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*Full Length Research Paper*

# Infrastructure support and new plant formation: A factor analysis approach

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**This study is aimed to explore the result of a questionnaire survey on the plant locations of Japanese manufacturing industries from 1997 to 2003 and the objective is to investigate the impact of infrastructure support on the incubation of new manufacturing plants and to identify the regional variety of the impact. The major finding is that there is a location factor consisting of various infrastructure supports and the role of infrastructure-based location factor varies across space. Also, this study found that the impact of the factor normally grows as infrastructure density rises; however the growth turns to a decline when population density is extremely high.**

**Key words:** Industrial location, transport infrastructure, factor analysis, Japanese manufacturing.

## INTRODUCTION

All location theories are virtually stems from two classical location theories; one is Weber's cost-minimization principle and another is Marshall's ideas of agglomeration. Firstly, needless to say, transport costs have always taken crucial roles in the modern development of location theories since Thünen (1826). The classical Weberian location model defined the optimum location of plant as a point of location that minimizes distances to market and raw materials (Weber, 1929) and he also showed that this optimum point can vary according to the spatial differences in other production input costs such as labor and land costs. His idea was developed further by Christaller (1966), Losch (1944, 1954) and Isard (1956) and matured at the end of the 1960s. This tradition has been inherited by new economic geographers and transport costs still take a vital role in the new economic literatures (Krugman, 1991a, b; Fujita et al., 1999; Fujita and Thisse, 2002) as they link it to the spatial differences in goods price index that represents the impact of agglomeration economies.

Also, regarding empirical studies, there are many important studies that explored the role of several transport infrastructures in firms' location choice. Barkley and McNamara (1994) found in the Georgia and South Carolina survey from 1980 to 1990 that access to interstate highway is the most important location factor. To the best of author's knowledge, this is the only survey-based empirical research on the role of infrastructure support and other empirical literatures rely on econometric approach. For instance, Coughlin et al. (1991), Friedman et al. (1992) and Smith and Florida (1994) found a positive correlated between the local development of transport infrastructure and location choice of manufacturing plants in the US. In addition, some of them investigated the impact specific to highway or road.

A negative correlation between manufacturing activity and distance to highway was found by Guimarães et al. (1998) for Puerto Rico and Luker (1998) and Gabe and Bell (2004) for US counties. And, Coughlin and Segev (2000), Holl (2004a, b, c) and Cieślik (2005) demonstrated that road infrastructure is key to attract local manufacturing plants. All of those findings reasonably support the positive of role of infrastructure to the new formation of plants. In line with those literatures, this study explores the result of a location survey and discusses the role of infrastructure investment, particularly highway infrastructure, in the context of Japanese manufacturing sector by factor analysis. Almost all empirical studies for the relationship between infrastructure and regional growth are econometric studies and there are few survey-based studies have been introduced for the investigation of the role of infrastructure support. Therefore, this study fully utilizes the result of a location survey of manufacturing plants and pays a particular attention to the regional impact of infrastructure support.

**Table 1.** The overview of the survey result and the location reasons.

| Location reason | Primary reason | | Secondary reason | |
|---|---|---|---|---|
| | Frequency | Share (%) | Frequency | Share (%) |
| Total | 5495 | 100.0 | 7581 | 100.0 |
| Access to airport | 23 | 0.4 | 106 | 1.4 |
| Access to harbor | 74 | 1.3 | 94 | 1.2 |
| Access to highway | 507 | 9.2 | 999 | 13.2 |
| Access to railroad | 6 | 0.1 | 71 | 0.9 |
| Business and logistic service | 178 | 3.2 | 472 | 6.2 |
| Availability of land | 2038 | 37.1 | 1622 | 21.4 |
| Availability of industrial zone | 696 | 12.7 | 1099 | 14.5 |
| Less restriction from surrounding environment | 372 | 6.8 | 1024 | 13.5 |
| Commuting convenience | 388 | 7.1 | 903 | 11.9 |
| Support from local government | 549 | 10.0 | 682 | 9.0 |
| Manager's personal ties | 225 | 4.1 | 225 | 3.0 |
| Co-location with other firms | 66 | 1.2 | 89 | 1.2 |
| Others | 373 | 6.8 | 195 | 2.6 |

In order to organize the discussion, this study raises the following two questions. Do infrastructure investment and arrangement actually attract new plants? If it does, is the positive impact of infrastructure support even across space. The first question is the main inquiry of this study and the second question investigate whether the role of infrastructure might be diluted by other negative geographical conditions such as over-congestion and over-competition. Haughwout (1998) pointed out that the role of transport infrastructure varies across regions and suggested a hypothesis that there is a regional dissimilarity in the preference to transport infrastructure. This idea is quite reasonable because production and location conditions differ across space and the benefit of transport infrastructure can be differentiated by the property of region.

Holl (2004a) confirmed this hypothesis by an econometric study in Spanish manufacturing sector. So, this study grapples with those questions from a survey-based approach.

## METHODOLOGY

### Data

The questionnaire data used in this study is published annually by the Japan industrial location center (JILC), which is in a close affiliation of the Ministry of Economy, Trade and Industry (METI). The objective of question-naire survey is to investigate the reasons of location choice of new plants in Japan, and the results are used for the reorganization of land development and the improvement of location efficiency. The scope of the subject (the respondent) and the timing of the survey are listed as follows:

i) Subject: Two-digit SIC manufacturing industries.
ii) Scope: All new plants (including research institutions) that bought or rent more than 1,000 $m^2$ of land.
iii) Timing: When the contract is made between the owner and buyer (debtor) of land.

New plants include those of both existing firms and new start-up firms. Plants whose size is smaller than one thousand square meters are excluded from the subject. If we express the size of 1,000 $m^2$ by a square, the length of one side becomes approximately 31.62 m; therefore, small plants are not included in the subject. Table 1 lists the location reasons offered to the respondents and their choice frequencies and shares. According to the table, the most important reason of location choice is apparently the availability of land. 37% of the respondents chose the availability of land for the primary reason; therefore, land is a precious resource in Japanese manufacturing sector and the first priority for the location choice. Also, the survey found that firms emphasize the availability of industrial zone, support from local government, and access to highway.

Among several location reasons, infrastructure advantages are represented by access to several transport means, the availability of industrial zone, commuting convenience and business and logistic service, and those reasons become important for the investigation of the positive role of infrastructure arrangement led by government. In addition, Figure 1 represents the spatial distribution of the number of new plants and their density. The local number of new plants corresponds to the local number of respondents in the survey. For more detailed names of Japanese

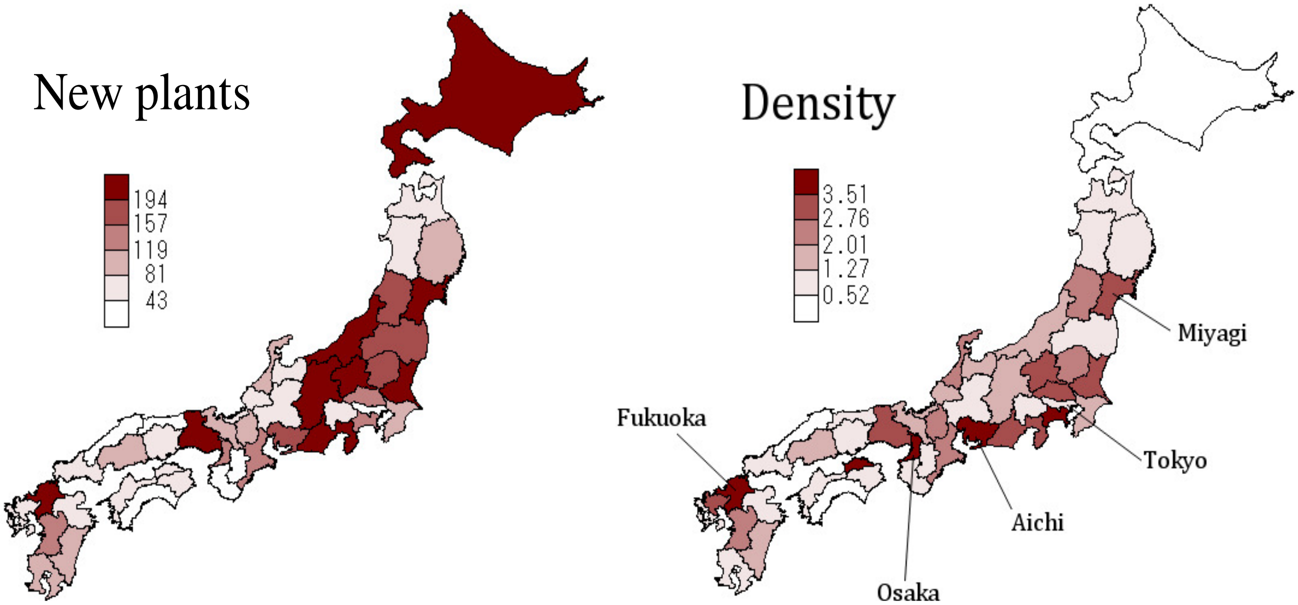


**Figure 1.** The number of new plants and their density (per 100 km$^2$).

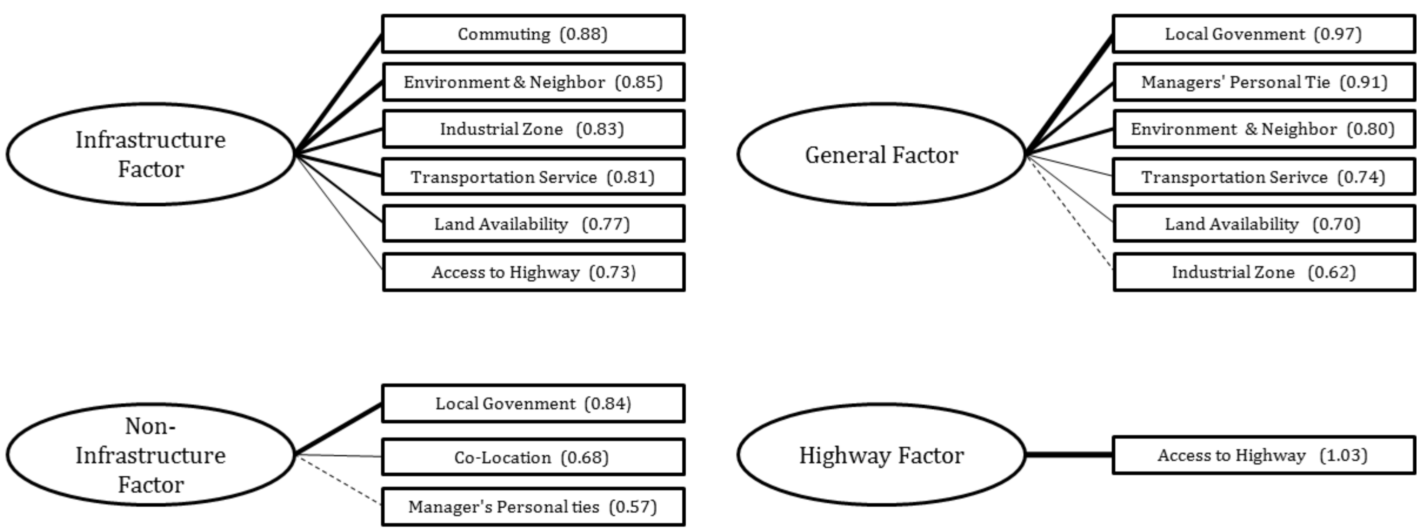


**Figure 2.** A portrayal of location factors identified in the factor analysis.

prefectures and their positions, see Figure 6 in the Appendix.

### Structure of data set

This section describes the structure of the data set and discusses the advantages and disadvantages of factor analysis. The data set of the survey result is a cross-sectional data and expressed in a matrix form. Denote $i$ and $r$ respectively for the identification number of prefecture and location reason. Also, 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 reason $r$ by prefecture $i$ can be represented by $X_{ri}$ and the data set can be expressed as a matrix form:

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

$$X_{ri} = f_{r1}s_{1i} + f_{r2}s_{2i} + u_r s_{ri}^u \tag{2}$$

There are two major advantages in factor analysis. Firstly, factor analysis abstract several reasons evenly emphasized by prefecture into a few location factors. For instance, when the number of factors is limited to two, the frequency that reason *r* is chosen by prefecture *i* can be expressed by the following equation:

The common factor consists of $f_{r1}s_{1i}$ and $f_{r2}s_{2i}$, where $f_{r1}$ and $f_{r2}$ are the factor loading of the first and second factor respectively and $s_{1i}$ and $s_{2i}$ are the score of the corresponding factor for prefecture *i*. The specific factor is represented by $u_r s_{ri}^u$ and $s_{ri}^u$ is the score of the specific factor. All prefectural uniqueness that are not exhibited in the location reasons are assumed to be summarized in this specific factor.

Factor analysis is helpful to characterize the unique impact of location factor by the variation in factor scores. Under no influence of the specific factor, $X_{ri}$ is only dependent 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 $X_{ri}$ is shaped solely by the variance of prefecture- specific $s_{ki}$. Since the objective of this study is to characterize regional variety in location reasoning, the region-specific scores take a crucial role to measure the difference. Hair et al. (2006) well defined the meaning of factor loadings and scores in words. Factor loadings are the correlation of the original variables (location reason) and factors and loadings indicate the degree of correspondence between the variable and the factor. Therefore, higher loadings make the variable representative of the factor and loadings are the means of interpreting the role of each variable in defining each factor. In addition, squared factor loadings indicate what percentage of the variance in an original variable is explained by a factor. Factor score is a composite measure created for each observation (prefecture) on each factor. The factor score conceptually represents a few degree of how much each observation is significantly related to a factor that consists of variables. Higher (lower) values on the variables with high loadings on a factor will result in a higher (lower) factor score.

Also, I would like to remind the limitation of factor analysis. Unlike component analysis, common factor analysis does not fully utilize the statistical information contained in data sets but only summarized the common variance among variables (location reasons) into factors. Therefore, unique variance of each variable does not consist in the common factors but reside in part of specific factor. This means that regional-specific characteristics not reflected in the common factor are all summarized in the specific factor and the researcher cannot control the specific features. In other words, factor analysis only considers common varieties shared among all samples (prefectures) and other diversities are disregarded by leaving them into the specific factor. This incomplete use of statistical information is the major restriction of factor analysis. Therefore, we should keep in mind that the results derived from factor analysis only capture the common differences shared by all regions.

In processing the factor analysis, the author applied the maximum likelihood method to extract the factors, which is commonly used in this analysis. The method of rotation is promax rotation that is appropriate when the goal of research is to derive theoretically meaningful factors (Hair et al., 2006). The scores of factors are computed by regression method. The number of factors is specified based on the latent root criterion that counts the number of eigenvalues greater than one. The result of $\chi^2$ statistics is also presented in each table so as to show that the location reasoning of new plant is reasonably differentiated. In addition, the value of Cronbach's coefficient $\alpha$ is presented at the bottom of each analysis[1].

The application of factor analysis to spatial study is by no means unusual and this technique is now increasing applied in management studies as well as in economic geography (for example, Marginson and Mcaulay, 2008; Galbraith et al., 2008; Zhou et al., 2008). There are two common advantages in the applications. Firstly, it summarize various behavioral reasons into a few latent reasons that firm's managers have, and secondly the summated scale, such as factor score, measures how much each latent reason can differently works on the behavior of individual actors. Particular to location decision of firm, factor analysis brings us a unique analytical advantage that complex location reasoning is abstracted into a few theoretically meaningful factors and the theoretical factors are independently transformed to a scale that differentiates regional features.

The application of factor analysis to social science studies has become common since Rummel (1970) and Harman (1976) published textbooks of applied factor analysis for socio-economic data. Harrigan (1985) initially advocated the usefulness of multivariate statistical tech-niques, particularly exploratory factor analysis and cluster analysis, in management science[2]. Dorf and Emerson (1978) is one of the earliest attempts and they used an exploratory factor analysis to account for the spatial transition of production location from urban to rural. Agarwal and Ramaswami (1992) identified a few 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 location factor is identified as one of the essential strategic factors. Lane et al. (2001) used a confirmatory factor analysis for the examination of the influence of knowledge acquisition from international joint venture. Recently, multivariate statistical approach is increasingly applied in a wide variety of studies in business strategies. Govindarajan and Praveen (2006) performed both exploratory and confirmatory factor analysis for the investigating the disruptiveness of innovations[3].

Mani et al. (2007) applied a factor analysis to inves-tigate the ownership structure of FDI portfolio in context of the entry mode and its equity level[4]. Marginson and McAulay (2008) also used factor analysis to the debate on short-termism[5]. Reuer and Arino (2007) used factor analysis for uncovering the incentives of corporate alliance strategy and its forms (for example, M and A, non-equity agreements, contractual provisions). Galbraith et al. (2008) particularly focused on the location behavior of high-technology manufactures. Zhou et al. (2008) used confirmatory factor analysis and found that the market orientation of firms improves product quality and job satisfaction of employees in China. In spite of the full-fledged popularity of multivariate techniques in management studies, they have rarely been applied to location study. Hence, this study utilizes the advantages of exploratory

[1] This Cronbach's $\alpha$ is to measure the consistency of questionnaire survey. More specifically, the value becomes larger when respondents' attitudes are parallel to the variables consist in a factor. For instance, if a respondent considers that market proximity is an important location reason, it is necessary for keeping the survey consistent that the respondent on the other hand emphasizes access to transport infrastructure as well because transportation advantage improve market proximity and they mutually compensate one another. If this is not the case, the attitude of the respondent becomes contradictory and the questionnaire result becomes hardly reliable. Cronbach's $\alpha$ measures such consistency in the result of factor analysis and the value should normally be higher than 0.7 for securing the consistency.

[2] See also Ketchen and Shook (1996) for the literature review of studies based on cluster analysis

[3] The disruptiveness of innovation represents a situation that large and historical market leaders become struggling to develop and introduce new product and service innovations.

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

[5] Short-termism is an idea that the short-term business performance is important to secure the long-term values, which is originally advocated by Porter (1992).

factor analysis to the analysis of location survey result.

## FACTOR ANALYSIS

This section performs a factor analysis to abstract the region-specific reasoning of location choice and to see if we can identify an infrastructure location factor. Each region has different geographical features and some regions have more infrastructure distribution than the others. If so, we can reasonably expect that location decision of plants are affected by the infrastructure distribution. So, in this section we explore the variety of the impact of infrastructure in location decision of plants (Table 2). Table 2 demonstrates the factor loadings of each location reason and some significant reasons are ticked to highlight the importance. The number of factors is specified to two by the latent root criterion and the minor reasons are removed from the data beforehand[6]. Both $\chi^2$ statistics and p-value are at the sufficient level.

The values of those loadings are plotted in Figure 3. Recall that factor loadings are the correlation of the original variables (location reason) and factors and loadings indicate the degree of correspondence between the variable and the factor. Therefore, higher loadings make the variable representative of the factor, and loadings are the means of interpreting the role of each variable in defining each factor. We can interpret the factors as follows:

Firstly, regarding the primary reason, the factor loadings of the first factor are greater for infrastructure-related reason, such as commuting convenience, Industrial zoning, unrestricted environment, access to highway and business and logistic services. We, therefore, label the first factor as an infrastructure factor. Also, support from local government, personal ties and proximity to other firms are rated higher for the second factor. In contrast to the infrastructure nature of the reasons emphasized in the first factor, those of the second factor are more oriented toward public and private relationship. Therefore, in contrast to the reasons in the first factor supported by physical infrastructure, we specify the second factor as a non-infrastructure factor. We may also identify the factor as an institutional or relational factor.

Moreover, the factor loadings of the secondary reason have different feature than those of the primary reason. The factor loading of access to highway is drastically high for the second factor. While commuting convenience has a minor positive impact, the relative difference to the first factor is negligible. So, we disregard the influence of commuting convenience and simply term the second factor as a highway access factor. Meanwhile, the first factor is strongly characterized by local public support and managers' social connections. Also, business and logistic services and lesser restriction from surrounding environment have sufficiently great loadings. Those reasons roughly represent local institutional and relational supports. So, we label the first factor as a general advantage factor that summarizes all location advantage factor and individual location reason are summarized in Figure 2

Now, let us discuss the regional impact of those two factors by looking at the spatial distribution of the factor scores. The scores of each factor are presented in Table 3 and their spatial distributions are portrayed in Figure 4. Factor score is a composite measure created for each observation (prefecture) on each factor and higher (lower) values on the variables with high loadings on a factor will result in a higher (lower) factor score. Firstly, let us look at the factor scores in the primary reason. Plants emphasizing the infrastructure factor are concentrated in urban areas; particularly in prefectures around Tokyo, Osaka and Aichi. Since the infrastructure factor principally represents commuting convenience, less constraints from surrounding environment and neighbors and industrial zone, it is quite reasonable that the location factor becomes more significant in such industrialized prefectures.

The factor also characterizes the advantages of better highway access, and if the goods produced by those plants around major metropolitan area are flown to the central markets, their emphasis on transportation can be understood with clear reasoning. In contrast, the second factor is non-infrastructure factor that consists of advantages in local governmental support, managers' personal linkages and co-location and has greater scores in the country side. The impact of the location factor is especially significant for Tohoku area in the northern part of the main island and Kyushu area in the southern island.

We can reasonably expect that the range of the business in such areas is limited to local markets and the preference to transport infrastructure to major markets becomes weaker. Also, land is relatively abundant and the availability of space would not be the major obstacle to alternate their location choice. It is, therefore, quite convincing that local policies and personal ties become more predominant for those regions. We are able to summarize the results as firms in urban area tend to rate infrastructure higher, while those in the country side appreciate local institutions and social linkages more.

Next, let us look at the distribution of the scores of the secondary reason. The secondary reasons are reduced into two location factors; one is a general advantage factor and another is a highway access factor. According to Figure 4, an increasing number of new plants are attracted to the highway factor in prefectures around Tokyo and in Osaka and Aichi. Hence, similar to the distribution of the infrastructure factor discussed previously, new plants in urban area stress the advantage arising from infrastructure. Since those areas are the three largest urban regions in the nation, the result shows how highway access is important to attract new production activities in urban areas. The impact of transport

[6] The minor reasons here are access to railroad, airport and harbor that are rarely chosen for the important location reason.(Table 1).

**Table 2.** Factor loadings of the first and second factors for the primary and secondary reasons by prefecture (a: Only ticked items are included for the computation).

| No. | Primary reason | | | | | Secondary reason | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Factor 1 | | Factor 2 | | | Factor 1 | | Factor 2 | | |
| Factors | Infrastructure Factor | | Non-infrastructure Factor | | communality | General Factor | | Highway Factor | | communality |
| Access to highway | ☑ | 0.73 | □ | 0.08 | 0.61 | □ | -0.06 | ☑ | 1.03 | 0.97 |
| Business and logistic service | ☑ | 0.81 | □ | -0.10 | 0.57 | ☑ | 0.74 | □ | 0.15 | 0.74 |
| Land availability | ☑ | 0.77 | □ | 0.25 | 0.90 | ☑ | 0.70 | □ | 0.35 | 0.97 |
| Industrial zone | ☑ | 0.83 | □ | 0.06 | 0.79 | ☑ | 0.62 | □ | 0.31 | 0.77 |
| Environment and neighbor | ☑ | 0.85 | □ | 0.05 | 0.78 | ☑ | 0.80 | □ | 0.19 | 0.91 |
| Commuting convenience | ☑ | 0.88 | □ | -0.08 | 0.70 | □ | 0.47 | □ | 0.51 | 0.83 |
| Support from local government | □ | -0.01 | ☑ | 0.84 | 0.70 | ☑ | 0.97 | □ | -0.17 | 0.73 |
| Manager's personal ties | □ | 0.27 | ☑ | 0.57 | 0.59 | ☑ | 0.91 | □ | -0.15 | 0.65 |
| Co-location with other firms | □ | -0.06 | ☑ | 0.68 | 0.41 | ☑ | 0.45 | □ | 0.11 | 0.28 |
| Cronbach's *α* | | 0.82[a] | | 0.63[a] | | | 0.91[a] | | 0.90 | |
| | The $\chi^2$ statistic is 38.30 | | | | | The $\chi^2$ statistic is 38.30 | | | | |
| | The degrees of freedom is 19 | | | | | The degrees of freedom is 19 | | | | |
| | The p-value is 0.00544 | | | | | The p-value is 0.00544 | | | | |

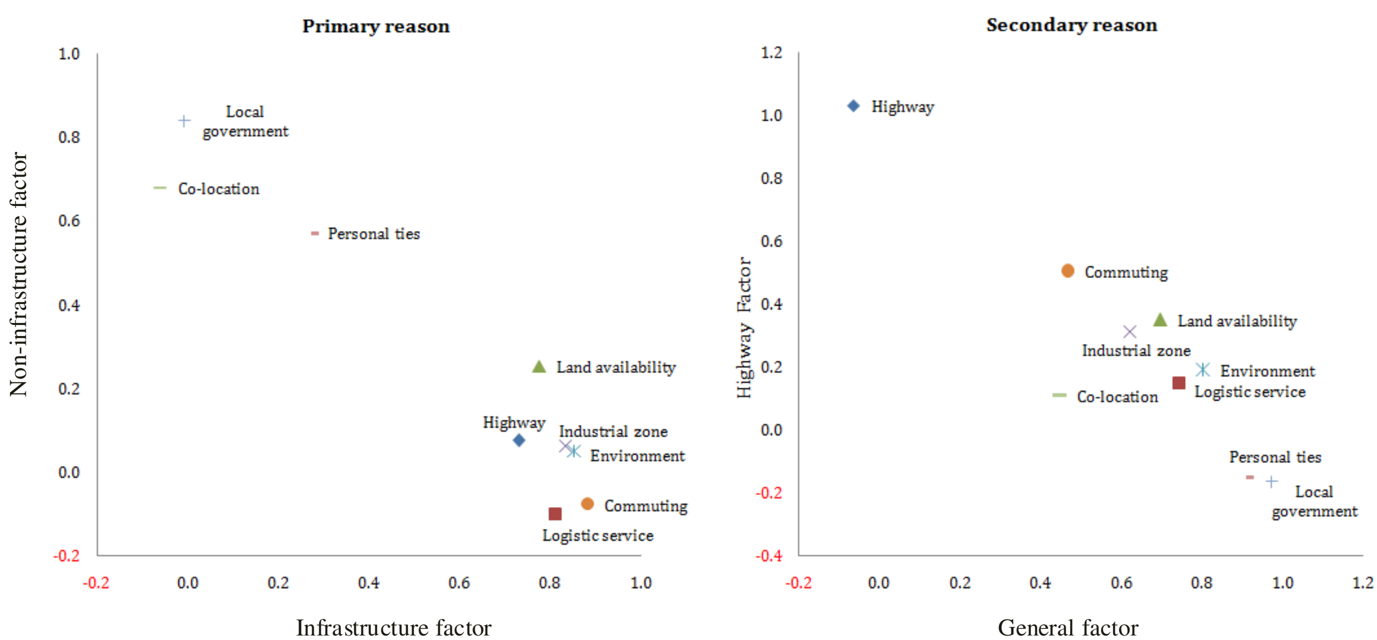


**Figure** 3. The plots of the factor loadings of the first and second factors for the primary and secondary reasons by prefecture.

infrastructure becomes larger in peripheral industrial regions, which are the peripheral prefectures around metropolitan cities, such as Tokyo and Osaka. This can be rationalized if we consider that the demand for highway access grows rather in such inner-city areas requiring more congestion-related costs. Related to this, it is also important to note that the highway factor is not necessarily emphasized in Tokyo and Osaka and this might be arising from over congestion that reduces the economic return of highway construction. The same thing can be said to the previous infrastructure factor. Moreover, the impact of the general advantage factor is particularly

**Table 3.** The score of the factors of the primary and secondary reasons by prefecture.

| Rank of reason | | Primary reason | | Secondary reason | |
|---|---|---|---|---|---|
| No. | | Factor 1 | Factor 2 | Factor 1 | Factor 2 |
| Factors | | Infrastructure | Non-Infrastructure | General Factor | Highway Factor |
| 1 | Hokkaido | 1.67 | 1.72 | 3.38 | -0.44 |
| 2 | Aomori | -0.55 | -0.61 | -0.14 | -1.20 |
| 3 | Iwate | -0.67 | 0.39 | -0.02 | -0.10 |
| 4 | Miyagi | 0.99 | 1.17 | 0.64 | 1.26 |
| 5 | Akita | -0.60 | -0.16 | 0.05 | -0.88 |
| 6 | Yamagata | 0.23 | 1.44 | 1.60 | -0.67 |
| 7 | Fukushima | 0.15 | 1.09 | 0.35 | 0.35 |
| 8 | Ibaragi | 1.35 | -0.23 | -0.88 | 2.15 |
| 9 | Tochigi | 1.21 | -0.71 | 0.43 | 0.58 |
| 10 | Gunma | 2.08 | -0.96 | 1.70 | 0.18 |
| 11 | Saitama | 1.03 | -1.21 | -0.69 | 1.56 |
| 12 | Chiba | 0.28 | -0.78 | -0.74 | 0.86 |
| 13 | Tokyo | -0.94 | -0.82 | -1.04 | -0.74 |
| 14 | Kanagawa | 0.92 | -0.64 | 0.26 | 0.42 |
| 15 | Niigata | 0.77 | 1.12 | 1.50 | 0.70 |
| 16 | Toyama | -0.40 | -0.17 | 0.25 | -0.28 |
| 17 | Ishikawa | -0.68 | 0.46 | 0.29 | -0.59 |
| 18 | Fukui | -0.76 | -0.19 | -0.43 | -0.74 |
| 19 | Yamanashi | -0.65 | -0.55 | -1.05 | -0.11 |
| 20 | Nagano | 0.79 | 0.95 | 1.20 | 0.66 |
| 21 | Gifu | -0.15 | -0.55 | -0.91 | 0.89 |
| 22 | Shizuoka | 1.86 | -0.11 | 0.06 | 2.22 |
| 23 | Aichi | 1.28 | -0.23 | 0.87 | 1.26 |
| 24 | Mie | -0.76 | 1.86 | 0.91 | -0.30 |
| 25 | Shiga | -0.08 | -0.29 | -1.12 | 0.94 |
| 26 | Kyoto | -0.12 | -0.48 | -0.83 | 0.45 |
| 27 | Osaka | 0.67 | -1.02 | -0.83 | 1.19 |
| 28 | Hyogo | 2.12 | 0.06 | -0.34 | 2.55 |
| 29 | Nara | -0.80 | -0.99 | -1.01 | -0.77 |
| 30 | Wakayama | -1.02 | -0.62 | -0.96 | -0.71 |
| 31 | Tottori | -0.95 | -0.51 | -0.37 | -1.14 |
| 32 | Shimane | -1.18 | -0.22 | -0.42 | -1.02 |
| 33 | Okayama | -0.42 | -0.32 | -0.29 | -0.18 |
| 34 | Hiroshima | 0.15 | -0.01 | 0.65 | -0.56 |
| 35 | Yamaguchi | -0.99 | -0.11 | -0.45 | -0.49 |
| 36 | Tokushima | -1.27 | 0.38 | -0.74 | -0.83 |
| 37 | Kagawa | -0.28 | -0.59 | -0.98 | -0.27 |
| 38 | Ehime | -0.51 | -0.48 | -0.45 | -0.85 |
| 39 | Kochi | -1.16 | -0.31 | -0.56 | -0.93 |
| 40 | Fukuoka | 0.96 | 2.77 | 2.31 | 0.86 |
| 41 | Saga | -0.77 | 0.21 | -0.35 | -0.57 |
| 42 | Nagasaki | -0.72 | -0.72 | -0.69 | -0.78 |
| 43 | Kumamoto | -0.36 | 1.54 | 0.46 | -0.24 |
| 44 | Oita | -0.57 | -0.10 | -0.13 | -0.90 |
| 45 | Miyazaki | -0.09 | 0.12 | -0.18 | -0.58 |
| 46 | Kagoshima | -0.10 | 0.09 | 0.33 | -1.12 |
| 47 | Okinawa | -0.96 | -0.68 | -0.63 | -1.09 |

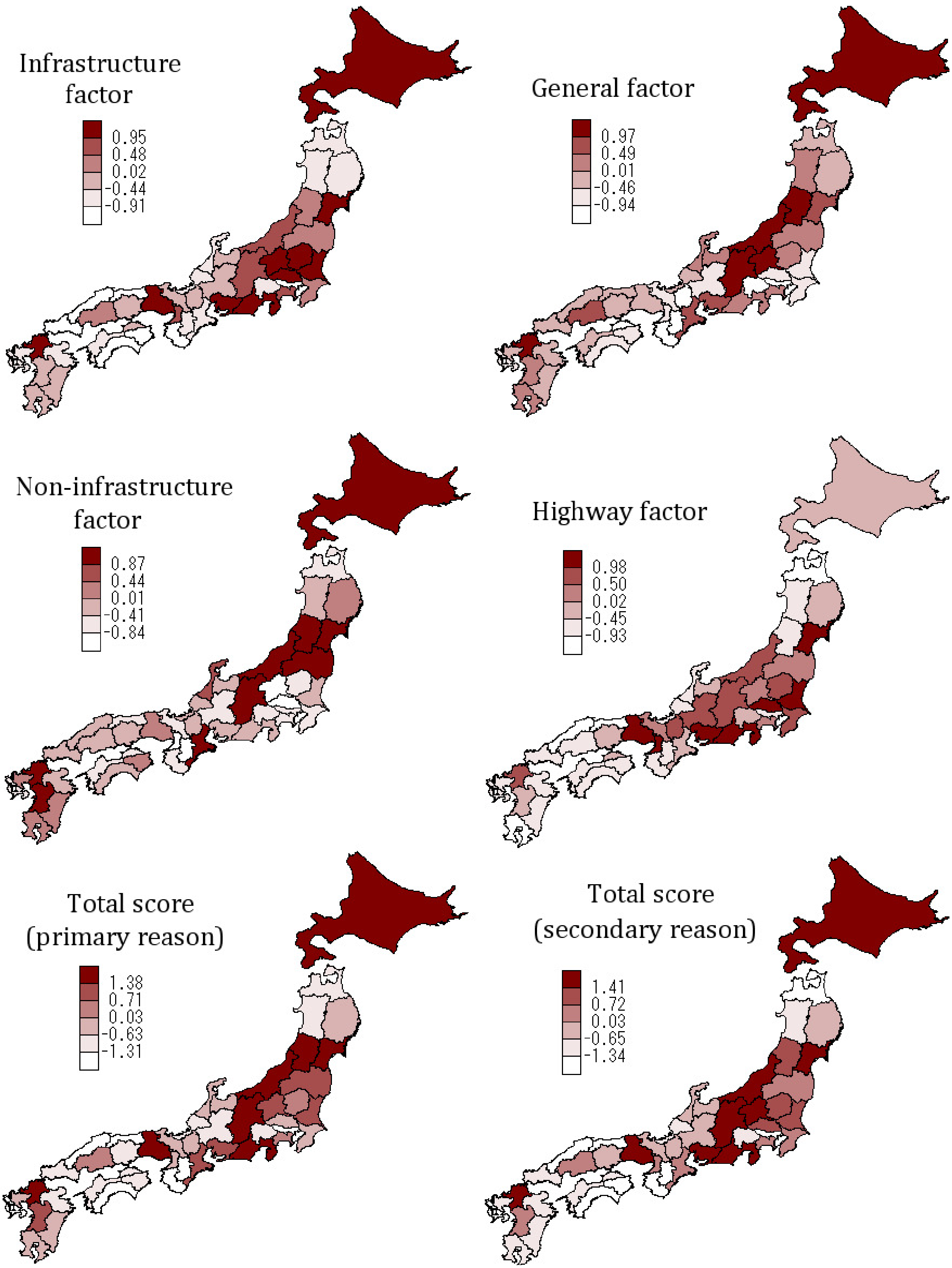


**Figure 4.** Percentile maps of the score of the factors for the primary and secondary reasons by prefecture.

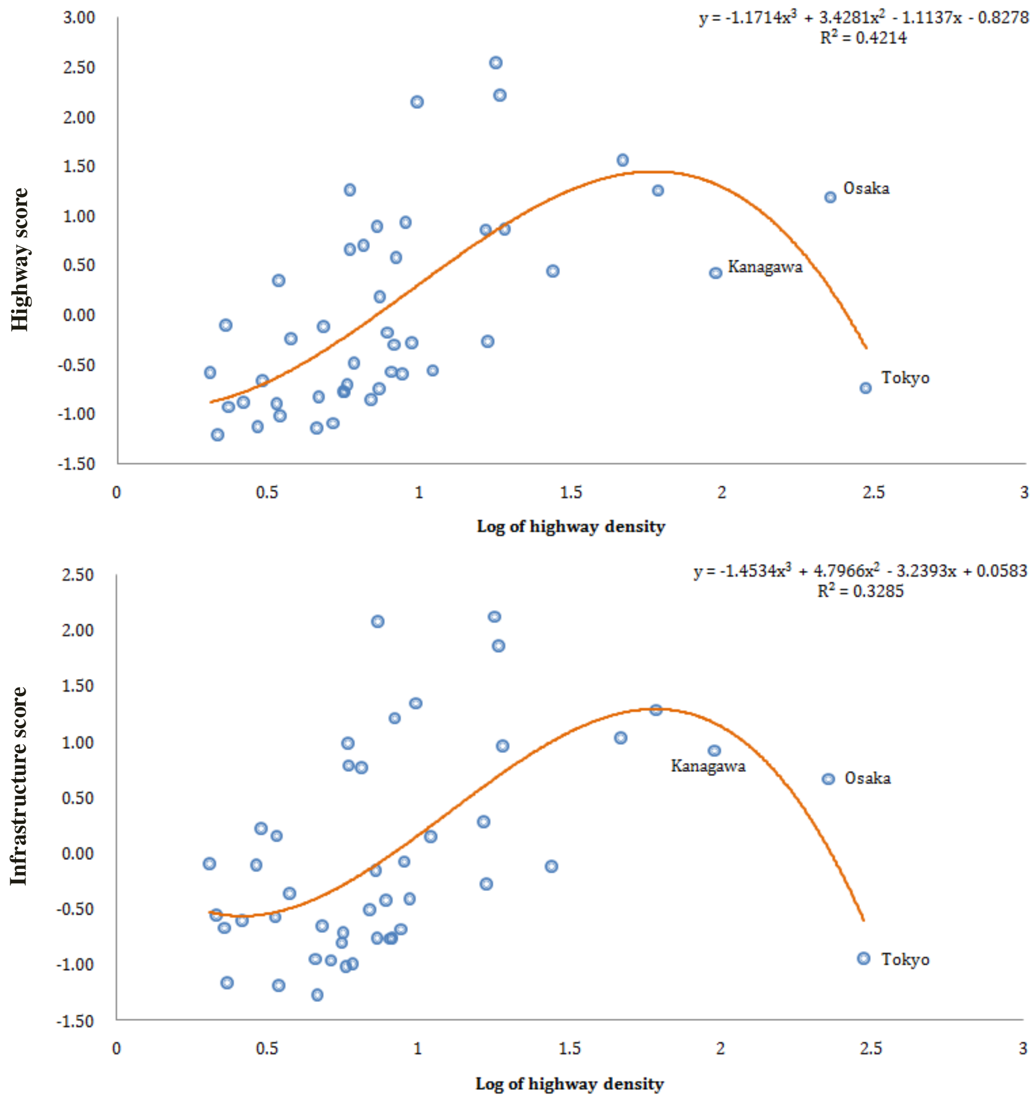


**Figure 5.** The correlation between highway distance per area of land (km/100km$^2$) and the scores of infrastructure factor and highway factor.

significant in the hinterland of metropolitan areas, and the factor rarely strengthens the attraction force of new plants to the metropolitan areas. The spatial pattern is quite analogous to that of the non-infrastructure factor in the primary reason. Therefore, we can find a similar location reasoning to account for the score pattern of the institution factor. In summary, the regional analysis granted us some implications and this analysis particularly useful for choosing policy tools in the inter-prefecture competition for attracting new plants. Firstly, as mentioned by Holl (2004a), there is no omnipotent set of local features comprising a favorable location environment. Policy tool should be appropriately chosen for its own geographical characteristics. If the region is in a suburb area, physical infrastructure investment is noticeably helpful to encourage the birth of new plants. In contrast, if it is in the country side, local government support mixed with local network promotion can have a major impact. Secondly, highway is particularly useful in urban location but not necessarily in the country side as well as in metropolitan center.

The demand for transport infrastructure is not constant across regions and there is a tendency that plants in the peripheral industrial regions more emphasize its role. Figure 5 must be helpful to see the regional impact of highway infrastructure. The horizontal axis of the plot represents the logarithm of highway distance density. The density is computed as the total distance of highway over the total area of land (km/100 km$^2$). The vertical axis of the upper and lower plots represents the score of the highway access factor and infrastructure factor, respectively. As seen in the inverse-U shape of the approximation curve, highway infrastructure becomes more important for location decision as the density becomes greater; however, the positive role suddenly declines for most populated metropolitan prefectures such as Tokyo, Osaka and Kanagawa. Thus, the attraction force of new plants grows in the peripheries of the core prefectures and the impact diminishes as population density rapidly rises in megacities.

## Conclusion

At the beginning, this study raised the following questions. Do infrastructure investment and arrangement actually attract new plants? If it does, is the positive impact of infrastructure support even across space. This concluding section answers to the questions and summarize the result. The survey asked the reason of location choice and factor scores are proportional to the choice frequency of location reasons that comprises location factors. Therefore, the result directly answers to the question of whether infrastructure becomes the reason of their location choice. Plants emphasizing the infrastructure factor are concentrated in urban areas; particularly in prefectures around Tokyo, Osaka and Aichi. Since the infrastructure factor principally represents commuting convenience, less constraints from surrounding environment and neighbors and industrial zone, it is quite reasonable that the location factor becomes more significant in such densely populated prefectures. The factor also characterizes advantages in better highway access. If the goods produced by those plants around a major metropolitan area are flown to the central markets, their emphasis on transportation can be rationalized. Also, Figure 5 shows that the scores of highway access factor are proportional to the highway distance density. This indicates that highway access more frequently chosen for the location reason as highway access improves. Thus, infrastructure arrangement, indeed, can be a major source of causing new plant formation.

In contrast, new plants in the country side value higher the non-infrastructure factor that consists of advantages in local governmental support, managers' personal linkages and co-location. This factor partly implies Hoover's advantage of manager's home-field (Hoover, 1948; Figueired et al., 2002) and business risk cutback (Isard 1975). The impact of the location factor is especially significant for Tohoku area in the northern part of the main island and Kyushu area in the southern island. We can reasonably expect that the range of the business in such areas is limited to local markets and the preference to transportation infrastructure to major markets becomes weaker. Also, land is relatively abundant and the availability of space would not be the major obstacle to alternate location choice. It is, therefore, quite convincing that local policies and personal ties become predominant for those regions.

We are able to summarize the results as firms in urban area tend to rate infrastructure higher and those in the country side value local institutions and social linkages more. Given those two contrasting location factors, infrastructure vs. relational, the impact of infrastructure is different across space and the importance varies according to the regional production system.

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**Appendix:**

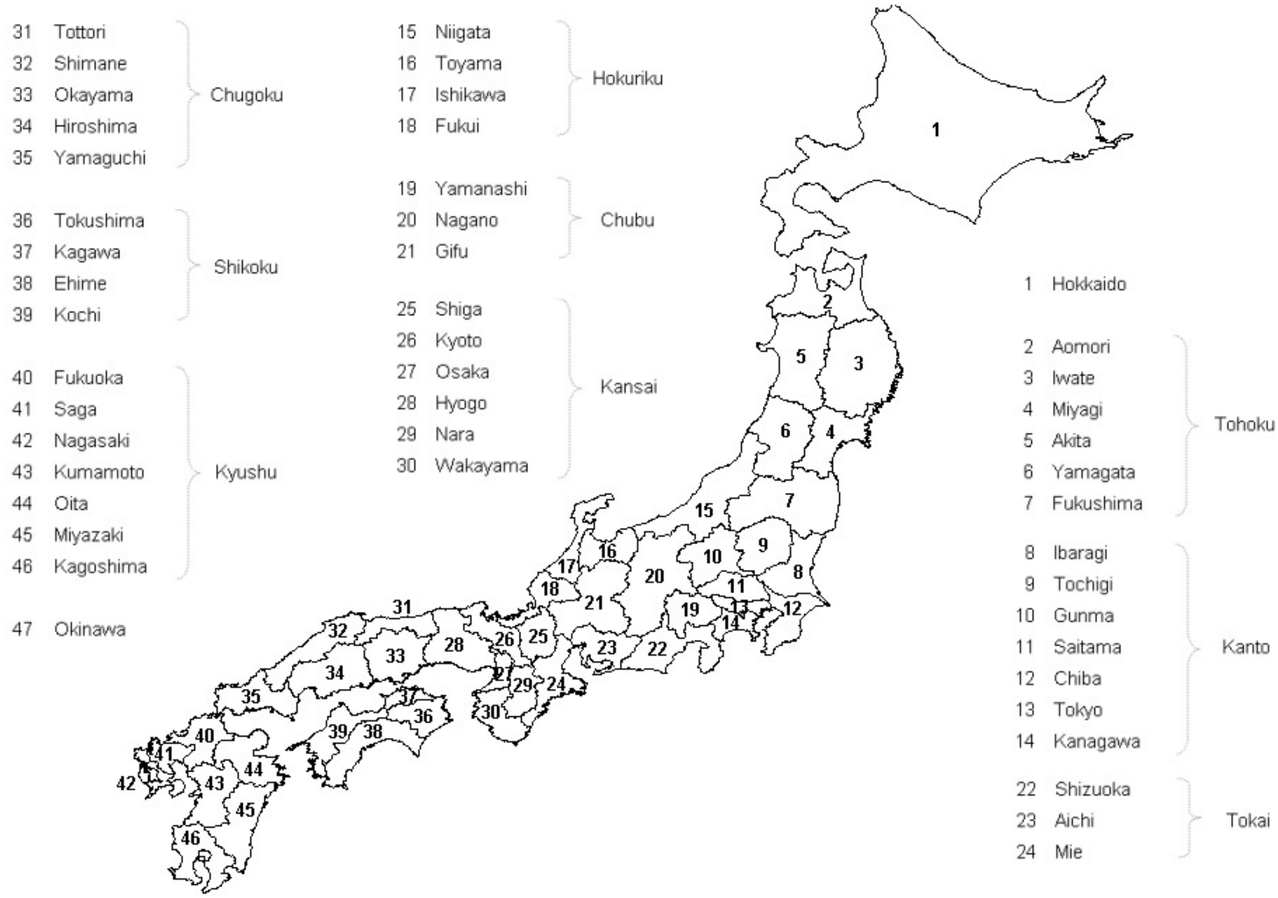


**Figure 6.** The name of 47 prefectures and 9 areas in Japan.