

Age Composition of Foreign Population in Japan and the Financial Strength Index of Municipalities

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Abstract. To find similar municipalities instantly, some studies in Japan have examined a calculation method that employs age-composition vector data for the population in the country. It has already been reported that the average score of the Financial Strength Index (FSI) of municipalities that are output by the calculation is correlated with the score of the original municipality. This study reported that a similar correlation could be observed only in foreign population data.

1. Introduction

In municipal policymaking, referring to the governance of similar municipalities is a practical way to improve the quality of decision-making. Recently, as a quick and instant method for finding similar municipalities, some studies in Japan have examined a calculation method that employs only age-composition vector data of the population [1-3]. A government website also provides information service that exploits this type of calculation [4]. A previous study reported that the average FSI score of municipalities that are output by the similarity calculation was strongly correlated with the FSI score of the original municipality [3].

This study reports that even with foreign population data, the average FSI score of the municipalities output by the similarity calculation is correlated with the FSI score of the original municipality. Section 2 summarizes the instant calculation method of age composition similarity (ACS calculation). Section 3 reports the relationship between the results of the ACS calculation based on foreign population and the financial strength index of municipalities.

2. Calculation of Age Composition Similarity

This section summarizes ACS calculation. Although the details of the calculation vary, we followed the early context in this study [1]. The following summarization is basically equivalent to Section 2. of [3].

The basic similarity score between the two population vectors is obtained using the following simple cosine formula:

$$\cos(\vec{x}, \vec{y}) = \frac{\vec{x} \cdot \vec{y}}{|\vec{x}||\vec{y}|} = \frac{\sum_{i=1}^{17} x_i y_i}{\sqrt{\sum_{i=1}^{17} x_i^2} \sqrt{\sum_{i=1}^{17} y_i^2}}$$

Each vector has 17 dimensions and reflects a municipality's population structure by five-year age groups (the "17th dimension" refers to the population aged ≥ 80 years). If we focus on one municipality, the other municipalities can be ordered according to their similarity scores to the first focused municipality. The top municipalities (the top "40" municipalities were usually examined) on

the list are the outputs of the ACS calculation. In [1], population data were derived from the Residential Basic Book of Japan by Ministry of Internal Affairs and Communications [5].

The ACS calculation can be modeled as follows: $M = \{m_1, m_2, \dots, m_p\}$ denotes the set of municipalities. For each $m_x \in M$, the output of the ACS calculation with threshold number n (such as 40 in the last paragraph) is defined as follows:

$$ACS(m_x, n) = \{m_y \in M \mid Rank(m_y, List(m_x)) \leq n\}$$

Here, $List(m_x)$ denotes the list of all the members of $M - \{m_x\}$. The order in the list reflects the degree of similarity to m_x , which is obtained using the cosine calculation described above. $Rank(m_y, List(m_x))$ denotes the rank of m_y in $List(m_x)$ (we used 40 as n in this study).

3. Calculation of ACS and the Financial Strength Index

Employing foreign population data, this section examines the relationship between the municipalities and the output municipalities of the ACS calculation from the viewpoint of the FSI. The FSI is an index of local governments' financial strength. This is a simple arithmetic average of the scores calculated as [standard financial revenue] / [standard financial requirement] for three fiscal years. The higher the FSI, the greater is the total amount of financial resources reserved, meaning that the local government has more financial resources to spare. FSI is a typical industrial index.

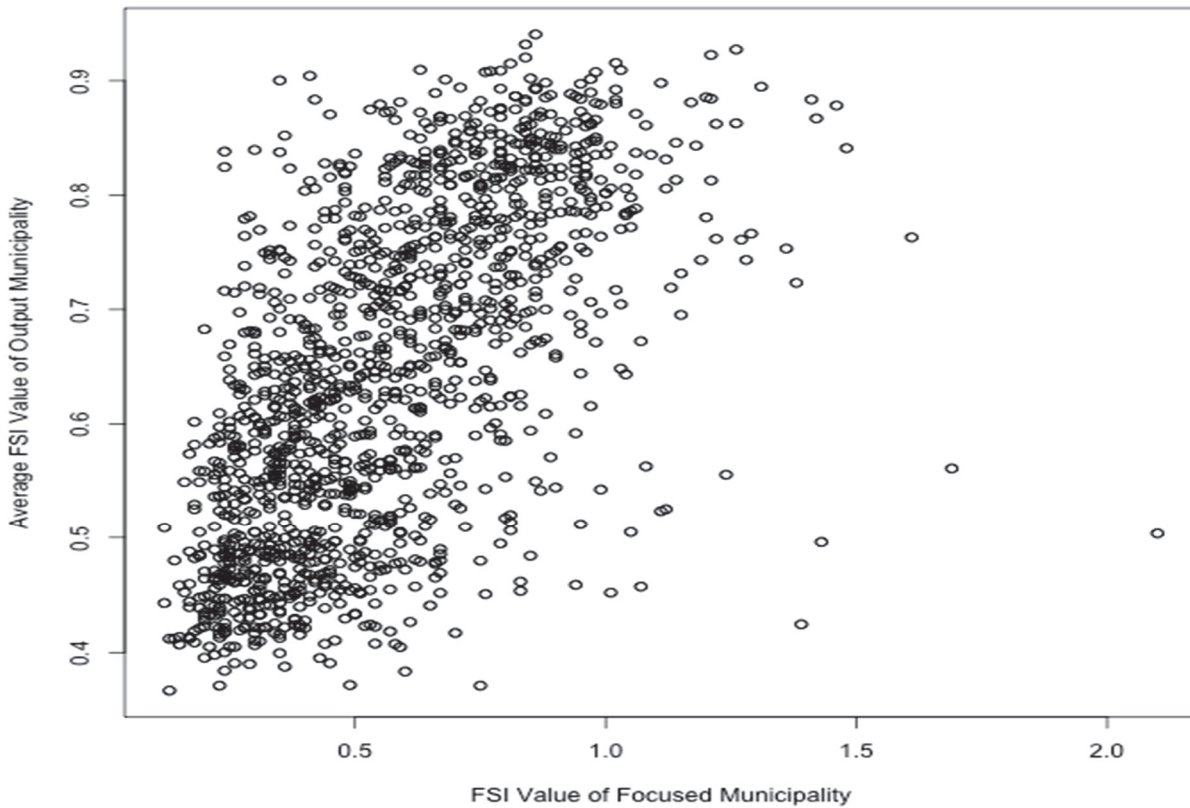


Fig. 1. Similarity of FSI Values of Output Municipalities

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The method of examination is basically equivalent to Section 3 of [3], and is as follows: 1) for each municipality that has complete age composition data of foreign residents, the FSI value is clear and listed (N=1,403); 2) for each municipality, the average FSI value of the output of the top 40 municipalities is obtained by the ACS calculation; and 3) using these two lists, this study examines the correlation between the FSI score of the original municipality and the average FSI score of the municipalities that are output by the ACS calculation. (For procedures 1 and 2, this study used data from the 2023 version of [5]. However, the FSI data were based on the latest governmental survey conducted in 2021.)

The results were as follows: Pearson's correlation coefficient was 0.613 ($p < 0.001$). The average FSI score of the output municipalities in the ACS calculation was correlated with the FSI score of the original municipality. Fig. 1 shows a scatter plot of the FSI value of the original municipality and the average FSI value of the output municipalities.

4. Concluding Remarks

Based only on the foreign population data, this study demonstrated that the average FSI score of the municipalities yielded by the ACS calculation was correlated with the FSI score of the original municipality. Based on the total population, this type of result would seem reasonable, as the tax income of the municipality is related to the share of the working-age population. However, the result obtained here is interesting because the foreign population is still less than three percent of the total.

However, the background mechanism of the correlation found in this study remains unclear. To clarify how strongly the ACS calculation with foreign population data is related to the FSI score, it would also be valuable to compare the calculation output with outputs from other types of similarity calculations that are based, for example, on the scale or ratio of the foreign population of a municipality. Examining the basis of the correlation found here is a task for the next stage of this study. If the topic of local decision-making is related to its foreign residents, the municipalities' output by calculating the foreign population may be more valuable than municipalities' output by calculating the total or national population. ACS calculations for a foreign population may have significant potential for decision-making related to foreign residents.

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