al. (2008) discovered that there is a tendency for firms to transact with those in close proximity and that firm location is also affected by the location of the hub firm in the industrial organization. Following this line of research, the present study investigates how such unique industrial relationships are linked to Marshallian advantages in the modern production and technological environment. In particular, this study examines whether Japanese stable supplier-buyer networks can be synchronized with Marshall's cluster advantages as observed during the British industrialization period.

This paper is organized as follows. Section 2 describes the data of the questionnaire survey. Section 3 briefly describes the EFA method and its recent applications. Section 4 presents the results of the exploratory factor analysis and identifies Marshallian industrial cluster factors. Finally, Section 5 concludes by describing the location factors and highlighting the uniqueness of individual regions.

2. Data

The questionnaire data used in this study are published annually by the Japan Industrial Location Centre (JILC), which is closely affiliated to the Ministry of Economy, Trade, and Industry (METI). The objective of this survey is to investigate the actual reasons behind the location choices of new manufacturing plants in Japan, and the results are used to reorganize land development and improve the efficiency of location decisions. The subjects (respondents) and the timing of the survey are described below:

- participating industries: two-digit SIC manufacturing industries
- the range of participants: all plant managers (including research institutions) who bought or rented more than 1,000 m^2 (about 11,000 square feet) of land from 1997 to 2004
- timing of the questionnaire: when the contract is made between the land owner and buyer/lessor (debtor).

The regional authority requires a response to the questionnaire from all buyers/lessors for land areas

larger than 1,000 m^2, which is considered to be new plant construction. Plants with size below 1,000 m^2 are excluded from the study. If we express the size of 1,000 m^2 as a square, the length of one side becomes approximately 31.62 m; therefore, small plants are not included in the study. New plants in this context include those of both relocating firms and new start-ups, which unfortunately cannot be discerned in the survey data.

This questionnaire specifically asks why plant managers chose their location region. It is important to note that the purpose of this questionnaire is not to find why they chose a specific point of location in a region but why they chose a location region within the country. Although some might wonder why other important reasons such as access to highway and industrial zoning are not included in the choices, those factors are more relevant to the choice of a specific location point, not to the choice of a region. The JILC simultaneously conducts another questionnaire survey to find out the reasons for the choice of location point for the project; however, the discussion about this survey goes beyond the scope of this study and the topic should be investigated separately in another study.

Regarding the description of the respondent plants, the average number of employees for the sample plants is 38.4, and the average land area is 11,880 m^2. Also, the plants in the questionnaire survey are distributed into four categories. The first is a production facility integrated with headquarters, which concurrently holds management and administrative functions. The second is a hub production facility specializing solely in production and whose production capacity is the largest in the firm. The third is a peripheral production facility that takes partial charge of the production of the hub production facility (the second type). The final category is a new enterprise production facility to promote R&D and project venture businesses. The proportion of respondents from the first, second, third and fourth types of plants are 38.2%, 28.5%, 21.9% and 8.4%, respectively, from 1997 to 2004; 3.0% of plants belong to none of those four types. For this analysis, plants are not specified by these categories, instead being grouped by industry and prefecture having different proportions of each type of plant.

An additional set of statistics from the survey indicates that plants are strictly tied to their home location and are relatively immobile once their locations are established. The results from 1997 to 2004 suggest that 69.94% of new plants locate within the prefecture where their headquarters are established. While 30.06% of them are constructed in other prefectures, only 11.88% crossed the regional border. Therefore, approximately 90% of the new plants locate within their headquarters' region. Furthermore, 92.87% of relocating plants remained in the original prefecture, 7.13% moved to other prefectures, and only 1.06% crossed the regional border. Thus, most relocating plants located in the original region. Based on these statistics, this study deems plants as rarely mobile entities; their search process is fundamentally myopic (Maskell and Malmberg, 2007), and, although their location options theoretically encompass the entire country, they are limited to their original region.

Table 1 lists the location reasons offered to the respondents, their choice frequencies, and proportions. As the table demonstrates, apparently the most important reason is land availability. Twenty percent of the respondents selected land availability as the primary reason, and this tendency is shared among most plants, implying that land is a precious resource for the Japanese manufacturing sector and the first priority for location choice. The survey also found that firms emphasize proximity to market, related firms, headquarters and raw materials. Other major reasons include support from local government and the costs of land and labour. Therefore, we infer that firms highly prioritize both proximity- and cost-related factors. Figure 1 presents the spatial distribution of the number of new plants and their density. The number of new local plants corresponds to that of the respondents in the survey.

Among location advantages arising from industrial clusters, the proximity to related firms and headquarters, skilled labour, business and logistic services, co-location of plants, and water availability are most closely associated with Marshallian advantages because they represent supporting firms and industries, skilled labour, and shared input resources. Access to research institutions is most closely associated with knowledge spillover because technological transfers are more likely to occur. Thus, although this study's purpose is to identify a region that fulfills all the Marshallian advantages, the proximity to market and raw materials and land-related reasons are considered to be transport-related or cost-based location reasons because they are closely related to transport costs and fixed production costs.

Table 1. Overview of the survey results and the location reasons.

Location reason	Primary reason		Secondary reason	
	freq.	%	freq.	%
Total	5752	100.0%	8349	100.0%
Access to Raw Material Inputs	320	5.6%	560	6.7%
Proximity to Market	696	12.1%	693	8.3%
Proximity to Related Firms	629	10.9%	672	8.0%
Availability of Labour	290	5.0%	975	11.7%
Technical Skills of Labour	30	0.5%	97	1.2%
Proximity to Headquarters	624	10.8%	469	5.6%
Support from National Government	71	1.2%	108	1.3%
Support from Local Government	486	8.4%	803	9.6%
Personal Ties	205	3.6%	240	2.9%
Co-location with Other Firms	62	1.1%	107	1.3%
Availability of Industrial Water	47	0.8%	131	1.6%
Access to Business and Logistic Services	85	1.5%	197	2.4%
Access to Research Institutions	9	0.2%	43	0.5%
Availability of Land	1150	20.0%	1596	19.1%
Land Price	592	10.3%	1317	15.8%
Amenities (Education, Leisure, Shopping)	25	0.4%	90	1.1%
Other	431	7.5%	251	3.0%

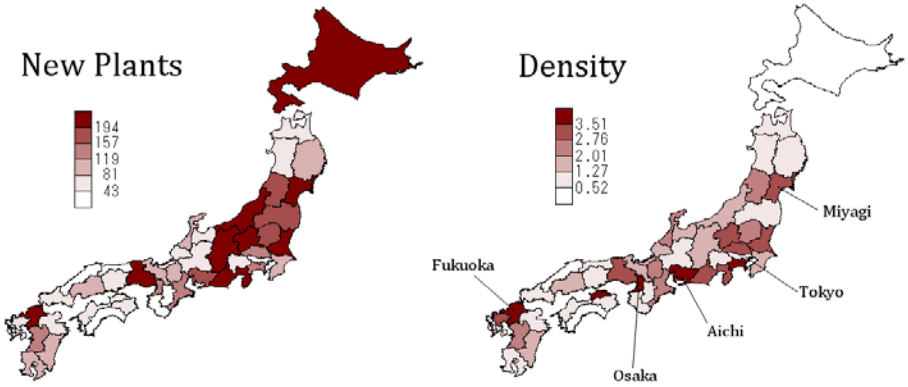

Figure 1. The number of new plants and their density (per 100 km^2).

3. Methodology

This section describes the structure of the data set and discusses the advantages and disadvantages of exploratory factor analysis (EFA). The data set of the survey results is cross-sectional and expressed in a matrix form. Denote i and r, respectively, as the identification number of prefecture and location reason. Let p and q stand for the number of prefectures and location reasons, respectively. Then, $i = \{1, 2, \cdots, p\}$ and $r = \{1, 2, \cdots, q\}$. The frequency of choices in location reason r by prefecture i can be represented by X_{ri}, and the data set can be expressed as a matrix form (1).

$$\boldsymbol{X} = \begin{pmatrix} X_{11} & \cdots & X_{1i} & \cdots & X_{1p} \\ \vdots & \ddots & \vdots & & \vdots \\ X_{r1} & \cdots & X_{ri} & \cdots & X_{rp} \\ \vdots & & \vdots & \ddots & \vdots \\ X_{q1} & \cdots & X_{qi} & \cdots & X_{qp} \end{pmatrix} \quad (1)$$

There are two major advantages of EFA. First, EFA abstracts several reasons evenly emphasized by prefecture into only a few location factors. For example, when the number of factors is limited to three, as they are in the following analysis, the

frequency with which prefecture i selects reason r can be expressed by the following equation.

$$X_{ri} = f_{r1}s_{1i} + f_{r2}s_{2i} + f_{r3}s_{3i} + u_r s^u_{ri} \quad (2)$$

The common factor consists of $f_{r1}s_{1i}$, $f_{r2}s_{2i}$, and $f_{r3}s_{3i}$, where f_{r1}, f_{r2}, and f_{r3} are the factor loadings of the first, second and third factors, respectively, and s_{1i}, s_{2i}, and s_{3i} are the scores of the corresponding factors for prefecture i, which is useful for evaluating the regional uniqueness of the location behaviour. The specific factor is represented by $u_r s^u_{ri}$, and s^u_{ri} is the score of the specific factor. All unique prefectural characteristics not exhibited by the common factors are assumed to be summarized in this specific factor.

In essence, EFA is a data summarization technique and is helpful to identify a few underlying location factors. Specific to the purpose of this research, EFA is particularly useful in characterizing the location pattern of an individual prefecture by the variation of factor scores, whose location factors are numerically specified by the loadings. The issue is whether we can find a plant manager's tendency to search for Marshallian advantages in the general decision-making process, rather than directly and distinctly asking the importance of these advantages. In doing so, EFA is a quite useful technique for finding such aggregated advantages in the underlying location trend in the raw survey data.

The X_{ri} are under no influence of the specific factor, being dependent only on f_{rk} and s_{ki}, where k is the identification of factors. Since f_{rk} is equally shared by all prefectures, the variance of prefecture-specific X_{ri} depends solely on the variance of prefecture-specific s_{ki}. Because the purpose of this study is to characterize regional variety in location reasoning, the variation of prefectural scores plays a crucial role in measuring the spatial difference. Once an industrial cluster factor is identified, the influence of agglomeration advantages can be measured by the magnitude of the scores.

Hair et al. (2006) defined the meaning of factor loadings and factor scores accurately. Factor loadings are the correlation of the original variables (location reason) and underlying factors summarizing the variables, and loadings indicate the degree of correspondence between the variable and the factor. Therefore, higher loadings make the variable more representative of the factor, and loadings are the means of interpreting the role of each variable in defining underlying factors. The factor score is a composite measure created for each observation (prefecture) for each factor. The factor score conceptually represents the degree to which each observation is significantly associated with a factor consisting of several variables. In this study, higher factor scores represent a greater number of new plants selecting their location because of that location factor, and as equation (2) represents, the dependent variable is the number of new plant locations due to reason r and the independent variable is the factor scores of the three factors computed for each prefecture. EFA is performed on the raw choice frequency data; therefore, the magnitude of factor scores for individual prefectures directly correlates with the number of new plant locations due to advantages summarized in the location factor.

In processing the EFA, the author applies the maximum likelihood method, which is commonly used in such analysis, to extract the factors. The method of rotation is promax rotation, which is appropriate when the research goal is to derive theoretically meaningful factors (Hair et al., 2006). The scores of factors are computed by the regression method. The number of factors is specified based on the underlying root criterion that counts the number of eigenvalues greater than one. The resulting χ^2 statistics are also presented in each table to show that the location decision making for a new plant is reasonably differentiated. In addition, the value of Cronbach's coefficient a is presented at the bottom of each analysis[1].

Exploratory factor analysis has limitations that can affect the results of the procedure. Unlike component analysis, common EFA does not fully utilize the statistical information contained in the data set, only summarizing the common variance among variables (location reasons) into factors. Therefore, each variable's unique variance does not consist of the common factors but resides in an element of the specific factor. This implies that prefecture-specific characteristics not reflected in the common factor are

[1] Cronbach's a measures the consistency of the questionnaire survey. More specifically, the value becomes larger when respondents' attitudes are parallel to the variables in a factor. For example, if a respondent considers that market proximity is an important location reason, it is necessary to maintaining consistency in the survey that the respondent also emphasizes access to transport infrastructure, because the transportation advantage improves market proximity and they are compatible with one another. If this is not the case, the respondent's valuation of factors becomes internally contradictory and reduces the questionnaire's reliability. Cronbach's a measures such consistency in the results of factor analysis, and the value should generally be higher than 0.7 to ensure consistency.

contained in the specific factor, and the researcher cannot control the residual variance remaining in the specific features. In other words, EFA considers only common varieties shared among all samples (prefectures), and other differences are disregarded by being located within the specific factor. This incomplete use of statistical information is the major restriction of EFA. Therefore, it is important to consider that the results derived from EFA capture only the differences common to all regions.

The origin of the application of factor analysis to industrial cluster studies has been traced back to Streit (1969), Roepke et al. (1974), and Czamanski (1974), and there are many recent empirical studies that attempt to identify the presence and location of industrial clusters (e.g., Bergman and Feser, 1999; Feser and Bergman, 2000; Feser and Sweeney, 2002; Patton and Reweta, 2003; Titze et al., 2011)[2]. However, many scholars draw attention to the inadequacy and insufficiency in the current regional input-output analysis of the identification of clusters (e.g., Doeringer and Terkla, 1995; Rosenfeld, 1997; Bergman, 1999; Martin and Sunley, 2003; McCann and Sheppard, 2003; vom Hofe and Chen, 2006; Cruz and Teixeira, 2010). Doeringer and Terkla (1995) specifically point out that, although input-output analysis of cluster identification has been dominant in cluster studies for the last three decades, the approach neither characterizes the relationship among local agencies, such as supporting firms and government, nor discerns various benefits arising from clustering (vom Hofe and Chen, 2006). While the above-mentioned studies use only input-output tables, this study directly applies EFA to a location survey, which is an effective method for determining why firms cluster and combining various cluster advantages in the underlying location factors. As long as cluster advantages are merged and localized in a region, they should be combined in an underlying location factor through the EFA. Thus, unlike the conventional approaches, this approach captures Marshall's cluster advantages more comprehensively[3].

Furthermore, the application of EFA is by no means limited to spatial studies, now being increasingly applied in management studies as well as in economic geography[4] (e.g., Marginson and Mcaulay, 2008; Galbraith et al., 2008; Zhou et al., 2008). There are two common advantages of these applications. First, EFA summarizes various behavioural reasons into a few underlying reasons. Second, the summated scale or factor score measures how much each underlying reason can affect the behaviour of individual actors. Particular to firms' location decisions, EFA offers us the unique analytical advantage of abstracting complex location reasoning into a few theoretically meaningful factors and independently transforming these theoretical factors into a scale that differentiates among regional features.

Recently, a multivariate statistical approach has been increasingly applied in a wide variety of studies in business strategies. Govindarajan and Praveen (2006) performed both exploratory and confirmatory factor analyses to investigate innovation disruption[5]. Mani et al. (2007) applied factor analysis to investigate the ownership structure of an FDI portfolio in the context of entry mode and equity level[6]. Marginson and McAulay (2008) also used EFA for the debate on short-termism[7]. Reuer and

[2] For a more comprehensive review of empirical cluster studies, see vom Hofe and Chen (2006), which classified three types of empirical approach for cluster identification.

[3] Other than the research that has attempted to define and discover industries, there are many empirical studies that partially discovered the positive influence of industrial agglomeration. For example, Davis and Weinstein (1999) showed evidence of the influence of demand linkages in the location decisions of Japanese manufacturing companies. Carlton (1983), Wheeler and Mody (1992), Dumais et al. (1997), and Rosenthal and Strange (2003) specifically discussed the issues of localized externalities as well as the location of new plants. The inclusion of independent variables to represent Mashallian advantage has become essential in recent econometric studies (e.g., Autant-Bernard, 2006; Devereux et al., 2006; Kogut and Chang, 2008; Arauzo and Viladecans, 2008). However, they are all econometric studies and no formal survey study has been introduced in this field, making this study one of the earliest attempts to find an industrial cluster based on a location decision survey.

[4] The application of EFA to social science studies has become common since Rummel (1970) and Harman (1976) published textbooks of applied factor analysis for socioeconomic data. Harrigan (1985) initially advocated the usefulness of multivariate statistical techniques, particularly EFA and cluster analysis, in management science. Dorf and Emerson's 1978 study is one of the earliest attempts, and they used EFA to account for the spatial transition in manufacturing production from urban to rural areas. Agarwal and Ramaswami (1992) identified several location factors to determine the choice of specific foreign market entry modes. Carter et al. (1994) and Stearns et al. (1995) derived six strategic factors of venture firms and identified a location factor as one of the essential strategic factors. Lane et al. (2001) used confirmatory factor analysis to examine the influence of knowledge acquisition from international joint ventures.

[5] Innovation disruption represents a situation where large and historical market leaders struggle to develop and introduce new product and service innovations.

[6] Entry mode represents a dichotomous choice between full or partial ownership control of FDI. Equity level is measured as a continuous span of ownership control from 0 to 100 percent.

[7] Short-termism is a concept which implies that short-term business performance is important to secure long-term values, as originally advocated by Porter (1992).

Arino (2007) used EFA to reveal the incentives of corporate alliance strategies and forms (e.g., M&A, non-equity agreements, and contractual provisions). Galbraith et al. (2008) focused on the location behaviour of high-technology manufactures. Zhou et al. (2008) used confirmatory factor analysis and found that in China firms' market orientation improves product quality and job satisfaction of employees. Despite the maturity and popularity of multivariate techniques in management studies, they have rarely been applied to location studies. Thus, this study appears to be one of the first attempts to apply such advantages to the analysis of location survey results.

4. Results

This section presents the results of the EFA and summarizes the region-specific reasoning for location choice. Each region has different geographical features, and certain regions have greater distribution of population, firms, available land, specialized inputs, transportation infrastructure, and public support than others. Thus, it is reasonably expected that the reason for the location choice is affected by the distribution of various local resources, which shapes unique regional advantages. This spatial dissimilarity makes EFA application effective in the search for industry clusters because, if cluster advantages are significant only for a group of prefectures, the regional advantages must be contained in an underlying location factor and the prefectures should be characterized by a greater factor score of the industry cluster factor. Among many location advantages, EFA particularly focuses on discovering an industrial cluster factor.

Table 2 shows the factor loadings of each reason by region-specific location reasoning. The number of factors is limited to three for both cases, which is specified by the underlying root criterion. A sufficient variance in region-specific location preference is found in the significance of both the χ^2 statistic and *p*-value. Recall that factor loadings are the correlations of the original variables (number of plant locations due to reason r) and each of the three factors. Therefore, higher loadings make the variable more representative of the factor, and loadings are the means of interpreting the role of each variable in defining each factor. According to Hair et al. (2006), a factor loading greater than 0.4 is considered to be statistically significant. In addition, squared factor loadings indicate what percentage of the variance in an original variable is explained by a factor.

Table 2. Factor loadings of the first, second and third factors by prefecture.

		Primary reason				Secondary reason			
		Factor 1	Factor 2	Factor 3	Communality	Factor 1	Factor 2	Factor 3	Communality
		Industrial Cluster	Transport & Labor	Network		Industrial Cluster	Proximity & Support	Production Input	
Proximity	Access to Raw Material Inputs	☐ -0.24	☑ 0.95	☐ 0.05	0.72	☐ 0.28	☑ 0.39	☑ 0.37	0.81
	Proximity to Market	☐ 0.14	☑ 0.53	☑ 0.41	0.83	☐ -0.02	☑ 0.82	☐ 0.25	0.91
	Proximity to Related Firms	☑ 0.43	☐ 0.03	☑ 0.55	0.81	☑ 0.38	☑ 0.58	☐ 0.04	0.83
	Proximity to Headquarters	☑ 0.39	☐ 0.20	☑ 0.34	0.62	☑ 0.53	☑ 0.38	☐ 0.10	0.82
	Business and Logistic Services	☐ -0.14	☑ 0.70	☐ -0.04	0.37	☑ 0.44	☐ 0.10	☐ 0.17	0.42
	Access to Research Institutions	☑ 0.66	☐ -0.17	☑ 0.41	0.77	☑ 0.59	☑ 0.38	☐ -0.26	0.56
Labor	Availability of Labour	☐ 0.05	☑ 0.48	☐ 0.26	0.46	☐ -0.17	☐ 0.09	☑ 0.98	0.85
	Technical Skills of Labour	☐ 0.20	☑ 0.31	☐ 0.09	0.27	☑ 0.62	☐ -0.18	☑ 0.41	0.70
Land	Availability of Land	☐ 0.36	☐ 0.19	☐ 0.05	0.28	☑ 0.84	☐ 0.03	☐ -0.10	0.64
	Land Price	☑ 0.73	☐ 0.15	☐ -0.23	0.50	☐ 0.24	☐ 0.01	☑ 0.53	0.52
Policy	Support from National Government	☑ 0.41	☑ 0.59	☐ -0.26	0.60	☐ 0.04	☑ 0.54	☐ 0.15	0.44
	Support from Local Government	☐ -0.21	☐ 0.12	☑ 0.93	0.75	☐ 0.00	☑ 0.43	☑ 0.50	0.66
Other	Manager's Personal Ties	☐ 0.12	☐ -0.16	☑ 0.37	0.15	☐ -0.08	☑ 0.59	☐ -0.03	0.27
	Co-location with Other Firms	☑ 0.55	☐ 0.27	☐ 0.21	0.80	☑ 0.83	☐ 0.24	☐ -0.02	1.00
	Availability of Industrial Water	☑ 1.00	☐ -0.09	☐ -0.04	0.84	☑ 0.58	☐ 0.32	☐ 0.14	0.89
	Amenities (Education, Leisure, Shopping)	☑ 0.61	☐ -0.26	☐ 0.04	0.27	☐ 0.17	☑ 0.69	☐ -0.18	0.52
Cronbach's α		0.80	0.70	0.78		0.78	0.88	0.87	
		The chi square statistic: 95.48				The chi square statistic is 108.46			
		The degrees of freedom: 75				The degrees of freedom is 75			
		The p-value: 5.55E-02				The p-value is 6.96E-03			

Note: A check mark indicates that a loading is significant (i.e., greater than 0.4).

Let us consider the result for the primary reason first. Many of the cluster advantages are represented by the first factors as the loadings, illustrated in Figure 2, are greater for water availability, co-location with other firms, and proximity to related firms, headquarters and research institutions. Therefore, this first factor roughly approximates Marshallian cluster advantages. However, labour skills and business and logistics services play only a marginal role in configuring the cluster factor and the first factor, and do not completely represent the Marshallian advantages. Furthermore, greater factor loadings are found for land price, amenities, and national policy support, whose advantages are often found in the periphery of major metropolitan areas[8]. Therefore, rather than being clearly specified as a general industrial cluster factor, the first factor should be viewed as a rural or suburban industrial cluster factor highlighting relational advantages, which we will investigate in the spatial variance of the factor scores.

Although the discovery of an industrial cluster factor is the primary purpose of this study, the other two factors contain important implications for the general location study. The factor loadings of the second factor are higher for proximity to raw materials, proximity to the market, and business and logistic services. Labour availability and skill also have higher factor loadings, so that it is possible to infer that the second factor is more oriented toward transportation- and labour-related advantages, and the factor can be specified as the transport & labour factor[9]. Finally, the third factor is more associated with local relationships. Proximities to market, related firms, and headquarters, which summarize formal industrial relationships, have high loadings. The greatest loading is found for support from local government, and having personal ties also has a minor impact. Thus, it is possible to conclude that this factor contains the advantages arising from both private and public relationships as well as formal and informal networks.

Considering all three principal factors, the analysis thus far finds that the first factor best approximates cluster advantages, particularly regarding industry complexes. However, the advantages summarized in the industrial cluster factor are incomplete and contain other advantages such as land price. Therefore, the analysis of the primary reasons only partially discovered a Marshallian cluster factor mixed with other advantages such as land, amenities, and policy support.

Next, let us interpret the factors of the secondary reasons. Larger loadings are found for co-location, labour skills, industrial water, access to research institutions, and proximity to headquarters, related firms, and business and logistic services. In addition to these, land availability has a large loading. The pattern of the loadings of this factor, also shown in Figure 2, is analogous to that of the industrial cluster in the primary reason; however, this factor more appropriately reflects the essential advantages arising from Marshallian clusters, highlighting localized supporting firms, a skilled labour pool, knowledge, and shared input resources. Therefore, although they are secondary reasons, this factor is more appropriately labelled as the industry cluster. Again, this factor contains a degree of emphasis on land availability, and the advantages are biased towards the rural area.

Additionally, the advantages implied in the second factor are associated with proximity to related entities, such as proximity to raw materials, the market, headquarters, and related firms, and with support from local agencies, such as policy support from national and local government, the manager's personal ties, and local amenities. Therefore, these advantages are contained in the proximity and support factor, which encompasses all location advantages other than land and labour[10]. The significant reasons of the third factor are also somewhat related to production inputs: raw materials, labour, land, and public support. This is distinguished from the other two factors to the extent of their focus on direct production inputs; hence, the factor is labelled a production input factor.

[8] Although the author attempted the cases of two and four factors, the industry cluster factor could not be disaggregated from the three reasons.

[9] Regarding this second factor, the greatest loading is found to be proximity to raw materials. The formation of industrial concentration is more or less governed by 'natural advantages', which, on the one hand, includes climatic, geological, and fishery suitability for raw materials of light manufacturing industries and, on the other hand, implies natural or manmade transportation routes necessarily shaped by the physical configuration of the land (Dicken and Lloyd, 1990; Glaeser et al. 1992; Gordon and McCann, 2000).

[10] In addition to advantages in proximity and infrastructure, the second factor in this case includes governmental support. Doeringer and Terkle (1995) reviewed a series of survey studies and underscored the role of governmental partnership in the formation of clustering.

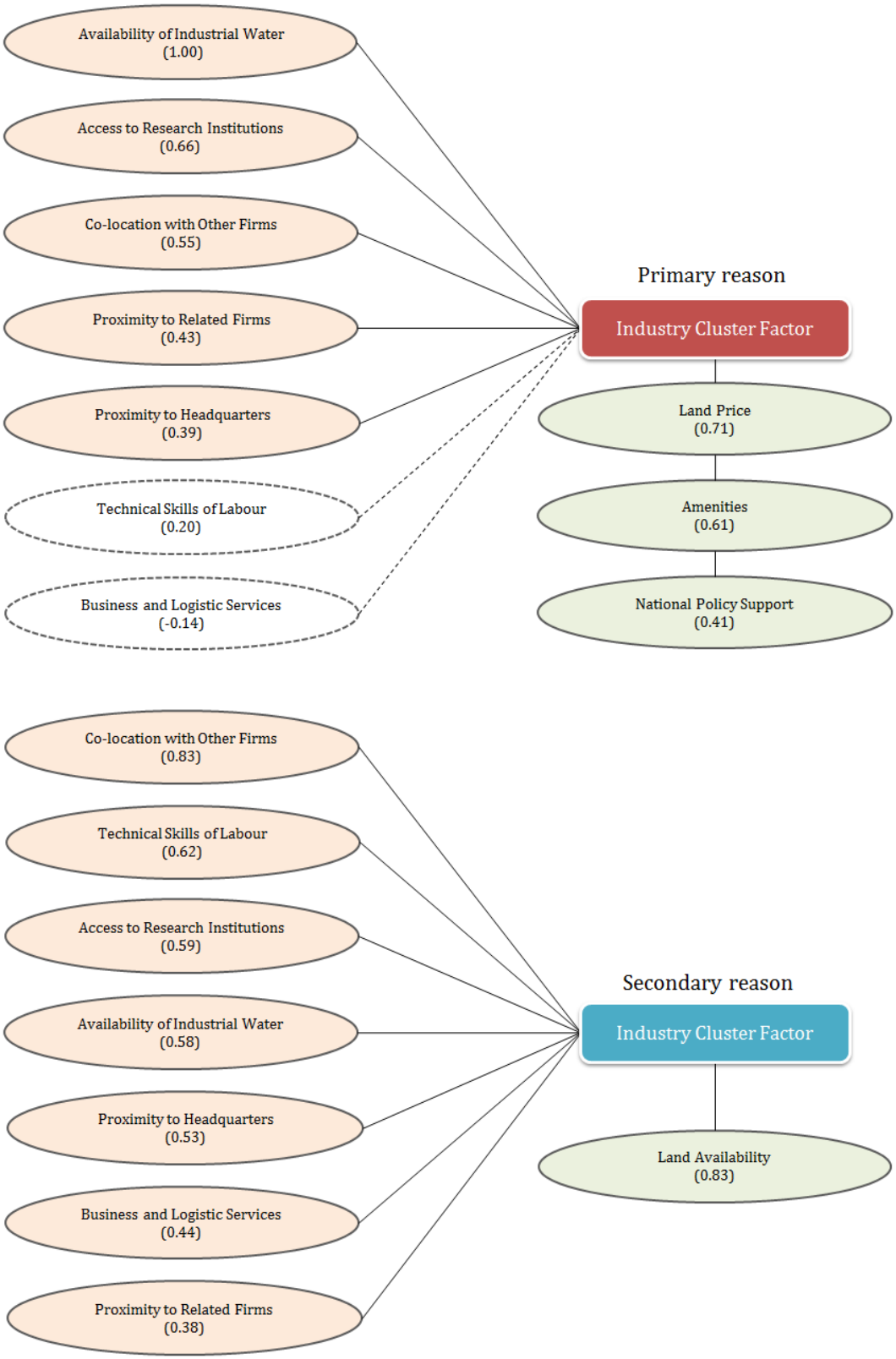

Figure 2. The industry cluster factor and factor loadings of key location reasons.

Lastly, this study examines the regional variety of the significance of these three location factors by considering the spatial variation of factor scores. The analysis is focused on the scores of the two industry cluster factors found in the primary and secondary reasons. As long as industry cluster advantages are present in a region, the scores of two similar factors should increase identically in the same region, regardless of the difference in the primary and secondary reasons. The spatial crossover of the greatest scores of the two industrial cluster factors reveals the existence and position of the Japanese manufacturing industry cluster.

Individual factor scores are presented in Table 3, with each prefecture having a specific factor score for each location factor. Figure 3's standard deviation map presents the spatial variation in the scores of the primary reasons. In this specific analysis, higher scores represent more new plants that chose their location for the location factor.

Table 3. Scores of the first, second and third factors by region.

		Primary reason						Secondary reason					
		Factor 1		Factor 2		Factor 3			Factor 1		Factor 2		Factor 3	
		Industrial Cluster		Transportation & labour		Network			Industrial Cluster		Proximity & Support		Production Input	
1	Hokkaido	○	-1.58	●	6.29	○	-1.39	1	Hokkaido	◔	-0.47	○	-0.32	●	4.22
2	Aomori	◔	-0.28	◔	0.45	◔	-1.01	2	Aomori	◔	-0.17	○	-0.24	◔	-0.54
3	Iwate	○	-2.66	◔	0.43	◕	2.24	3	Iwate	◕	1.41	○	-1.12	◔	-0.72
4	Miyagi	◔	-0.49	◔	0.93	◑	1.23	4	Miyagi	◑	0.32	◔	0.44	◑	0.62
5	Akita	◔	-0.15	◔	0.35	◔	-0.96	5	Akita	◑	0.41	◔	-0.21	○	-0.91
6	Yamagata	◑	0.54	◔	0.51	◔	0.00	6	Yamagata	◕	1.76	○	-0.42	○	-1.00
7	Fukushima	◕	1.77	○	-0.69	◔	-0.66	7	Fukushima	◕	1.78	○	-0.27	○	-1.07
8	Ibaragi	◔	-0.23	◔	0.21	◕	1.45	8	Ibaragi	○	-2.88	●	5.62	○	-1.55
9	Tochigi	◔	-0.96	◔	0.78	◑	1.22	9	Tochigi	◔	-0.93	◕	2.77	○	-1.09
10	Gunma	◕	1.79	○	-2.04	◑	1.20	10	Gunma	◕	1.87	◔	0.84	○	-1.65
11	Saitama	◑	0.06	○	-0.81	◑	1.16	11	Saitama	◔	-0.21	◔	0.37	◑	0.41
12	Chiba	◔	-0.45	◔	0.37	◔	0.02	12	Chiba	◔	-1.05	◔	0.78	◔	0.31
13	Tokyo	◔	-0.92	◔	-0.20	◔	-0.31	13	Tokyo	◔	-0.82	○	-0.27	◔	-0.36
14	Kanagawa	○	-1.53	◔	0.59	◕	1.68	14	Kanagawa	○	-1.92	◑	2.05	◑	0.56
15	Niigata	●	2.66	◔	0.41	○	-1.94	15	Niigata	●	4.00	○	-1.10	○	-1.34
16	Toyama	◔	-0.64	◔	-0.13	◑	0.46	16	Toyama	◕	1.27	○	-0.53	○	-1.11
17	Ishikawa	◔	-0.25	◔	-0.07	◔	0.03	17	Ishikawa	◑	0.03	○	-1.57	◑	1.61
18	Fukui	◔	-1.23	○	-0.57	◑	0.99	18	Fukui	◔	-0.70	○	-0.54	◔	0.24
19	Yamanashi	◔	-0.25	◔	-0.13	◔	-0.59	19	Yamanashi	◔	-1.43	◔	0.17	◑	0.53
20	Nagano	●	3.95	○	-1.14	○	-2.22	20	Nagano	●	3.91	○	-1.31	○	-2.14
21	Gifu	◑	1.00	○	-0.93	◔	-0.85	21	Gifu	◑	0.62	◔	-0.11	○	-1.05
22	Shizuoka	◑	0.60	◔	0.21	◑	0.86	22	Shizuoka	◔	-0.71	◔	0.92	◕	1.84
23	Aichi	◔	-0.63	○	-1.26	●	3.54	23	Aichi	◕	2.40	◔	-0.04	○	-1.47
24	Mie	◕	2.37	○	-0.99	◔	-0.93	24	Mie	◔	-0.20	◔	0.12	◑	0.87
25	Shiga	◕	1.46	○	-0.83	◔	-0.78	25	Shiga	◕	2.62	○	-1.39	○	-1.64
26	Kyoto	◑	0.39	◔	0.13	○	-1.13	26	Kyoto	◔	-0.38	◔	0.19	◔	-0.31
27	Osaka	◔	-0.33	◔	-0.32	◑	0.52	27	Osaka	○	-2.32	◔	1.08	◑	1.48
28	Hyogo	◔	-0.14	◔	0.52	◕	1.76	28	Hyogo	○	-1.58	◑	2.22	◑	0.95
29	Nara	◔	-0.84	◔	-0.28	◔	-0.34	29	Nara	◔	-0.65	○	-0.33	◔	-0.19
30	Wakayama	◔	-0.65	◔	-0.23	◔	-0.52	30	Wakayama	◔	-0.93	◔	-0.20	◔	-0.26
31	Tottori	◔	-0.14	○	-0.60	◔	-0.69	31	Tottori	◔	-0.82	○	-0.58	◔	0.24
32	Shimane	◔	-0.85	◔	0.28	◔	-0.72	32	Shimane	◑	0.11	○	-1.13	◔	-0.35
33	Okayama	◑	0.28	○	-0.54	◔	-0.37	33	Okayama	◔	-0.67	◔	0.04	◔	0.13
34	Hiroshima	◔	-0.54	○	-0.59	◑	0.97	34	Hiroshima	◔	-0.48	◑	1.27	◔	-0.81
35	Yamaguchi	◑	0.47	○	-0.48	◔	-0.87	35	Yamaguchi	◑	0.02	○	-1.49	◑	0.87
36	Tokushima	◑	0.13	◔	-0.31	◔	-1.07	36	Tokushima	◔	-0.57	◔	-0.11	◔	-0.47
37	Kagawa	◑	0.80	○	-1.15	◔	-0.51	37	Kagawa	◑	0.78	○	-1.20	◔	-0.46
38	Ehime	◔	-0.31	◔	0.05	◔	-0.51	38	Ehime	◑	0.20	○	-0.47	◔	-0.73
39	Kochi	◔	-1.13	◔	0.30	◔	-0.34	39	Kochi	◔	-0.62	○	-0.35	◔	-0.32
40	Fukuoka	●	2.91	○	-0.67	◑	0.45	40	Fukuoka	●	2.87	○	-0.40	◑	0.47
41	Saga	◔	-0.68	◔	0.09	◔	-0.09	41	Saga	◔	-0.57	◔	-0.12	◔	0.19
42	Nagasaki	◔	-1.04	◔	0.31	◔	-0.38	42	Nagasaki	○	-1.76	◔	-0.12	◑	0.86
43	Kumamoto	◕	1.49	◔	0.12	○	-1.16	43	Kumamoto	○	-2.29	◔	-0.05	●	3.39
44	Oita	◔	-0.69	◔	0.03	◑	0.09	44	Oita	◔	-0.63	○	-0.56	◑	0.67
45	Miyazaki	◔	-0.70	◔	0.57	◑	0.12	45	Miyazaki	◑	0.48	◔	0.04	○	-0.97
46	Kagoshima	○	-1.92	◔	1.04	◑	1.16	46	Kagoshima	◑	-0.04	○	-1.67	◑	1.46
47	Okinawa	◔	-0.47	◔	-0.03	◔	-0.79	47	Okinawa	◔	-1.04	○	-0.67	◑	0.57

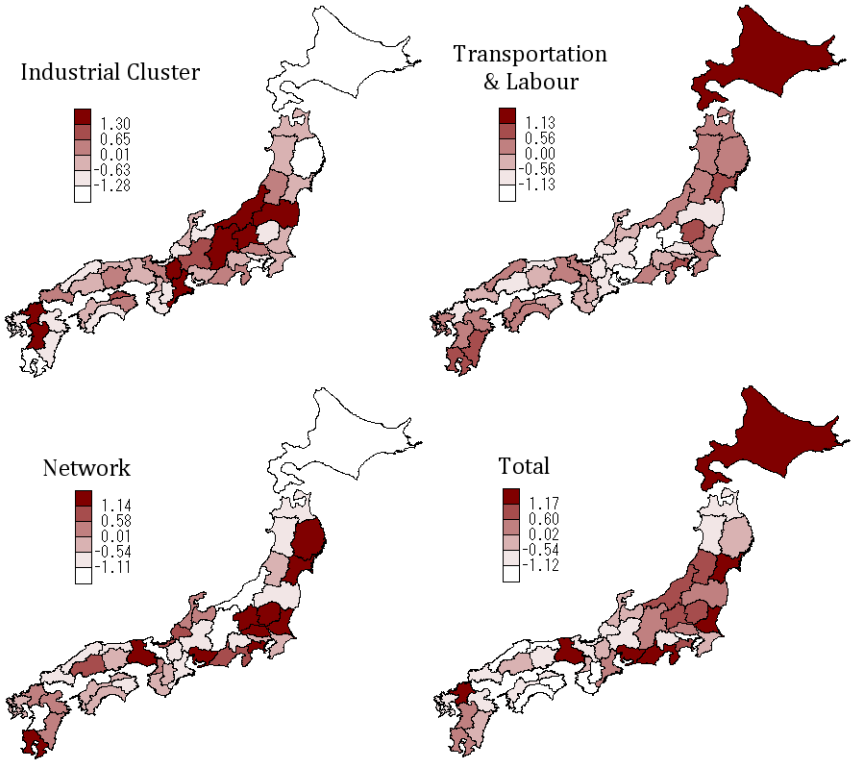

Figure 3. Spatial distribution of the factor scores of the primary reason.

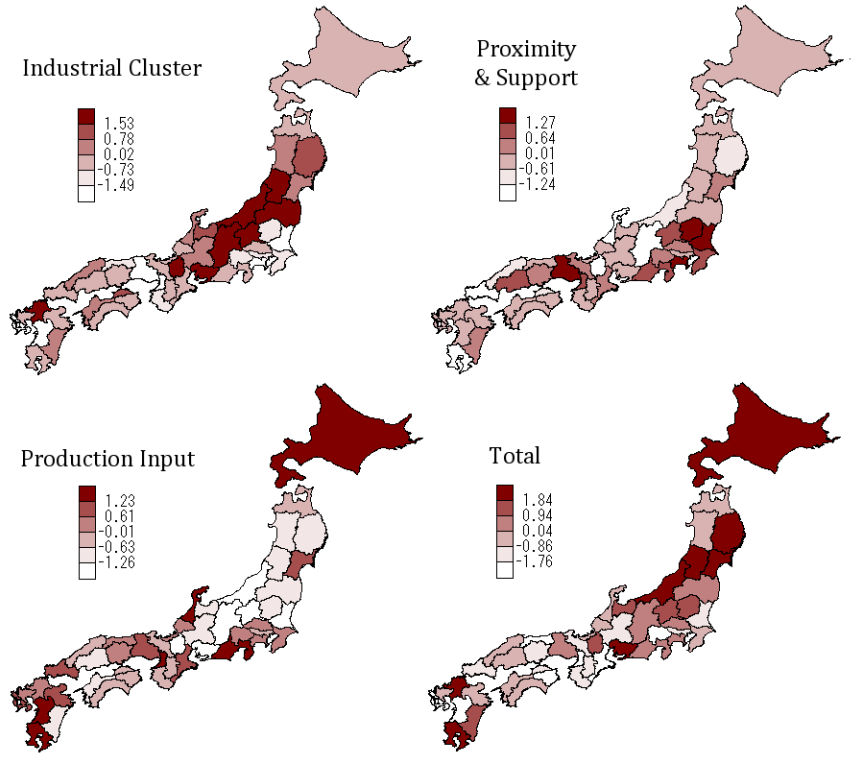

Figure 4. Spatial distribution of the factor scores of the secondary reason.

Plants emphasizing the industrial cluster factor are concentrated on the peripheries of the core populated prefectures, such as Tokyo, Osaka, and Aichi. The scores are particularly high in the northern prefectures of the Kanto area centred around Tokyo. These prefectures offer firms less congestion and cheaper land prices than do the urban prefectures, which is consistent with the interpretation of the first industrial cluster factor because these prefectures neighbour metropolitan areas, with the advantage of agglomeration benefits, particularly proximity to related firms, headquarters and research institutions. The lower population density of such regions also improves land availability. Therefore, the periphery of the Kanto area is the strongest candidate for an industrial cluster in Japan.

Next, let us consider Figure 4's representation of the variation of scores in the secondary reason. First, the industrial cluster factor is more influential in the northern part of Japan and the prefecture around the Kanto area. The spatial pattern of the scores is quite similar to that of the first industrial cluster factor in Figure 3. This is reasonable as the composite location reasons of these two factors are quite analogous. Second, the most significant reason in the proximity and support factor is proximity to markets and amenities. These advantages should be found more abundantly in urban areas than in rural areas. As expected, the scores of this factor increase in the Kanto and Kansai areas centred around Tokyo and Osaka, respectively. This finding is, therefore, consistent with the essential features of the factor loadings. Finally, the most significant reason in the production input factor is labour availability, and the scores rise in the rural prefectures, which is also consistent with the unemployment rate generally increasing in rural prefectures.

In addition, the lower-right maps in both Figure 3 and Figure 4 depict the total of these three scores for individual prefectures, and it characterizes the overall location advantages represented by these three factors. The spatial pattern of the total advantage is quite similar to the distribution of new plant locations in Figure 1, and the correlation coefficient between them is 0.981 and 0.970 for the primary and secondary reasons, respectively. This result suggests that these location factors collectively contribute to regional plant creation; therefore, regional location advantages are reasonably disaggregated into the three location factors.

Finally, this section responds to the questions raised at the beginning. The purpose of this study was to identify an industrial cluster factor and specify the spatial position of the region with the cluster advantages contained in the cluster factor. As observed in the EFA results thus far, this study found two important factors that reasonably approximate Marshallian cluster advantage, although the cluster advantages are more likely to be found in rural areas due to the simultaneous emphasis on land availability. The spatial distributions of the scores of two industrial cluster factors, found in the primary and secondary reasons, are comparable to one another and exhibit a distinct pattern. Because of the successful identification of the industrial factor and the spatial variation of the scores, this study reliably reveals the fact that Marshallian advantages are indeed localized in a particular region.

Next, let us consider the second question, which is to specify the location of an industrial cluster in Japan, as Figure 5 illustrates. The industrial cluster factor was identified in both primary and secondary reasons, and the spatial distribution appears in Figure 3 and Figure 4. Figure 5 shows the distribution with particular emphasis on the most significant scores. The standard deviations of the scores of the primary and secondary reasons are 1.294 and 1.523, respectively, and the map is partially shaded for prefectures whose score is greater than the standard deviation, which consists of the upper 15.87% of the entire distribution[11]. In order to identify prefectures with the greatest score on the industrial cluster factor, the shade is deeper for prefectures with scores greater than double the standard deviation, which are 2.589 and 3.045 for the primary and secondary reasons, respectively, and it consists of the upper 2.28% of the entire distribution.

As observed in Figure 5, the highest scores are found in the north Kanto area, and the score is particularly high for Nagano and Niigata, which are relatively close to the Tokyo metropolitan area and have relatively abundant land for such a convenient location. Because of the significant scores and their geographical features, we are reasonably justified in concluding that an industrial cluster exists in the region, and the region exhibits most Marshallian advantages, such as related firms, knowledge spillover, skilled labour, and shared input resources, as the factor is characterized in the above EFA. As Figure 1 depicts, it is important to note that the vast majority of new manufacturing plants are built in

[11] Note that the mean of factor scores is always zero.

and around the industrial cluster region, which indicates that the growth of manufacturing production correlates with the formation of an industrial cluster and implies that the advantages inherent to an industrial cluster in fact stimulate regional economic growth or sustain regional production.

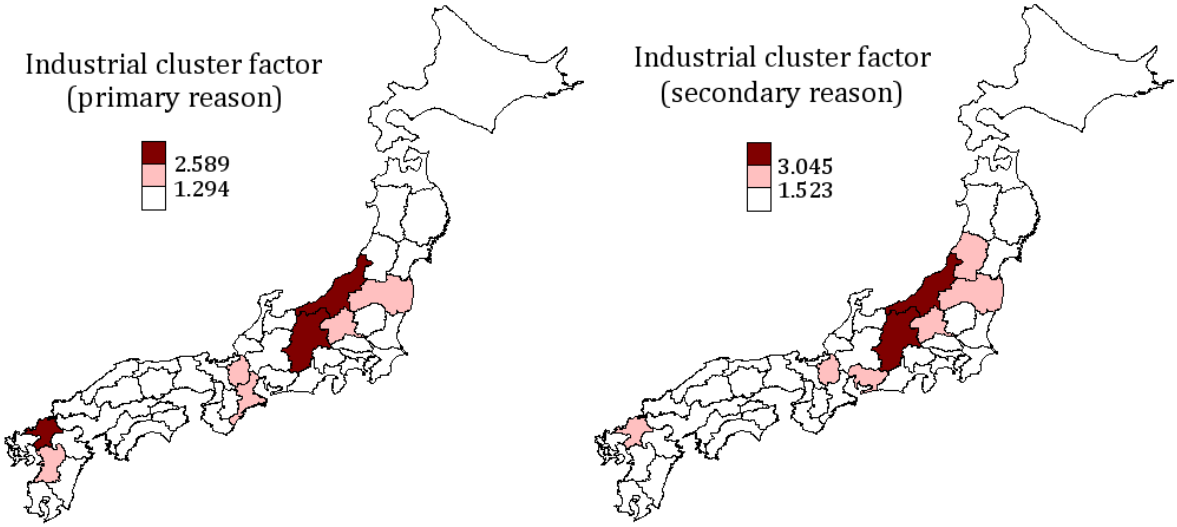

Figure 5. Spatial position of prefectures that have factor scores of industrial cluster factor greater than 2σ and σ. (2σ = 2.589 and σ = 1.294 for the primary reason and 2σ = 3.045 and σ = 1.523 for the secondary reason)

5. Conclusion

This study has explored Marshall's type of industrial cluster in the Japanese manufacturing sector. At the beginning, the author raised two questions: Are all four Marshallian advantages localized in a region, collectively forming an industrial cluster advantage? If such region exists in Japan, where is it located? The findings reasonably support the existence of Marshallian manufacturing clusters in the modern economic and technological environment. The industry cluster in Japan is found in Nagano and Niigata prefectures. Although the roles of the four Marshallian advantages are not equally important, the advantages contained in the two industrial cluster factors in the primary and secondary reasons reflect the essence of Marshallain advantages; therefore, this study reliably discovered a Marshallian cluster in the two prefectures. Moreover, in both primary and secondary reasons, this study found significant loadings in the relational advantages, such as co-location among firms and proximity to related firms and headquarters. These advantages are compatible with other Marshallian advantages including access to research institutions, business and logistic services, and skilled labour. Thus, the unique Japanese inter-firm relationship is consistent with other Marshallian cluster advantages.

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Appendix

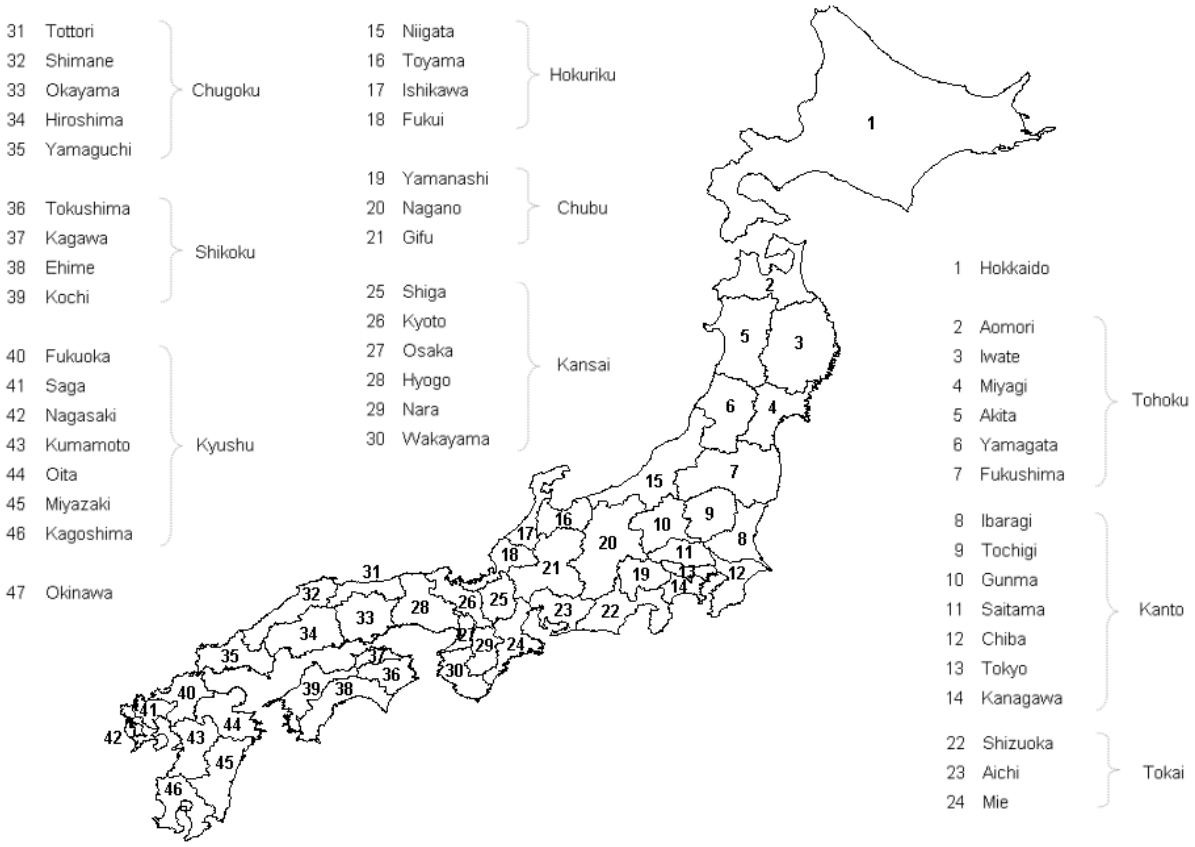

Figure A1. Names of 47 prefectures and 9 areas in Japan.