An Analytical Model on Time Series Data in Inland Prefecture of Japan

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Abstract

In Japan, administrative divisions are classified in 47 prefectures. Among them, there are 8 prefectures with "inland prefecture" that isn't facing the sea. These inland prefectures are considered to have different properties from "coastal prefecture" that is facing the sea. Therefore, in this study, we quantitatively analyze the influence of the following factors on value of manufactured goods shipments of "inland prefecture" and "coastal prefecture", based on our previous studies. These factors are population, area, value of forestry goods shipments, value of fishery goods shipments, presence of ordinance designated city, before and after the collapse of the bubble, before and after the Lehman shock, and so on. This analysis model is characterized by handling time series quantitative data and qualitative data.

In this study, we validate the model by conducting empirical analysis model using time series data. Furthermore, we will try to quantitatively grasp the common points and differences of the industrial structure between inland prefecture and coastal prefecture based on estimates of parameters obtained from such empirical analysis. Furthermore, we will consider expanding application of our analysis model not only to domestic data but also to overseas data.

Keywords
Inland prefecture, Coastal prefecture, Statistical data by prefectures, Time series data for an analysis model, Industrial structure

1. Introduction

Japan is an elongated island country, and because the distance between one ocean and the other ocean (e.g. the Pacific Ocean and the Sea of Japan) is short, most prefectures face the sea "coastal prefectures". However, in Honshu regions where the Pacific Ocean and the Japan Sea are relatively far apart, that is, in the Kanto, Chubu and Kinki districts, "Inland Prefecture" does not face the ocean. It is Tochigi prefecture, Gunma prefecture, Saitama prefecture in the Kanto district, Nagano prefecture, Yamanashi prefecture, Gifu prefecture in the Chubu region, Shiga prefecture and Nara prefecture in the Kinki district, total of 8 prefectures.

As a matter of course, the above-mentioned inland prefecture has a common personality (special characteristics to other prefectures, for example, "catch height" is very small) which arises from not facing the ocean. On the other hand, the eight inland prefectures have different characteristics. The authors [1] pointed out the specialty and diversity of these "inland prefectures" and point out that Nakasendo and Koshu Kaido were developed in the Edo period as a historical factor established inland Japan. Along with the area and the presence or absence of a plain, eight inland prefectures with diverse characteristics are presented with a framework (Japanese inland prefecture classification framework) that classifies into four.

As a result, the inland prefecture (Nagano Prefecture and Gifu prefecture) with a large area naturally has large population, agricultural shipment value, and industrial shipment value.

2. Specialty and diversity of inland prefecture in Japan

Japan is surrounded by the ocean, and Japan has the characteristic of slender national land and most prefectures in Japan face the ocean. However, the eight prefectures do not face the ocean, and "inland prefectures" have different characteristics from other prefectures. The remarkable specialty of "inland prefecture" is that the number of fishery workers is very small and there are few large cities (Saitama City in Saitama prefecture only). For that reason, inland prefecture has no cities with a population of 500,000 or more expect for Saitama City, and the prefecture with cities with a population of 400,000 or more is also only in Tochigi Prefecture (Utsunomiya City) and Gifu Prefecture (Gifu City). It is self-evident that the number of fishermen in inland prefecture is very small, but the fact that there are few populous cities is because large Japanese cities are formed along the coast.

However, considering that the population of 5 prefectures excluding Yamanashi, Shiga, and Nara prefectures reaches more than 1.5 million people, Saitama prefecture (fifth place nationwide) with a population of over 7 million people, so the population of each inland prefecture can never say that it is few. For that reason, the authors [1] points out the following factors. It is said that ① Saitama, Tochigi and Gunma prefectures are located in the plain (Kanto plain) with more population than mountainous areas, and ② Nagano prefecture is located in the mountains, but the area is large, Gifu prefecture has both sides of the plain of ① and the population of ②. On the other hand, the population of Yamanashi, Shiga, and Nara prefectures are small. because they do not fall under either ① or ②.

Meanwhile, in the prefecture facing the ocean, agriculture and industries are generally in a trade-off relationship in general, but the inland prefecture has the following special characteristics. In other words, prefectures with a large amount of agricultural shipment have a large industrial shipment value (product shipment amount etc.). As for this factor, the author [1] sees from the aspect of ① and ② above. That is, the prefecture corresponding to ① has plains suitable for agriculture (especially vegetables) and industry. In addition, because it is close to consuming areas of big cities, agriculture and industry are developed at the same time. Also, in Nagano Prefecture, which corresponds to ②, there are many business operators developing agriculture and industries simply because of the large area.

However, with regard to the industries in Nagano Prefecture, it can be pointed out that not only the factors of ② but also the factors of the development of the precision machinery industry aiming at "the Switzerland of Japan" have greatly contributed. In contrast, Yamanashi, Shiga and Nara do not correspond to ① and ②, agriculture and manufacturing industry are not well developed. Therefore, even in the same "inland prefecture", the eight

prefectures have similarities in terms of population, topography and industry, and each inland prefecture has different diversity.

3. Inland prefecture in Japan and the five main roads of the Edo period of Japan

Since many large cities in Japan have been formed and developed in basically the coastal areas such as Tokyo, Osaka, Nagoya, Yokohama, Kobe, Fukuoka, Hiroshima and Sendai, the inland prefecture tends to be left behind in such development by all means is there. However, in order to be established as an independent prefecture, it is necessary to have a suitable industrial scale and a population of a city (for example, the prefectural capital), and because these conditions are satisfied, the inland prefecture is established as an independent prefecture [1].

As described above, the inland prefecture, which tends to be left behind in the development of cities and industries, as a historical factor leading to the establishment as an independent prefecture, has been developed in the Tokaido, Nakasendo , Koshu kaido, Oshu kaido, Nikko kaido[1]. All of the above 5 roads pass through the current inland prefecture, and five inland roads were in communication with seven inland prefectures other than Nara prefecture. Among other things, Nakasendo passed through five prefectures (Saitama, Gunma, Nagano, Gifu and Shiga prefectures) out of the eight inland prefectures, the old road was playing a major role in the development of Central Honshu (inland) . Meanwhile, there is a historical factor that the capital of Japan (Heijo Heijo) was located also in Nara Prefecture, the only inland part where five old roads do not pass.

The five roads in the Edo era were the main roads at the time and cultural spheres and industrial zones were formed along this line, so the cultural area and the industrial area worthy of the current prefecture were formed [1]. On the contrary viewpoint, unless the five roads were developed in the Edo period, cultural areas and industrial areas were not be formed in the mountains in central Honshu and it can be thought that the current inland prefecture has not been established. In other words, the presence of inland prefecture in Japan depends greatly on the historical factors as mentioned above.

4. Inland prefecture classification framework

To describe the characteristics of inland prefecture in Japan as briefly as possible, the authors [1] proposed the following "A classification framework of inland prefecture" (**Fig.1**) as below. With this proposed framework, the characteristics of inland prefecture in Japan can be classified into four by combining the axes "area" and "presence or absence of plain".

	S-1 Saitama,Tochigi,Gunma	**B-1** Gifu
Presence Plains		
Absence	**S-2** Yamanashi,Siga,Nara	**B-2** Nagano
	Less than 10,000 ㎢	10,000 ㎢ or more
	Area	

Fig.1 A classification framework of inland prefecture

First, type S-2 and type B-2 in Fig. 1 briefly show the features of the inland prefecture in which the plain does not exist in the prefecture and the basin replaces the plain. On the other hand, only Nagano Prefecture is classified as type B-2, and the plain does not exist in the prefecture, but the area is large and the scale of population and industrial shipment value is large because of the area. Next, paying attention to type S-1 and type B-1 type where the plain exists in the prefecture, the following points are characteristic. Saitama prefecture, Tochigi prefecture, Gunma prefecture located in the Kanto plain are classified as type S-1, but only Gifu prefecture located in Nobi Plain is classified as type B-1.

And the inland 3 prefectures in the metropolitan area are classified in type S-1, and Gifu prefecture in the Chukyo area is classified in type B-1. It finds out that the two types have a common character of inland prefecture in the metropolitan area. The inland prefectures belonging to two types are stronger characteristic of "prefecture located in the metropolitan area" than the characteristic of "prefecture in the mountain". Saitama prefecture has a population of more than 7 million people (the fifth place in Japan), and most of the prefecture is covered in the Kanto plain and it is a perfect urban type prefecture. In addition, it has the only ordinance designated city (Saitama city) in inland prefecture.

Meanwhile, Gifu prefecture of type B-1 has mountains of altitude 3,000 meter in height, and from that sense it also has characteristics close to Nagano prefecture of type B-2 and Yamanashi prefecture of type S-2. For that reason, Gifu Prefecture of type B-1 is an inland prefecture which has the character of both "prefecture located in metropolitan area" and "prefecture located in mountain".

5. Model

With this analysis model[x], we try to quantitatively analyze the impact of industrial shipment value in the coastal prefecture and inland prefecture in Japan from the following factors. The factors are population, area, existence of ordinance designated city, before and after the bubble economic collapse, before and after the Lehman shock.

First, time series data of industrial shipment value by prefecture is set as explained variable y_{ijt}.

$i = 1$: inland prefecture, $i = 2$: coastal prefecture

j: prefecture number, t: fiscal year

$k=1$: population, $k=2$: area, $k=3$: ordinance designated city, $k=4$: before collapse of the bubble economy,

$k=5$: before the collapse of the bubble economy to Lehman shock

Set explanatory variables for inland prefecture and coastal prefecture as z_{ijkt}

$k = 6$: agricultural shipment value, $k = 7$: forestry shipment amount

At this time, it is assumed that the partial regression coefficients for the explanatory variable x_{ijkt} common to all prefectures are a_k (a_1 to a_5), the partial regression coefficient for the explanatory variable z_{ijkt} by inland prefecture coastal prefecture is b_{ki} (b_{6i}, b_{7i}), the constant term is a 0 , You can think of the following "panel data analysis model of industrial shipment value by prefecture" as below. Where e_{ijt} is the residual term.

$$y_{ijt} = a_0 + \sum_{k=1}^{5} a_k \cdot x_{ijkt} + \sum_{k=6}^{7} \sum_{i=1}^{2} b_{ki} \cdot z_{ijkt} + e_{ijt} \qquad (1)$$

Therefore, the estimate of the parameter vector $\boldsymbol{a}^T = (a_0, a_1, a_2, a_3, a_4, a_5, b_{61}, b_{62}, b_{71}, b_{72})$ that minimizes the sum of squares of the residuals e_{ijt} (the least squares estimators) of equation (1) is given by the normal equation of equation (2).

$$\boldsymbol{a} = (\boldsymbol{X}^T \cdot \boldsymbol{X})^{-1} \boldsymbol{X} \boldsymbol{y} \qquad (2)$$

$$\boldsymbol{a}^T = \left(a_0, a_1, a_2, a_3, a_4, a_5, b_{61}, b_{62}, b_{71}, b_{72} \right)$$

$\boldsymbol{X}$: $(47 \cdot T)$ rows and 10 columns of independent variables matrix

$i = 1$

$$\boldsymbol{X} = \left(1, x_{1j1t}, x_{1j2t}, x_{1j3t}, x_{1j4t}, x_{1j5t}, z_{1j6t}, 0, z_{1j2t}, 0 \right)$$

$i = 2$

$$\boldsymbol{X} = (1, X_{2j1t}, X_{2j2t}, X_{2j3t}, X_{2j4t}, X_{2j5t}, 0, Z_{2j6t}, 0 Z_{2j7t})$$

$\boldsymbol{y}$: $(47 \cdot T)$ dimension of dependent variables vector, $\boldsymbol{y} = (y_{(ijt)})$

6. Empirical analysis

As a result of the empirical analysis of the proposed model[1], the value of the multiple correlation coefficient with a high degree of R = 0.805 was obtained, and the estimated value of the parameter as shown in Table 1 was obtained. From the results of Table 1, it can be seen that the parameter a_1 of the population and the parameter a_3 of the ordinance designated city greatly affect the industrial shipment value in common explanatory variables of all the prefectures. Prefectures such as Tokyo, Osaka, Kanagawa prefecture and Aichi prefecture, which have a large

population, also have the ordinance designated cities, and the values of the parameters of this proposed model are in conformity with the reality.

On the other hand, the area parameter a_2 has a negative influence on the industrial shipment value. In Japan, the prefecture with a large area such as Iwate prefecture, Fukushima prefecture, Nagano prefecture, Niigata prefecture and Kagoshima prefecture has a relatively high reliance on primary industries such as agriculture and forestry, compared to other prefectures with small area. The proposed model seems to reflect these points. Also, the largest area Hokkaido has large industrial shipment value with primary industry. In other words, Hokkaido is also popular in Sapporo city, the ordinance designated city, and secondary industries are also popular and have different characteristics from other prefectures with a large area.

Next, parameters a_4 before a collapse of the bubble economy and before the Lehman shock are negative, and a_5 is a positive value. This proposed model shows interesting results that the price, price decline of the stock price and land price had a bad influence on the Japanese economy before and after the collapse of the bubble economy. But the fluctuation of industrial shipment value is small (stock price collapsed about 50% decline was recorded one year after).

Parameters b_{61} and b_{62} that are the weight of agricultural shipment value in inland prefectures and coastal prefectures are positive values. It seems that this result seems to be caused by the fact that agriculture is actively performed even in many coastal prefectures. On the other hand, parameter b_{62}, the weight of the forestry shipment value is a plus value and the weight of the parameter b_{72} is a minus value. From this result, it can be seen that in inland prefecture, the forestry shipment value is positive relative to the industrial shipment value, and in the coastal prefecture, it works minus. In other words, the proposed model suggests a trade-off between forestry and industrial in coastal prefecture, which is in line with the reality. In this respect, the proposed model seems to reflect the differences between inland prefecture and coastal prefecture.

Table 1. Analysis results

	Independent variables	Estimated results
a_0	Intercept	54.3×10^5
a_1	Population	45.4×10^5
a_2	Area	-22.4×10^5
a_3	Presence of ordinance designated city	24.1×10^5
a_4	Before and after the bubble economic collapse	-2.12×10^5
a_5	Before and after the Lehman shock	4.96×10^5
b_{61}	Value of agricultural goods shipments in inland prefecture	9.37×10^5
b_{62}	Value of agricultural goods shipments in inland prefecture	20.5×10^5
b_{71}	Value of forestry goods shipments in inland prefecture	6.03×10^5
b_{72}	Value of forestry goods shipments in inland prefecture	-4.40×10^5
Multiple correlation coefficient		0.805

7. Conclusion

In this research, based on the previous study, the industrial shipment value of "coastal prefecture" and "inland prefecture" in Japan is estimated from factors such as population, area, existence of ordinance designated city, before and after the collapse of the bubble, before and after the Lehman shock. Furthermore, empirical analysis of the proposed model using panel data from 1986 to 2012 was conducted, and multiple correlation coefficient $R = 0.805$ could be obtained. In addition, the proposed model has common explanatory variables of all prefectures and explanatory variables by inland prefecture and coastal prefecture. In this point as well, we can grasp the common point for industrial shipment value and the difference in industrial structure between coastal prefecture and inland prefecture, based on the estimated values of parameters obtained from empirical analysis.

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