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The Study About Gini Coefficient Model Using Public Facility Data

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ABSTRACT
Nowadays the regional gaps between the metropolitan area and the local areas in Japan have expanded. We can also guess the importance of this problem from the situation which “Headquarters for Overcoming Population Decline and Vitalizing Local Economy” has been established in the Cabinet and various efforts for that have been made. Gini coefficients have often been used when the regional gaps are analyzed but, in many cases, the Gini coefficients focus on incomes of people. Then we have developed a new model of Gini coefficients which focuses on the number of public facilities to analyze the regional gaps from the viewpoint of public infrastructure. Thus it has turned out to be no regional gap from the viewpoint of public infrastructure around principal stations as a result of the analysis conducted on the basis of the data concerning the number of public facilities around principal stations of 47 prefectures by using the model.
Keywords - Regional Revitalization, Gini Coefficient, Regional Gaps

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I. INTRODUCTION

Japan today is facing growing inequalities between metropolitan Tokyo and regional cities. The gravity of this problem is implied by the fact that the Japanese government has established the Headquarters for Overcoming Population Decline and Vitalizing Local Economy [1], which undertakes various initiatives. The Gini coefficient is a method employed in analyzing social disparities, but many studies apply it to individual incomes. The current study takes an approach to social polarization in terms of public infrastructure. We have thus developed a new Gini coefficient model focusing on the number of public facilities. Using this model, we analyzed data on public facilities around major railway stations in 47 prefectures in Japan. The results showed that there were no major regional disparities among all these 47 prefectures in terms of near-station public infrastructure.

II. BACKGROUND

Japan has been active in efforts to redevelop regional areas, with the Cabinet Office’s Headquarters for Overcoming Population Decline and Vitalizing Local Economy established in 2014 being an example. The underlying idea is that revitalization of regions is indispensable for the country’s economic growth. The Headquarters aims mainly to support small and medium enterprises, assist talent-matching between universities and local businesses, and pursue various initiatives to lessen social inequalities among different regions. In studies of social polarization, the Gini coefficient is used as one of the inequality measurements. To cite a few examples of analyses based on the Gini coefficient, the Cabinet Office’s 2012 Annual Report on the Japanese Economy and Public Finance[2] analyzed the income disparity and found that the income distribution was in a downward trend and that the intragenerational gap was widening. Tachibanaki[3] has conducted an international comparative study of Gini coefficients and suggests that, contrary to the general belief, income is distributed less equally than the international standards. Meanwhile, the Ministry of Health, Labour and Welfare published the survey on the redistribution of income 2011[4], in which income redistribution was analyzed in terms of the improvement of Gini coefficients, and reported that it was shown to be effective to some extent to resolve the inequity in income distribution.

As we discuss in Section 2, some new Gini coefficient models have been suggested recently, targeting data other than income, such as the percentage of people receiving social welfare services and social security benefits. However, there has not been a model that addresses data on public facilities. The “public facilities” in this study refer to not only the infrastructure managed by the national or local governments, but also some facilities for public use managed by the private sector. It is highly important to analyze public infrastructure and services that cater to the basic needs in life, whether they are administered by the public or private sector, as they concern the social life of the nation.

In this study, therefore, we have developed a Gini coefficient model that addresses the number of public facilities. Section 4 presents an evaluation trial using this model. The results showed that no major regional disparities were found among the 47 prefectures in terms of near-station public infrastructure. Based on this result, a discussion is presented in Section 5.

III. EXISTING AND RELEVANT STUDIES

The Gini coefficient is an index which can be used to analyze income inequality between nations and regions, and it is obtained through a combination of the Lorentz curve and the line of perfect equality. The coefficient's scale is between 0 and 1, where a value closer to 1 indicates greater inequality.

Many of the existing studies concerning the Gini coefficient use a model that deals with data on income[5-8]. Suzuki[5] calculated the Gini coefficients based on income data by dividing it into the impact of "real wage income" and that of "differences in labor structures." The results indicated that prefectures with high income levels were inhabited by high-income earners who worked for major corporations or manufacturers, and the wages for those who worked for smaller businesses or in the service industry in the same area were raised through the leveling of wages internal to that area. Thus, he concluded that these were the factors contributing to the interregional inequality.

Similarly, Otsuka[6] analyzed income data to obtain the Gini coefficients, from which she concluded that an increase of elderly population did not necessarily make the income-level inequality greater; its impact on the inequality could be reduced, depending on the fluctuation of the elderly population.

"The 2009 Minister of State for Economic and Fiscal Policy Report [7] "states that the inequality continues to grow in terms of wages and household income, but the progress of the disparity has been moderate in recent years. The increasing inequality in household income is mainly attributed to the growing number of the unemployed due to the economic downturn. The estimate of wage inequality with the unemployment rate factored in suggests that the disparity decreased during the period of economic recovery between 2002 and 2007. The results from the Gini coefficients thus obtained from the income data led to the conclusion that the economic recovery was the most significant factor that contributed to the amelioration of the gap. The same report also states that the redistribution of income has a significant impact on minimizing the disparity, with social security being an effective means of redistribution owing to the aging population, whereas taxation is losing impetus for the same purpose. With reference to the survey on income redistribution, Japan has a relatively low level of effectiveness from income redistribution compared to other OECD member states—the gaps remain almost unchanged after the redistributions for all age groups other than the senior population. Furthermore, it has been less effective if we look solely at a number of reforms of social systems, including social security, which have been implemented recently. Given these, the present redistribution systems arranged around the public pension fund are deemed insufficient for correcting the inequalities against working population.

Maeda et al.[8] address the income inequality in China through the Gini coefficient, with respect to the country's economic growth in recent years and the problem of income disparity. For their theoretical analysis, the authors theoretically consider the relationship between capital accumulation and the Gini coefficient. This theoretical consideration draws on the framework of the Harris-Todaro model, which is an economic model believed to be useful for analyzing the Chinese economy, in order to analyze the relationship between capital accumulation as a result of economic growth and the Gini coefficients. They thus elucidated that the Gini coefficients were determined by the rural population ratios and the relative income ratios in rural areas. In order to investigate the influence of capital accumulation on the Gini coefficients, they firstly analyzed the impact of capital accumulation on the two determinant factors separately. Using the results of this analysis, they probed the impact on the Gini coefficient models that reflected the intensity of impact of these cases respectively. As a result, they verified that capital accumulation always lowers the rural population ratio, and that on the other hand, the relative income ratio of the rural areas increased only if the rural population was sufficiently large and their productivity was sufficiently high. From this study, they have gained the knowledge that the Gini coefficient becomes smaller through capital accumulation based on economic growth only if those conditions are met. In other words, if the conditions are not satisfied, it is possible that the Gini coefficient increases as capital accumulation progresses, which points to the possibility of increasing income inequality together with economic growth.

Meanwhile, there are other Gini coefficient models proposed recently, designed to use data other than income data. Tashiro, et al.[9] studied people aged 65 or over who do not require long-term care (200,000 individuals across Japan) and investigated the regional correlation between income inequality (the Gini coefficient) and the number of remaining teeth of those people, comparing these figures according to the coefficients. Then, they conducted a multi-level analysis based on the ordinal regression logistic model with the dental status as an objective variable, personal variables as explanatory variables, including the samples' gender, age, education, equivalent income, current living conditions, household size, diabetes treatment and smoking status, and average equivalent income as a regional variable. In their conclusion, they recognized the correlation between the regional inequality of income and the inhabitants' dental statuses.

Ooi[10] addressed the question of why some prefectures have more students who continue with further education at universities. She harmonized her data so that social and economic factors {parents' occupations, their financial capacity, the distance to the university, number of available places in the faculty (capacity) and the domestic environment for studying} are leveled out throughout the country and applied the data to the Gini coefficient model. The result of the analysis thus identified the regional inequality.

There are also many papers that address the issue of social polarization without using the Gini coefficient. Miyazawa [11] created base data for analyzing regional disparities in the Japanese economy, using data on production and the number of employees.

Ushizawa, et al. [12] conducted a comprehensive analysis of the relationship between the data concerning the percentage of people living on welfare benefits and data on nine indicators (unemployment rates, divorce rates, the proportion of elderly population, income levels, the amount of savings, the proportion of property owners, the percentage of three-generation households, the production of the construction industry against the production of all industries). They thus developed and proposed an explanatory model of interregional inequalities. Based on this, they concluded that unemployment rates, divorce rates and the proportion of elderly population, the factors considered to be direct contributors to deteriorated livelihood, were the major factors in inequality. Regarding the regions that proved unexplainable, they showed that cultural differences, social relationships and other factors influenced in a complex manner. The existing studies such as the above apply non-income-based data to the Gini coefficient, but there have been no studies that propose a Gini coefficient model in terms of public facilities.

While the present study obtains Gini coefficients focused on data concerning the number of public facilities near the major railway stations in all of the 47 prefectures in Japan, there are some existing studies on interregional inequality in relation to the attributes of the stations[13-15]. However, they analyze the station attributes using dummy coefficients, and not the Gini coefficient.

IV. PROPOSED CONCEPT

A. Survey of public facilities

Before obtaining the Gini coefficient, it is necessary to establish a reference point common to all regions. In this study, therefore, we set railway stations as the reference point (because all prefectures have them and many people use them) to survey the public facilities in their vicinities. In practice, data were taken from the "Shutten Senryaku Joho-kyoku [16] " database to determine the major railway station for each prefecture by the number of users per day. The major stations determined in this way, we surveyed all public facilities located within 1 km radius from them.

Regarding the definition of "public facilities" in this study, we used the public facility information defined on Google Places API[17], as this program was used to obtain the data on the number of public facilities. It should be noted that the API can only return up to 20 facilities in one search session. Where there were more than 21 facilities in the area (near the station), therefore, we used the Mapion telephone directory[18] to supplement the data on the number of public facilities.

Table 1 below shows the numbers of public facilities for each prefecture, obtained based on the concept above. The stations constitute the rows and each column represents a type of public facility. While the values in Table 1 are the actual numbers of facilities, these are prone to relative distortion as the total numbers of facility types are variable. For example, as Table 1 indicates, the number of hospitals is far greater than the numbers of other facilities. If these figures are used in analyses as they are, the outcome will be subject to a significant bias. Therefore, we converted these figures into relative frequencies (dividing the number of a given facility by the total number of the same facility type), as shown in Table 2. The Gini coefficient for this study was, thus, calculated using the relative frequencies in Table 2.

Table 1: Number of public facilities for 47 prefectures

Prefectures	Station Name	Total number of public facilities	Number of public facilities										
			Police Station	Hospital	Municipal Office	Post Office	HIgh School	library	Sub way Station	Station	University	Firehouse	Park
Hokkaido	**Sappolo Station**	268	6	218	10	14	5	2	4	1	5	0	3
Aomori	**Aomori Station**	73	3	45	8	6	0	1	0	1	0	4	5
Iwate	**Morioka Station**	107	2	73	5	5	5	1	0	1	1	3	11
Miyagi	**Sendai Station**	258	7	197	14	13	3	1	6	3	1	0	13
Akita	**Akita Station**	115	5	78	5	6	6	2	0	1	0	1	11
Yamagata	**Yamagata Station**	98	1	61	10	7	2	2	0	1	1	0	13
Fukushima	**Koriyama Station**	83	1	57	5	6	4	0	0	1	1	5	3
Ibaraki	**Mito Station**	79	2	41	8	4	7	1	0	1	1	1	13
Tochigi	**Utsunomiya Station**	110	3	77	2	5	3	1	0	1	2	0	16
Gunma	**Takasaki Station**	118	1	86	3	5	2	0	0	1	0	3	17
Saitama	**Omiya Station**	207	4	164	5	8	3	2	0	1	3	2	15
Chiba	**Nishi Funabashi Station**	81	1	49	6	4	0	2	0	3	1	1	14
Tokyo	**Shinjuku Station**	406	3	331	6	19	5	2	7	13	8	2	10
Kanagawa	**Yokohama Station**	242	6	180	10	8	4	2	1	6	4	2	19
Niigata	**Niigata Station**	123	3	85	6	3	4	1	0	1	3	2	15
Toyama	**Toyama Station**	82	2	37	6	8	3	1	0	3	0	4	18
Ishikawa	**Kanazawa Station**	115	14	59	4	7	1	2	0	3	0	8	17
Fukui	**Fukui Station**	112	4	69	7	9	3	1	0	2	0	0	17
Yamanashi	**Kofu Station**	103	2	75	5	9	2	1	0	1	0	2	6
Nagano	**Nagano Station**	87	1	59	5	6	3	2	0	2	0	3	6
Gifu	**Gifu Station**	143	2	110	2	5	4	1	0	3	1	0	15
Shizuoka	**Shizuok**	170	4	123	8	7	2	2	0	4	2	2	16

	a Station												
Aichi	**Nagoya Station**	221	2	170	5	11	5	1	3	3	4	2	15
Mie	**Yokkaichi Station**	113	1	75	6	5	5	1	0	1	0	3	16
Shiga	**Shiga Station**	91	3	66	4	5	2	0	0	1	0	0	10
Kyoto	**Kyoto Station**	140	4	89	10	11	1	2	1	3	3	2	14
Osaka	**Osaka Station**	367	4	305	4	18	6	2	0	5	8	3	12
Hyogo	**Sannomiya Station**	314	5	246	11	12	4	1	3	6	5	4	17
Nara	**Nara Station**	130	5	87	9	8	4	1	0	2	2	0	12
Wakayama	**Wakayama Station**	144	3	109	7	7	1	0	0	2	1	0	14
Tottori	**Tottori Station**	103	2	60	9	5	0	1	0	1	0	3	22
Shimane	**Matsue Station**	56	0	37	4	6	0	1	0	1	0	4	3
Okayama	**Okayama Station**	204	1	165	5	8	6	1	0	1	1	3	13
Hiroshima	**Hiroshima Station**	171	2	126	6	6	5	1	0	1	3	2	19
Yamaguchi	**Shimonoseki Station**	49	1	28	6	4	0	1	0	1	0	2	6
Tokushima	**Tokushima Station**	139	3	100	8	7	4	1	0	1	1	3	11
Kagawa	**Takamatsu Station**	84	2	60	4	5	2	1	0	2	0	0	8
Ehime	**Matsue Station**	73	0	49	7	4	2	1	0	3	1	0	6
Kochi	**Kochi Station**	129	2	88	6	5	1	1	0	1	2	2	21
Fukuoka	**Hakata Station**	239	4	194	4	9	2	2	1	1	0	3	19
Saga	**Saga Station**	64	0	44	5	3	2	1	0	1	0	1	7
Nagasaki	**Nagasaki Station**	154	5	102	16	6	2	2	0	1	0	3	17
Kumamoto	**Kumamoto Station**	56	0	32	5	6	0	1	0	1	1	2	8
Oita	**Oita Station**	155	4	122	5	4	4	1	0	1	0	2	12
Miyazaki	**Miyaza**	102	5	65	9	5	3	1	0	1	1	1	11

	ki Station												
Kagoshima	**Kagoshimachuuou Station**	168	1	127	6	6	5	1	0	2	2	1	17
Okinawa	**Kenchō-mae Station**	122	1	87	6	5	2	1	0	4	0	3	13

Table 2: Number of public facilities for 47 prefectures (in relative frequencies)

Prefectures	Station Name	Total relative frequencies of public facilities	Relative frequencies of public facilities										
			Police Station	Hospital	Municipal Office	Post Office	HIgh School	library	Subway Station	Station	University	Firehouse	Park
Saga	Saga Station	0.0984	0.0000	0.0090	0.0163	0.0090	0.0144	0.0175	0.0000	0.0099	0.0000	0.0106	0.0117
Yamaguchi	Shimonoseki Station	0.1033	0.0073	0.0057	0.0195	0.0119	0.0000	0.0175	0.0000	0.0099	0.0000	0.0213	0.0101
Shiga	Shiga Station	0.1044	0.0219	0.0135	0.0130	0.0149	0.0144	0.0000	0.0000	0.0099	0.0000	0.0000	0.0168
Shimane	Matsue Station	0.1135	0.0000	0.0075	0.0130	0.0179	0.0000	0.0175	0.0000	0.0099	0.0000	0.0426	0.0050
Kumamoto	Kumamoto Station	0.1174	0.0000	0.0065	0.0163	0.0179	0.0000	0.0175	0.0000	0.0099	0.0145	0.0213	0.0134
Kagawa	Takamatsu Station	0.1199	0.0146	0.0122	0.0130	0.0149	0.0144	0.0175	0.0000	0.0198	0.0000	0.0000	0.0134
Ehime	Matsue Station	0.1309	0.0000	0.0100	0.0228	0.0119	0.0144	0.0175	0.0000	0.0297	0.0145	0.0000	0.0101
Gunma	Takasaki Station	0.1343	0.0073	0.0175	0.0098	0.0149	0.0144	0.0000	0.0000	0.0099	0.0000	0.0319	0.0285
Yamanashi	Kofu Station	0.1462	0.0146	0.0153	0.0163	0.0269	0.0144	0.0175	0.0000	0.0099	0.0000	0.0213	0.0101
Wakayama	Wakayama Station	0.1528	0.0219	0.0222	0.0228	0.0209	0.0072	0.0000	0.0000	0.0198	0.0145	0.0000	0.0235
Aomori	Aomori Station	0.1534	0.0219	0.0092	0.0261	0.0179	0.0000	0.0175	0.0000	0.0099	0.0000	0.0426	0.0084
Chiba	Nishi Funabashi Station	0.1622	0.0073	0.0100	0.0195	0.0119	0.0000	0.0351	0.0000	0.0297	0.0145	0.0106	0.0235

Tochigi	**Utsunomiya Station**	0.1639	0.0219	0.0157	0.0065	0.0149	0.0216	0.0175	0.0000	0.0099	0.0290	0.0000	0.0268
Fukushima	**Koriyama Station**	0.1645	0.0073	0.0116	0.0163	0.0179	0.0288	0.0000	0.0000	0.0099	0.0145	0.0532	0.0050
Tottori	**Tottori Station**	0.1673	0.0146	0.0122	0.0293	0.0149	0.0000	0.0175	0.0000	0.0099	0.0000	0.0319	0.0369
Yamagata	**Yamagata Station**	0.1689	0.0073	0.0124	0.0326	0.0209	0.0144	0.0351	0.0000	0.0099	0.0145	0.0000	0.0218
Nagano	**Nagano Station**	0.1720	0.0073	0.0120	0.0163	0.0179	0.0216	0.0351	0.0000	0.0198	0.0000	0.0319	0.0101
Gifu	**Gifu Station**	0.1741	0.0146	0.0224	0.0065	0.0149	0.0288	0.0175	0.0000	0.0297	0.0145	0.0000	0.0252
Mie	**Yokkaichi Station**	0.1792	0.0073	0.0153	0.0195	0.0149	0.0360	0.0175	0.0000	0.0099	0.0000	0.0319	0.0268
Oita	**Oita Station**	0.1799	0.0292	0.0249	0.0163	0.0119	0.0288	0.0175	0.0000	0.0099	0.0000	0.0213	0.0201
Fukui	**Fukui Station**	0.1804	0.0292	0.0141	0.0228	0.0269	0.0216	0.0175	0.0000	0.0198	0.0000	0.0000	0.0285
Okinawa	**Kenchō-mae Station**	0.1848	0.0073	0.0177	0.0195	0.0149	0.0144	0.0175	0.0000	0.0396	0.0000	0.0319	0.0218
Ibaraki	**Mito Station**	0.1857	0.0146	0.0084	0.0261	0.0119	0.0504	0.0175	0.0000	0.0099	0.0145	0.0106	0.0218
Miyazaki	**Miyazaki Station**	0.1866	0.0365	0.0132	0.0293	0.0149	0.0216	0.0175	0.0000	0.0099	0.0145	0.0106	0.0185
Kochi	**Kochi Station**	0.1871	0.0146	0.0179	0.0195	0.0149	0.0072	0.0175	0.0000	0.0099	0.0290	0.0213	0.0352
Iwate	**Morioka Station**	0.1890	0.0146	0.0149	0.0163	0.0149	0.0360	0.0175	0.0000	0.0099	0.0145	0.0319	0.0185
Akita	**Akita Station**	0.2038	0.0365	0.0159	0.0163	0.0179	0.0432	0.0351	0.0000	0.0099	0.0000	0.0106	0.0185
Toyama	**Toyama Station**	0.2071	0.0146	0.0075	0.0195	0.0239	0.0216	0.0175	0.0000	0.0297	0.0000	0.0426	0.0302
Tokushima	**Tokushima Station**	0.2103	0.0219	0.0204	0.0261	0.0209	0.0288	0.0175	0.0000	0.0099	0.0145	0.0319	0.0185
Kagoshima	**Kagoshimachuuou Station**	0.2121	0.0073	0.0259	0.0195	0.0179	0.0360	0.0175	0.0000	0.0198	0.0290	0.0106	0.0285
Niigata	**Niigata Station**	0.2139	0.0219	0.0173	0.0195	0.0090	0.0288	0.0175	0.0000	0.0099	0.0435	0.0213	0.0252
Okayama	**Okayama Station**	0.2199	0.0073	0.0336	0.0163	0.0239	0.0432	0.0175	0.0000	0.0099	0.0145	0.0319	0.0218
Nara	**Nara Station**	0.2227	0.0365	0.0177	0.0293	0.0239	0.0288	0.0175	0.0000	0.0198	0.0290	0.0000	0.0201
Hiroshima	**Hiroshima Station**	0.2378	0.0146	0.0257	0.0195	0.0179	0.0360	0.0175	0.0000	0.0099	0.0435	0.0213	0.0319
Nagasaki	**Nagasaki Station**	0.2471	0.0365	0.0208	0.0521	0.0179	0.0144	0.0351	0.0000	0.0099	0.0000	0.0319	0.0285
Saitama	**Omiya Station**	0.2593	0.0292	0.0334	0.0163	0.0239	0.0216	0.0351	0.0000	0.0099	0.0435	0.0213	0.0252
Shizuoka	**Shizuoka Station**	0.2674	0.0292	0.0251	0.0261	0.0209	0.0144	0.0351	0.0000	0.0396	0.0290	0.0213	0.0268
Fukuoka	**Hakata Station**	0.2703	0.0292	0.0395	0.0130	0.0269	0.0144	0.0351	0.0385	0.0099	0.0000	0.0319	0.0319
Kyoto	**Kyoto Station**	0.3114	0.0292	0.0181	0.0326	0.0328	0.0072	0.0351	0.0385	0.0297	0.0435	0.0213	0.0235
Ishikawa	**Kanazawa Station**	0.3338	0.1022	0.0120	0.0130	0.0209	0.0072	0.0351	0.0000	0.0297	0.0000	0.0851	0.0285
Aichi	**Nagoya Station**	0.4014	0.0146	0.0346	0.0163	0.0328	0.0360	0.0175	0.1154	0.0297	0.0580	0.0213	0.0252
Kanagawa	**Yokohama Station**	0.4098	0.0438	0.0367	0.0326	0.0239	0.0288	0.0351	0.0385	0.0594	0.0580	0.0213	0.0319
Osaka	**Osaka Station**	0.4539	0.0292	0.0622	0.0130	0.0537	0.0432	0.0351	0.0000	0.0495	0.1159	0.0319	0.0201
Hokkaido	**Sapporo Station**	0.4749	0.0438	0.0444	0.0326	0.0418	0.0360	0.0351	0.1538	0.0099	0.0725	0.0000	0.0050
Miyagi	**Sendai Station**	0.5116	0.0511	0.0401	0.0456	0.0388	0.0216	0.0175	0.2308	0.0297	0.0145	0.0000	0.0218
Hyogo	**Sannomiya Station**	0.5229	0.0365	0.0501	0.0358	0.0358	0.0288	0.0175	0.1154	0.0594	0.0725	0.0426	0.0285
Tokyo	**Shinjuku Station**	0.7886	0.0219	0.0675	0.0195	0.0567	0.0360	0.0351	0.2692	0.1287	0.1159	0.0213	

B. Preparation of quintile table

This section explains a model to prepare a quintile table from Table 2. The Cabinet Office surveys create quintiles by sorting the target households in terms of the monthly net income (income in cash) in order from the lowest to the highest and dividing the corresponding adjusted number of tabulated households into five quintile. In this way, five quintiles I to V are created in the order of income from the lowest to the highest. In the present study, however, it is impossible to divide the 47 prefectures equally into five segments because the rows represent the prefectures' main railway stations while intending to create quintiles by the values under Total shown in the third column of Table 2. Therefore, the quintile table is generated through the steps (1) to (4) shown below. Table 3 is the quintile table created from Table 2.

[Quintile model for this study]

(1) Sort the prefectures by the values under Total in Table 2 in ascending order.

(2) Extract the maximum and minimum total values from Table 2 and calculate the formula "= (max - min) / 5." The solution of the formula is defined as difference (DIFF). Based on Table 2, the minimum and maximum values are 0.0984 and 0.7886, respectively, and DIFF is 0.1380.

(3) As shown in Table 3, each quintile is marked with its range (classLO to classUP), according to which the Total data in Table 2 are reorganized. For example, the classLO for Class I is the minimum value (0.0984), and the classUP will be obtained by adding DIFF (0.1380) to classLO (0.0984), which is 0.2364. The classLO for Class II will be set as classUP of Class I (0.2364) + 0.0001 = 0.2365, and so forth. The rest is also determined using the same algorithm.

(4) Finally, distribute the data into one of the classes according to the defined ranges (classLO to classUP) and obtain the average of the Total values in each quintile. Take Class I, for example. The mean of the aggregate of Total values for all the prefectures in Table 2 that fall within the range between 0.0984 and 0.2364 is 0.1670. This value is set in the second column of Table 3.

Using the algorithm above, the quintile table (Table 3) is created. This table is set in the first and second columns of Table 4 to obtain the Gini coefficient, which will be explained later.

Table 3: Quintile table

Class (range of Total value) (classLO to classUP)	Mean value of the Total for the class
I (0.0984–0.2364)	0.1670
II (0.2365–0.3745)	0.2753
III (0.3746–0.5126)	0.4503
IV (0.5217–0.6508)	0.5229
V (0.6509+)	0.7886

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II. RESULTS OF THE ANALYSIS OF PUBLIC FACILITIES WITH GINI COEFFICIENT

This section describes the results of the analysis of public facilities shown in Table 2, using the Gini coefficient model explained in the previous section, with reference to Table 4 and Figure 1. Table 4 is arranged with Class (range) and Mean value of Total for the Class in the first and second columns, respectively, taken from the quintile table (Table 3), and the third column represents the cumulative value of Column 2 under Cumulative value of the mean values. For example, this value for Class II is a sum of the mean values for Classes I and II (0.1670 + 0.2753 = 0.4423 ≒ 0.44). Column 4 is for the line of perfect equality and shows the quintile points on this line. Column 5 is for Lorenz curve, and the values are obtained by dividing the cumulative mean for respective class by that for Class V (2.20) in Column 3. For example, the Lorenz curve value for the first quintile (Class I) is obtained thus: 0.17 / 2.20 ≒ 0.08. Column 6 (area) is for the area under the Lorenz curve for each class, and it is obtained according to the trapezoidal rule. For example, the area of the second zone (Class I) under the Lorenz curve is given thus:

$$0.028 = \frac{(0.40 - 0.20) * (0.08 + 0.20)}{2} \quad (1)$$

Lastly, the Gini coefficient in Column 8 is obtained by multiplying by two the value obtained by subtracting the sum of the trapezoidal area under the Lorenz curve (shown in Column 7, which is 0.3647) from the area under the line of perfect equality (0.5). Thus: (0.5 - 0.3647) * 2 = 0.2706. The Lorenz curve and the line of perfect equality thus obtained by the model above are illustrated in Figure 1. According to Hamamatsu[19], the Gini coefficient that indicates standard distribution in society is between 0.2 and 0.3. With reference to this range, the analysis results (Table 4 and Figure 1) show that the Gini coefficient is 0.27, and this suggests that there is no interregional inequality in terms of the number of public facilities around major railway stations.

Table 4: Gini coefficient obtained from the public facility data

Class (range)		Mean value of the number of public facilities	Cumulative value of the mean values	Line of perfect equality	Lorenz curve	Area	Sum of area	Gini coefficient
			0.00	0.00	0.00	0.008	0.3647	0.2706
I	0.0984–0.2364	0.1670	0.17	0.20	0.08	0.028		
II	0.2365–0.3745	0.2753	0.44	0.40	0.20	0.061		
III	0.3746–0.5126	0.4503	0.89	0.60	0.40	0.105		
IV	0.5127–0.6508	0.5229	1.42	0.80	0.64	0.164		
V	0.6509+	0.7886	2.20	1.00	1.00			

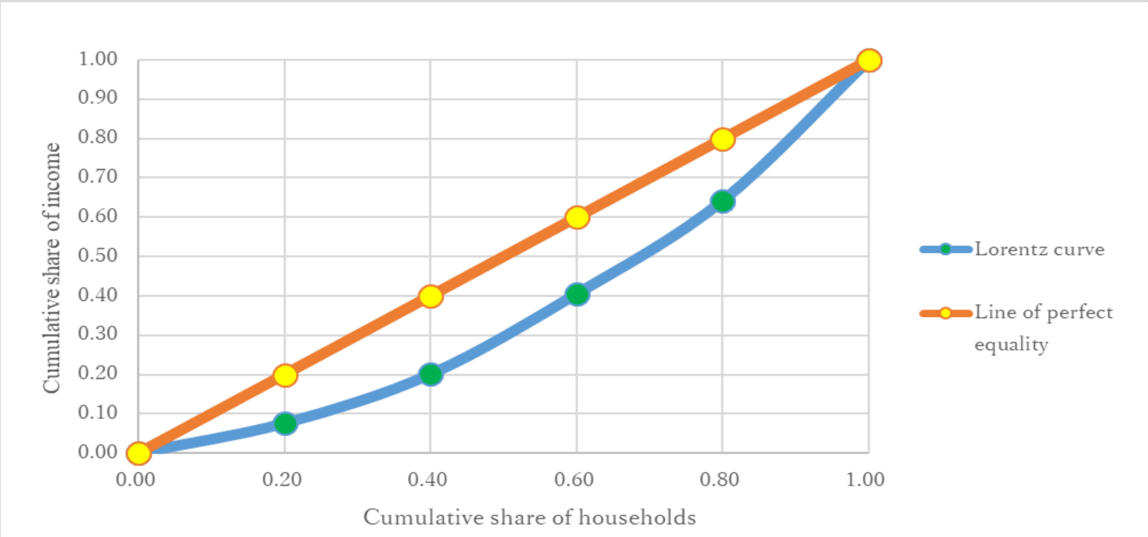

Figure 1: Gini coefficient obtained from the data on the number of public facilities

III. DISCUSSIONS ON THE ANALYSIS OUTCOMES

This section presents a discussion based on the Gini coefficient obtained in the previous section. As Table 2 is reordered by the Total values from the lowest to the highest, prefectures with many public facilities are gathered toward the bottom of the table, and many of these prefectures have a major city. If the Gini coefficient model in this study shows the existence of inequality (the Lorenz curve forms below the equality line), this will be interpreted that public infrastructure is concentrated in major cities. There are many reports that acknowledge inequality through income-based Gini coefficient analyses, such as the aforementioned 2012 Annual Report on the Japanese Economy and Public Finance[2] by the Cabinet Office. However, the Gini coefficient analysis made in the previous section reveals that interregional inequality does not exist in terms of public facilities. This result offers a very interesting insight.

In his paper, Ataka[20] gives an overview of recent studies and publications on the trends in social polarization. Ohtake[21], for example, concludes that inequality is largely explained by the growth of apparent income gap resulting from an increase of single-households and population aging. He points out the danger of focusing on inequality purely in statistics. Meanwhile, Matsutani[22] points out that the rapid aging of the labor population in urban areas is likely to diminish the size of the economy at a rate faster than the shrinking of the national economy as a whole. Based on this observation, he concludes that the economic gap between regions in Japan is expected to become smaller in the future. These two researchers make a point that interregional inequality requires all relevant factors to be considered, such as population, aging society and economy. This is a problem that is not easily resolved.

Nakayama[23] approaches the problem from the perspective of urban planning and asserts that cities must follow planned downsizing in the future, assuming that the population will inevitably decrease. He explains the necessity to reorganize urban space including surrounding areas based on planned population distribution, such as selective use of existing infrastructure, rather than shrinking the suburban areas without a plan.

Morikawa[24] discusses regional disparity from the viewpoint of the national administrative structures between centralized and decentralized systems, analyzing Japan in comparison with Germany, where regional disparity is smaller. He notes that opinions are divided on whether the high concentration of population and industry in Tokyo makes economic sense, as it is difficult to verify it precisely. His opinion is that, while it is difficult to fundamentally change the high concentration in Tokyo, it is desirable that that concentration is eased to some extent for equality between regions.

Referring to the policies on mitigation of the high concentration in Tokyo and interregional inequality, Kawasaki[25] attempts to determine whether the slowing population mobility in recent years is attributed to reducing regional gaps based on the ideas of neoclassical economics. He uses the marginal product of the factor of production to analyze how it is distributed among regions. The analysis found that the inequality in the marginal product of private capital was relatively small compared to the marginal product of labor, the regional inequality of which was great. He claims that the financial distribution for vitalization of regional economy has stopped the migration of people from rural to urban areas to an extent, but has compromised the potential to boost local productivity. His conclusion is that we need policies to improve the productivity of regional areas instead of considering financial redistribution in order to reform the Tokyo-focused centralization and promote autonomy of regional economies.

As seen in the previous section, we have found that there is no inequality in terms of the number of public facilities. This implies that the environment has been developed for businesses to step out into regional cities and create employment for local populations or improve local productivity. This, together with the aforementioned study by Kawasaki, suggests that the high concentration in Tokyo can be possibly decentralized.

Meanwhile, Mochizuki[26] points out that social polarization is not simply a matter of inequality, but it could cause an extreme imbalance of power between regions or degeneration of regional communities. As population declines and ages progressively in regional areas before these will manifest in urban populations, many local governments face financial difficulties. The degeneration of regional communities has thus become a serious problem. As the financial difficulties deepen, it is more difficult to provide support from the central government than before. Mochizuki therefore asserts that regional communities must take the initiative and strengthen their efforts to be self-reliant.

Takayama[27] gives an overview of the state of regional policies, stating that economic policies in recent years have shifted the focus from balanced development to regional revitalization. Like other papers and publications, he explains that an inequality exists today between prefectures, with Tokyo holding a significantly advantageous status. He analyzes that, given the advancing globalization and financial difficulties concerning the national economy, it is increasingly difficult to tackle interregional inequality as a central agenda of the national government policies, and thus the focus has veered toward regional revitalization where local authorities and economies must stand on their own feet. Where it concerns inter-prefectural disparity, many indexes point to the advantageous position held by Tokyo. However, the disparity between prefectures excluding Tokyo has been significantly reduced. To look at the issue from a different perspective, the high concentration in Tokyo is the most influential factor for inequality in the Japanese economy even today.

In many of the papers referenced above the unanimous point is that wealth is concentrated in major cities, or rather, in Tokyo alone, and this is polarizing society. However, the Gini coefficient analysis presented in the previous section has shown that, in terms of public infrastructure, there is no significant interregional disparity. Considering the arguments advanced by Nakayama, it seems tenable that urban space, including the surrounding areas, must be entirely reorganized based on planned population distribution, such as selective use of existing infrastructure. Together with Takayama's paper, the inequality between Tokyo and the rest of the country is expected to diminish through planned redistribution of the population highly concentrated in Tokyo, provided that other factors are also duly considered, such as capacity, regional variances in details, and so on for administrative and private services at the receiving end.

This study focused on public infrastructure as a new index to consider the issue of social polarization. The outcome of the analysis has proved that there is no disparity between major cities and regional cities in terms of public infrastructure, indispensable for residents' daily living. This suggests that redistributing urban populations to regional areas probably will not cause them major problems as far as their lives in the destination areas are concerned. Therefore, moving administrative functions and businesses, centralized in Tokyo, to regional cities can boost regional life and economy. Through the vitalization of regional cities, the wealth highly concentrated in Tokyo is redistributed to other parts of the country, and the Japanese economy is expected to thrive further. Mochizuki in his aforementioned paper considers the aging of regional populations problematic, but this aspect may be addressed appropriately if the population redistribution is planned carefully. The result gained in this study can facilitate new knowledge when considered in combination with other papers. In this regard, it offers valuable contributions toward further development of the Japanese economy.

IV. CONCLUSION

Vitalization of regional economies is gaining impetus in Japan today, and the Cabinet Office of the Japanese government takes a lead in various initiatives to address interregional inequality. While the Gini coefficient is an oft-used method in inequality research, it is applied mostly to income data, and there have been no Gini coefficient models that address the number of public facilities. This study, therefore, developed a new Gini coefficient model based on public facilities. Using this model, we analyzed the number of public facilities around major railway stations in 47 prefectures in Japan. The results found that there was no major disparity between these prefectures, the analysis of which is presented in Section 4. This finding implies that public infrastructure is sufficiently developed in regional cities. Given this result, we pointed out in Section 5 that redistribution of the population concentrated in Tokyo to regional areas would not cause problems in people's lives and that an overall improvement in income levels could be expected by boosting regional populations. Many papers referred to in Section 5 also indicate the problems deriving from the high concentration in Tokyo. Therefore, the knowledge imparted by them together with the outcome of this study can contribute toward the resolution of those problems, leading to improvement in the interregional inequality of Japanese society.

However, redistribution of population must be carefully planned, and other factors must be taken into consideration, such as administrative and private services indispensable for business and domestic activities. Therefore, the outcome of this study—that there is no inequality between regions in terms of public facilities—must be considered in combination with knowledge taken from other sources.

REFERENCES

[1]. Website of the Headquarters for Overcoming Population Decline and Vitalizing Local Economy, https://www.kantei.go.jp/jp/singi/sousei/info/#an2.
[2]. 2012 Annual Report on the Japanese Economy and Public Finance, http://www5.cao.go.jp/j-j/wp/wp-je12/h05_hz030304.html.
[3]. Tachibanaki, Toshiaki: Economic Inequality in Japan—a perspective on income and wealth, Iwanami Shinsho, 1998.
[4]. Ministry of Health, Labour and Welfare: Survey on the redistribution of income 2011, http://www.mhlw.go.jp/file/04-Houdouhappyou-12605000-Seisakutoukatsukan-Seisakuhyoukakanshitsu/h23hou_5.pdf.
[5]. Suzuki, Hideyuki: Consideration on Gini Coefficient Decomposition Technique and Its Application to Regional Wage Inequality, Development Bank of Japan Regional Policy Research Vol. 19, 2006.
[6]. Otsuka, Mayumi: Analysis on Income Inequality using Gini Coefficient—will the aging society influence the income inequality in Japan?, Nanzan University graduation thesis, 2008.
[7]. 2009 Minister of State for Economic and Fiscal Policy Report, http://www5.cao.go.jp/j-j/wp/wp-je09/09b00010.html.
[8]. Maeda, Junichi and Chin, Teki: Theoretical Analysis of Income Distribution with Gini Coefficient, J. Economic Sciences, 20-2, 2017.
[9]. Tashiro, Atsushi: Association between income inequality and dental status in Japanese older adults, Japanese Journal of Public Health 64(4), 2017.
[10]. Ooi, Masako: Study on differences of education rate among regions—based on prefecture data, Kyoto University Kyoto Institute of Economic Research, KIER Discussion Paper,Vol.1303, 2013.
[11]. Miyazawa, Toshiro: Japanese Economy and Macroanalysis of Regional Disparities, Journal of Iwate Prefectural University Miyako College 19(1), pp. 11-25, 2008.
[12]. Ushizawa, Kenji and Suzuki, Hiroo: Research on the Regional Differentials of Public Assistance, Sanno University Bulletin, Vol.24, No.2, 2004.
[13]. Nakamura, Tadakatsu: An Empirical Study of Factors Playing Roles in Commerce around

Stations—using GIS-based data, Studies of Regional Policy 17(2), pp. 45-55, 2014.
[14]. Ishida, Mikito and Nakagawa, Yoshihide: Research on the active state of local people and characteristics of the region—case of Suginami ward, 40th JSCE Annual Meeting, 2009.
[15]. Takahashi, Ryoko: Analysis on the impact of the locations of commercial facilities in stations on local economy, National Graduate Institute for Policy Studies master's thesis, 2014.
[16]. Shutten Senryaku Joho-kyoku website, http://storestrategy.jp/.
[17]. Google Places: https://developers.google.com/places/?hl=ja.
[18]. Mapion telephone directory, http://www.mapion.co.jp/phonebook/.
[19]. Hamamatsu, Seiji: Featured article "20% of the population earn 90% of income—simulation of leveled incomeintheworld",http://www.pref.toyama.jp/sections/1015/ecm/back/2001nov/tokushu/index.html#gini
[20]. Ataka, Yuji: Trends of arguments regarding the issues of regional inequality, http://www.econ.kobe-u.ac.jp/RePEc/koe/wpaper/2014/1406.pdf.
[21]. Ohtake, Fumio: Inequality in Japan, Nikkei.
[22]. Matsutani, Akihiko: New Formula of Declining Population and Economy, Nikkei.
[23]. Nakayama, Toru: City Planning in Japan at a Turning Point, Annals of the Japan Association for Regional Economic Studies 26, pp. 6-11, 2013.
[24]. Morikawa, Hiroshi: Regional Disparity and Regional Policy—a comparison with Germany, Kokon Shoin.
[25]. Kawasaki, Kazuyasu: Regional Revitalization through Public Private Partnership, Keiso Shobo.
[26]. Mochizuki Yukiyasu: Concepts of Inequality and Regional Disparity—a discussion on the factors and problems of regional disparities, PR Review 21, pp. 43-50, 2007.
[27]. Takayama, Masaki: Perspective of Regional Policy from an Equilibrium Policy to a Policy for Regeneration, Annals of the Association of Economic Geographers 55(4), pp. 283-299, 2009.

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