Visualizing Shiga prefecture using RESAS: cloud-based analysis system with government open big data

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***Abstract*—RESAS (Regional Economy Society Analyzing System) is a cloud based visualization system for Japanese government open data and is useful for regional policy making and business. In this paper, we discuss two kinds of problems in Shiga prefecture by using RESAS and Japanese government open data. We first consider population trend and movement of Shiga prefecture and find other prefectures that are highly related to Shiga's population movement. We take a closer look at the population change of the age of 20s. Then we present the topic of tourism in Shiga prefecture. We discuss strength and weakness of Shiga in terms of tourism resource, show statistics of domestic and international tourism, and propose tourism strategies appropriate for the local government of Shiga.**

***Keywords*-RESAS; big data; government open data; public data; visualization;**

I. Introduction

The demand for effective use of government open data (GOD) has increased in recent years. Most countries have their own official organization which conduct survey and provide GOD, such as population census, industrial report, employee report and so on [1], [2], [5]. Moreover, it is not difficult to get intergovernmental comparable statistics on a wide number of subjects. For example, OECD (Organisation for Economic Co-operation and Development) statistics are available in several forms of files in the statistics portal website of OECD [7].

The Japanese government also has the Statistics Bureau which conducts fundamental censuses and statistical surveys, and other relevant ministries produce statistics for their own policy purposes. The "Portal Site of Official Statistics of Japan (e-Stat)", established in 2008, provides a one-stop online service for obtaining statistical information published by ministries on the internet and helps users to download official statistics with convenient features such as retrieving data by prefecture and municipality [4], [12].

On the other hand, viewed from the point of data analysis, data visualization has become more and more important, because it is a quick and easy way to convey concepts in an effective manner, to translate big data into practical knowledge [3], [6], [9]–[11], [13]. Hence data analysis usually starts with drawing charts or graphs to visualize relations of complex data. However, data visualization is not a simple process at all. For example, one who already has GOD, would have difficulty to draw a time series graph to see the past 10 years' population inflow into a certain prefecture. Sometimes it is time consuming to determine what types of graph are suitable, and requires good understanding of statistical software skills about R, SAS, SPSS, Excel etc. For this reason, from April 2015, the Cabinet Secretariat and the Ministry of Economy, Trade and Industry, launched RESAS (Regional Economy Society Analyzing System). It also has become one of the world's largest visualization systems for Japanese GOD.

The objective of RESAS is to assist whoever wants to analyze public data easily [8] and eventually provide valuable insights to local government decision-makers or civilians through quick data visualization such as tile plot, path plot and so on. It is possible to draw the same graphs by using other software such as R, SAS, SPSS and Excel as well. However, RESAS has an advantage that it does not require collecting and importing data because it is implemented on the website. In addition, it is very easy to learn for beginners with little statistical knowledge.

This paper describes a part of our collaborative project with the local government of Shiga prefecture. The project was planned to find out the existing regional social problems

mainly related to population and economy. We only used Japanese government open data and RESAS to conduct the project.

In this paper, we focused only on topics of population and tourism issues to discuss the Shiga's current regional economy situation, since these issues are thought to be considerable factors which affect the regional economy. Thus, the purpose of this paper is to clarify Shiga's strength or weakness in terms of population and tourism by comparing Shiga to other prefectures under the similar situation of Shiga. For the population analysis, we first start with the overall population situation in Japan, and pay special attention to the population change of age of 20s. For the tourism analysis, we also start from the overall tourism situation and then compare Shiga to two prefectures. Secondary purpose of this paper is to introduce the useful visualization functions of RESAS.

The organization of this paper is as follows. In section II, we will start by presenting overall population situations followed by comparison of Shiga's population movement among the other major cities in Japan. In Section III, we will discuss strength and weakness of Shiga in terms of tourism resources, and propose tourism strategies appropriate for government of Shiga. We end the paper with some discussions on further study in Section IV.

II. The General Population Situation of Shiga

In this section, we discuss overall population trend and population movement of Shiga. In particular, we pay attention to the population change of the age of 20s by comparing Otsu city to several cities in Japan.

A. Population decline

According to Japanese Ministry of Internal Affairs and Communications Japanese population reached the peak of 128 million people in 2008. Shiga is one of the few prefectures at which population was still increasing. Its population is estimated to peak at 1.4 million people in 2015. However, after reaching this maximum, it would decline slightly to 1.3 million in 2040 (Fig. 1).

Another RESAS plot, such as Fig. 2, helps more comprehensive and easier understanding of factor causing the population change in Shiga. During the periods from 1964 to 1967 (forth quadrant), natural increase was the primary factor behind population growth, while both natural and migratory increase are the contributor to population growth from 1970s to 2010s. It is moving toward the lower-left direction of Fig. 2, that means Shiga would fall in population decline in a few years.

B. Population movement

The administrative divisions of Shiga prefecture consist of 13 cities and 6 towns, including the capital city of Otsu. We summarized migratory statistics for the past three decades at

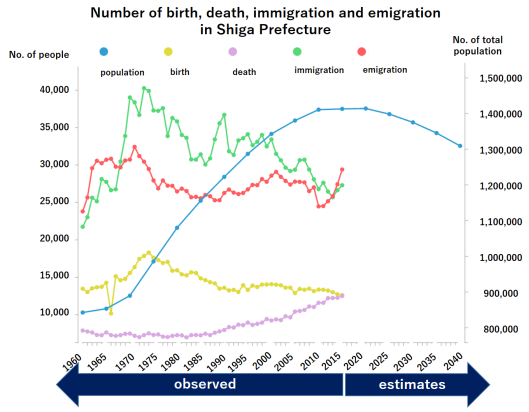


Figure 1: RESAS trend lines of population (blue), births (yellow), deaths (purple), immigration (green) and emigration (red) in Shiga prefecture.
Data source: Report on Internal Migration in Japan, Population Estimates, Ministry of Internal Affairs and Communications; Regional Population Projections for Japan: 2010-2040, National Institute of Population and Social Security Research; Vital Statistics in Japan, Ministry of Health, Labour and Welfare.

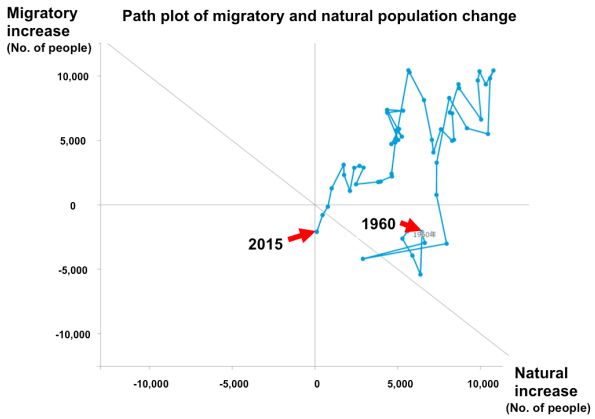


Figure 2: RESAS path plot of Natural increase (x-axis) vs. Migratory increase (y-axis) in Shiga. Natural increase equals births minus deaths. Migratory increase equals immigration minus emigration.
Data source: Vital Statistics in Japan, Ministry of Health, Labour and Welfare; Report on Internal Migration in Japan, Ministry of Internal Affairs and Communications.

the level of these 19 regions. As a result, four cities and one town (Otsu, Hikone, Kusatsu, Moriyama and Aisho) showed migratory increase —more people entered each city than left the city (Table I). The other 14 regions did not.

Next, we analyzed the population movement between 46 prefectures and Shiga, that is, migration from other prefectures to Shiga or vice versa. Fig. 3 represents 10

Table I: Cities in Shiga having migratory increase during last three decades (avg. per period)

City	Number of	1990s	2000s	2010s
Otsu	immigrant	15140.4	13929.3	12320.8
	emigrant	12980.8	12353.7	10783.8
	difference	2159.6	1575.6	1537
Hikone	immigrant	4469.8	4452.1	4224.8
	emigrant	4195.6	4357.1	3996.8
	difference	274.2	95	228
Kusatsu	immigrant	7170.4	6977.7	6960.3
	emigrant	5634	6534.8	5816.3
	difference	1536.4	442.9	1144
Moriyama	immigrant	3067	3553.8	3325.5
	emigrant	2716	2914.1	2940.3
	difference	351	629.7	385.3
Aisho†	immigrant	771.2	845.2	933.5
	emigrant	712.6	734	751
	difference	58.6	111.2	182.6

† Aisho is a district of town.
Data source: Report on Internal Migration in Japan, Ministry of Internal Affairs and Communications.

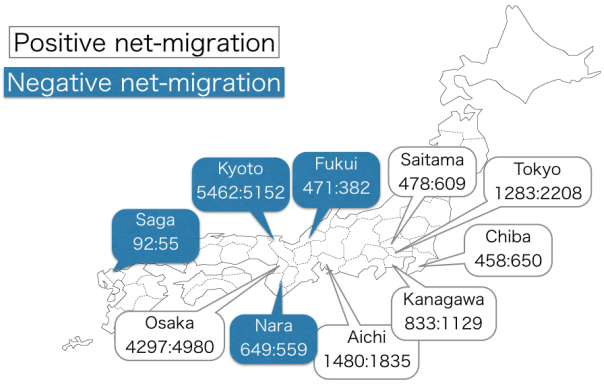


Figure 3: Prefectures associated to population movement of Shiga prefecture in 2015 (immigrant:emigrant)
Data source: Reproduced based on Report on Internal Migration in Japan, Ministry of Internal Affairs and Communications

prefectures which gave the statistically significant p-value of the null hypothesis that the ratio of immigrant to emigrant is one to one. For example, there was a statistically significant difference between 5,462 people who moved into Shiga from Kyoto, and 5,152 people who moved out of Shiga to Kyoto.

As seen from Fig. 3, Tokyo, Chiba, Kanagawa, Aichi, Saitama and Osaka prefectures are the regions with population outflow (more emigration than immigration), while more people moved into Shiga from Saga, Kyoto, Nara and Fukui in 2015. This result may be characterized by big city domination. This is due to the migration of labor to major cities, especially the age of 20s, because these cities offer a concentration of business enterprises and many opportunities for employment.

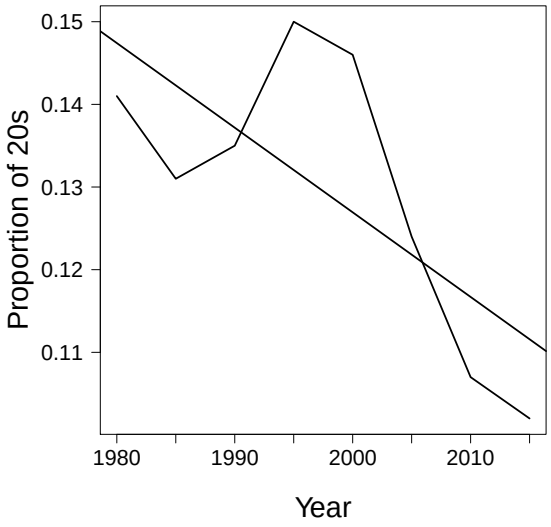


Figure 4: Linear regression for Proportion of 20s against Year (Otsu city, Shiga).

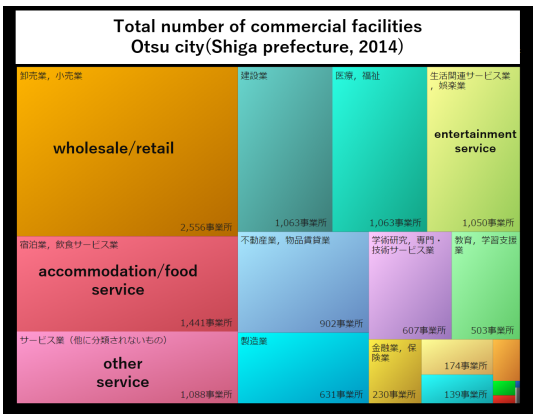
C. *Population change of the age of 20s*

As mentioned in subsection II-B, big city domination is considered as a cause for population outflow, especially in the age of 20s. If we consider overall ages, the five regions in Shiga show population increase (Table I).

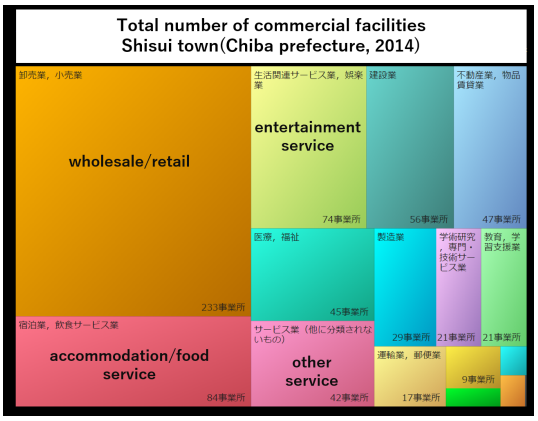
In contrast to overall population increase, the fitted regression line in Fig. 4 suggests that the age of 20s have gradually moved outside Otsu, the capital city of Shiga. On the contrary, though we do not show regression lines, Shisui town, Sakae town (Chiba prefecture), Ushiku city (Ibaraki prefecture), Ryuo town (Shiga prefecture) and Toyono town (Osaka prefecture) were the regions where the age of 20s are on slightly increasing trend.

One of the reasons for their behavior could be due to the industrial structure. To clarify the difference between Otsu and these five cities, we used industrial structure menu in RESAS. Fig. 5 illustrates the results of Otsu city and Shisui town. Orange, red and pink color tile in Fig. 5 represents wholesale/retail, accommodation/food and other service, respectively. The other kinds of facility of medical/welfare, real estates, research, manufacture, etc. are represented by other colors.

Among the six regions, Otsu has shown that it has less commercial facilities related to wholesale/retail and accommodation/food than those of others. This suggests that population change of age of 20s is correlated with industries of wholesale/retail and accommodation/food. We recommend that local government of Shiga should consider industrial structure when planning population policy for age of 20s.



(a) Otsu city (Shiga prefecture)



(b) Shisui town (Chiba prefecture)

Figure 5: RESAS Industrial structure tile plot.
Data source: Economic Census for Business Frame, Ministry of Internal Affairs and Communications; Economic Census for Business Activity, Ministry of Economy, Trade and Industry.

Table II: Number of arrivals and amount of consumption (2014, avg. per each cluster)

Cluster	Domestic arrivals (thousand)	consumption (million yen)	Foreign arrivals (thousand)	consumption (million yen)
Hokkaido, Shizuoka	46,185	**565,948**	**1,295**	**168,039**
Kanagawa	**93,826**	**690,142**	521	**51,862**
Saitama, Chiba, Hyogo, Aichi	**84,298**	436,402	210	12,705
Osaka	*	*	*	*
Fukuoka	*	*	*	*
Kyoto, Nara	37,110	243,752	**780**	48,773
Tokyo	**234,871**	**1,847,320**	**2,461**	**166,003**
Aomori, Akita, Toyama, Ibaraki	14,904	108,354	107	3,006
Fukui, Tottori, Tokushima, Kagawa, Saga	12,328	133,598	60	3,498
Iwate, Miyazaki, Kagoshima	**11,207**	117,386	92	7,224
Ishikawa, Oita, Yamanashi, Mie, Kumamoto, Gifu	23,442	227,539	427	26,216
Shiga, Wakayama, Shimane, Okayama, Nagasaki, Yamaguchi	12,526	117,128	133	5,411
Hiroshima, Ehime, Kochi	11,931	**85,867**	66	**2,764**
Miyagi, Gunma, Yamagata, Tochigi	26,598	232,044	**51**	4,526
Fukushima, Niigata, Nagano	26,632	334,378	171	12,276
Okinawa	8,364	394, 769	502	36,969

The figures in bold red, blue and black indicate maximum, minimum and the second/third respectively.
Symbol * indicates there is no available data
Data source: National Tourism Survey, Consumption Trend Survey for Foreigners Visiting Japan, Japan Tourism Agency.

III. Tourism in Shiga

This section introduces a different approach to Shiga from tourism point of view, including the topics on domestic or international tourism consumption, number of tourists and attractiveness of Shiga. In a similar way to the previous section, tourism data were gathered from the government websites.

A. Clustering 47 prefectures

We divided 47 prefectures into several groups by cluster analysis, using the tourism variables summarized in Table III, so that prefectures in the same group are more similar to each other than to those in other groups. Table II shows each cluster's summary statistics of tourist arrivals and consumption.

Table III: Variables related to tourism

Category	Variable	Unit
Location	distance from the major city	km
Nature	nature conservation area	ha
Economy	prefecture GDP population area / person	million yen m^2
Cultural Properties	National Treasures Important Cultural Property Special heritage, etc.	
Entertainment	Leisure facilities	
Tourism infrastructure	Hotel Ryokan	
Tourist arrivals Tourist consumption		thousand million yen

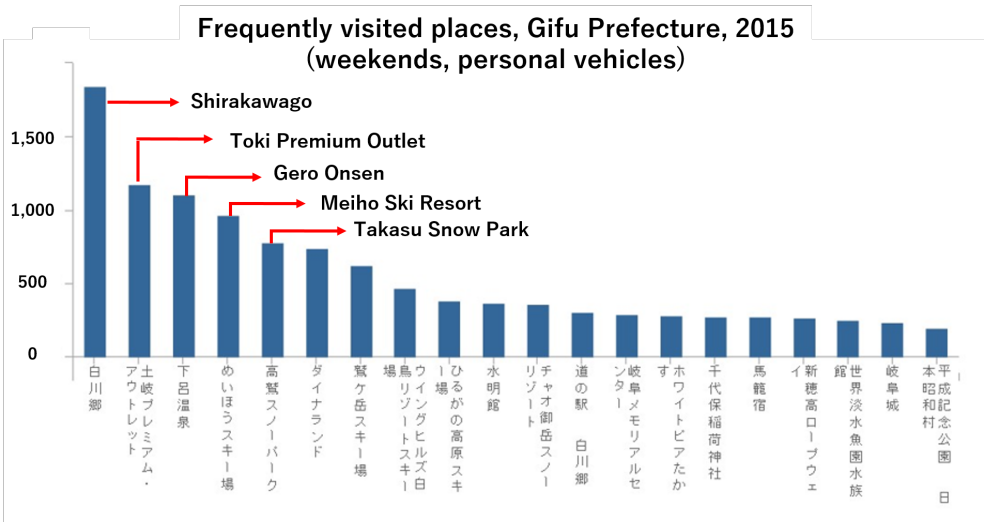


Figure 6: RESAS destination searching (weekends, personal vehicles). Frequently visited places of Gifu in 2015. *Data source*: NAVITIME JAPAN Co.

Table IV: Number of tourists and amount of consumption in 2014

	Shiga cluster Prefecture	**Tourists (thousand)**	**Consumption (million yen)**	**Target cluster Prefecture**	**Tourists (thousand)**	**Consumption (million yen)**
Domestic	**Shiga**	**16,030**	**124,394**	Ishikawa	14,948	189,681
	Wakayama	9,516	120,481	Oita	16,412	143,185
	Shimane	10,595	72,739	**Yamanashi**	**26,470**	**299,845**
	Okayama	10,356	103,527	Mie	27,211	264,262
	Nagasaki	2,614	72,263	Kumamoto	21,625	267,226
	Yamaguchi	15,277	108,302	**Gifu**	**33,983**	**201,034**
Foreign	**Shiga**	**138**	**8,381**	Ishikawa	149	10,086
	Wakayama	178	11,680	Oita	327	5,106
	Shimane	37	1,513	**Yamanashi**	**1,162**	**103,428**
	Okayama	57	1,806	Mie	82	4,895
	Nagasaki	368	8,208	Kumamoto	341	6,119
	Yamaguchi	22	875	**Gifu**	**500**	**27,660**

Data source: National Tourism Survey, Consumption Trend Survey for Foreigners Visiting Japan, Japan Tourism Agency.

Shiga prefecture was assigned to the cluster consisting of Shiga, Wakayama, Shimane, Okayama, Nagasaki and Yamaguchi. The second similar cluster to Shiga is the cluster of Ishikawa, Oita, Yamanashi, Mie, Kumamoto and Gifu, which show two to five times more arrivals and consumption both domestic and international. For this reason, we refer to the former as "Shiga cluster" and to the latter as "target cluster".

Further investigation of target cluster showed that Gifu and Yamanashi are the most popular prefectures in terms of domestic tourist arrivals and international tourist arrivals, respectively (Table IV). We will discuss more details about these two prefectures, in the next subsection.

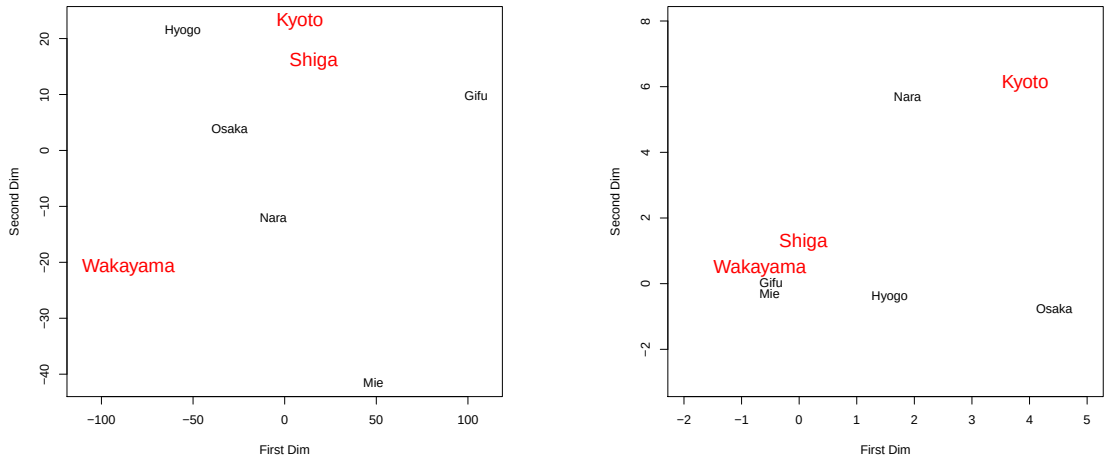
Table V: Destinations of Gifu and Yamanashi ranked in top 5

	Personal Vehicles	**Public Transportation**
Rank	**Gifu Prefecture**	
1	Shirakawago	Shirakawago
2	Toki Premium Outlet	Gero Onsen
3	Gero Onsen	Toki Premium Outlet
4	Meiho Ski Resort	Dyno Land
5	Takasu Snow Park	Meiho Ski Resort
Rank	**Yamanashi Prefecture**	
1	Fujiten Resort	Fujikyu Highland
2	Lake Kawaguchi	Lake Yamanaka
3	Lake Yamanaka	Lake Kawaguchi
4	Fujikyu Highland	Hottarakashi Onsen
5	Kamuimisaka Ski Resort	Fujiten Snow Resort

Data source: NAVITIME JAPAN Co.

B. Searching destination

Although there are some limitations, RESAS provides quite good visualizations of some private commercial data as well as public data. For example, RESAS's destination menu gives frequently searched destination rankings through car navigations data, which is offered by NAVITIME JAPAN Co. Fig. 6 illustrates Gifu's frequently searched destinations,



(a) MDS of distance matrix

(b) MDS of tourism resources

Figure 7: Multidimensional scaling (MDS) with variables of geographical distance and tourism resources of 47 prefectures. Prefectures which are not included in Table VI were masked.
Data source: Geospatial Information Authority of Japan(www.gsi.go.jp/KOKUJYOHO/kenchokan.html).

by retrieving under the condition of weekends and personal vehicles in 2015.

We retrieved in the same manner the most visited places in Gifu and Yamanashi by personal vehicles or public transportation. As can be seen from Table V, both prefectures are characterized by World Heritage, ski resorts and onsen (hot spring).

It should also be noted that Shiga already has these tourism factors such as, World Heritage of Hieizan Enryakuji, ski resort of Biwako Valley and hot spring Ogoto Onsen. Nevertheless, the amount of consumption and number of tourists in Shiga, shown in Table IV, are far below those of Yamanashi and Gifu.

C. Accessibility to Kyoto

Kyoto is one of the world's most popular cities to visit and Shiga has a good advantage of accessibility to Kyoto as well as its own tourism resources mentioned above. However, among more than four million foreign tourists visiting Japan in 2015, only about 2% (eighty thousand) visited Shiga (Table VI).

The question here arises: Dose Shiga make a good use of its locational advantage? To answer this question, it is worthwhile comparing Wakayama and Shiga prefectures, because these are the closest to Kyoto among the prefectures in Shiga cluster (which is defined in section III-A).

Fig. 7 shows multidimensional scaling (MDS) plots with variables of geographical distance and tourism resources, respectively. In terms of tourism resources, Kyoto is relatively closer to Shiga than Wakayama, as is the case of geographical distance. As seen from Table IV, there are more domestic tourists in Shiga than Wakayama, which implies that the short distance between Shiga and Kyoto seems to result in the increase of domestic tourists. However, that is not the case in foreign tourists; that is, fewer number of foreign tourists visited Shiga than Wakayama.

Table VI: Total number of foreign arrivals in Kyoto prefecture and adjacent prefecture, 2015

Prefecture	**Kyoto**	**Gifu**	**Mie**	**Shiga**
No. of arrivals	4,165,875	437,506	60,640	80,211
%	-	10.50%	1.46%	1.93%
Prefecture	**Kyoto**	**Hyogo**	**Nara**	**Wakayama**
No. of arrivals	4,165,875	1,007,093	900,455	197,589
%	-	24.17%	21.62%	4.74%

Data source: Consumption Trend Survey for Foreigners Visiting Japan, Japan Tourism Agency.

The above results suggest that local government of Shiga does not make full use of its geographical advantage. Therefore, when planning a tourism strategy for foreign countries, it should be addressed that Shiga is not only attractive but also convenient to access from Kyoto.

IV. Discussion

In this paper, we discussed topics concerning population and tourism of Shiga prefecture by using government open data, RESAS and several traditional statistical analyses.

As a result, we realized again the overall decline of population in Shiga, but five cities (Otsu, Hikone, Kusatsu, Moriyama and Aisho) have been found to be in increasing trends. Saga, Kyoto, Nara and Fukui prefectures seemed to

be highly related to Shiga's population change. Shisui town, Ushiku city, Ryuo town, Toyono town and Sakae town are the regions in which the age of 20s are slightly increasing. For the tourism analysis, we have found that Yamanashi and Gifu prefecture might be target prefectures of Shiga based on tourism GOD. We also derived three key words of World Heritage, ski resorts and onsen. Our research suggests that the policy makers of local government of Shiga should take into consideration the results above, when planning regional economy policy.

Finally, we discuss several limitations of our study and RESAS. First, although RESAS is equipped with useful visualization tools concerning various topics such as regional economics, industrial structure, business company, employment, comparison among the prefectures, etc., we have used only population and tourism menus to visualize Shiga. Second, in population analysis of section II-C, we adopted simple regression model with time variable as explanatory variable on proportion of age of 20s, but it is worth considering other explanatory variables such as birth rate. Third, RESAS is a well-organized tool, especially for beginners, to visualize regional economy, but it still dose not allow to export the graph shown on the screen. Fourth, at the present moment, RESAS provides results only in Japanese language, so the RESAS graphs and results which are presented in this paper were partly edited manually to be shown in English.

Despite the limitation of our study, we hope that these results will give an idea of how to analyze regional social problems by using GOD, RESAS and statistical analysis.

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