Potential demand of RORO shipping in East Asia visualized by the censored regression model

Doctor’s Dissertation

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Contents

Abstract

Censored regression, driven by maximum likelihood estimation, can estimate imaginary negative demand. In practical marine transportation, a level of freight or passengers demand less than the minimum to maintain profitability for ship is less than the minimum ship capacity for ports. Therefore, it is fundamentally important for ships' operators to call at ports where economically sufficient demand is available for their fleets. A censored regression model is suitable to analyze such truncated demand appearing with RORO shipping.

A threshold of minimum demand of RORO shipping, a level that is propitious to ships' operators and resource usage, is indispensable for highly efficient utilization of the ships capacity. Macro information related to the demand with variables of regional socioeconomic activities and sailing distance can be assigned according to reasonable rules for using censored regression (CR) to assess potential demand of RORO shipping at limited port networks.

Basing on the result in European case, the information of prefectural demand of automobile and some socioeconomic activities are collected in domestic Japan for censored regression. According the geographical characteristics of East Asia, distance and ship size are regarded as principal consideration aspects in this case. Under the result of Japanese case, this study chooses appropriate Chinese ports and builds port combinations between Japan and China for introducing potential new RORO shipping port networks in East Asia.

Definition: Short sea shipping shown in this paper equals to the meaning of RORO shipping.

Keywords: *Port networks, Regional transportation, RORO shipping, Cargo demand, Logistics, censored regression.*

1. Introduction

1.1. Study Background

Along with globalization of transportation, the opening of new short sea shipping port networks has become more convenient for regions with ports that are mutually proximal. *Bomba M. S. et al. (2004)* presented the comparisons between container-on-barge and short sea shipping basing on the intermodal short sea shipping in the United States along the Gulf of Mexico. In Europe, short sea shipping by RORO or ferries is well networked among countries because of their proximity. *Russo F. et al. (2013)* described that short sea shipping applies only to maritime transport services for goods or passengers in the range of domestic and international routes, and not crossing oceans. Former studies focus on the comparing of RORO and LOLO (lift on-lift off) services. What's more, the situation of deep sea shipping operators on higher distances, involving trans-oceanic routes are also presented in Mediterranean countries. For instance, within the Mediterranean region, short sea shipping accounts for a high percentage of traffic for Italy and France compared with the share of shipping over deep seas. Worldwide, international shipping accounts for over 75% of all shipping. *Browning J. et al. (2004)* already presented the important for establishment of the Yellow Sea transportation system which has been stressed that innovative technologies for ships, terminals and cargo handling systems should be introduced to realize competitive short sea shipping system in Northeast Asia.

1.2.Problem Identification

A threshold of minimum demand of shipping capacity, a level that is propitious to ferry operators and resource usage, is indispensable for highly efficient utilization of ferry capacity. Port networks in northeastern Mediterranean regions under the five main operators are separable into limited and non-limited port networks by ports that are called and not-called. *Ducruet C. (2006)* reports that potential port network cities can be assessed by consideration of micro-scale (local environment) and macro-scale (regional patterns) factors. Macro information related to freight demand with variables of regional socioeconomic activities and sailing distance can be assigned according to reasonable rules for using censored regression (CR) to assess potential short sea shipping demand at limited port networks. Thereby, one can produce a demand forecasting model that can predict a certain future short sea shipping market.

1.3. Objective of the Thesis

As described herein, the limit level of censored regression can be distinguished by the mean minus one standard deviation, following the general concept of the normal distribution theory, which differs from that of other papers describing censored regression. For instance, a report by *Anastasopoulos P. Ch. (2016)* describes the use of a tobit model (a censored regression model with respect to the inventor of the model), zero-inflated count data models, and an accident injury-severity rate and frequency also using a chi-square distribution.

Nassimbeni, G. (2001) models firms using a Tobit model, concluding that measurement instruments are virtual technology levers with the capacity to innovate firm characteristics that are analogous to regional freight tonnage and some short sea shipping socioeconomic activities. Although many studies have examined short sea shipping, no report of the relevant literature describes the use of censored regression to analyze short sea shipping characteristics. This study uses censored regression to explore latent elements for introducing potential new RORO shipping port networks in East Asia. What's more, *Cantore N. et al. (2018)* used the gravity model in international trades of environmental goods which is also suitable for this study on combinates ports.

1.4. Structure of the Thesis

This thesis will be divided into six chapters. A brief description of the contents of each chapter is given below.

Chapter 1: Introduction
This chapter presents the background information on the thesis, the overview of the thesis; its purpose and objective, and the general structure of the research.

Chapter 2: Censored Regression Model Characteristics
The purpose of this chapter is to explain the characteristics of censored regression model which is appropriate to utilize the practical information of short sea shipping ports. By the theory of censored regression model, setting reasonable limitation under actual condition is an important procedure in this study.

Chapter 3: Censored Regression Model in European Case
The aim of this chapter is to put practical information of Europe into censored regression model for finding the characteristic of chosen European model. Basing on the macro aspect analysis, the data include short sea shipping operators and regions with local ports, but also include regional populations, regional GDPs, number of regional tourists, and total regional freight tonnage.

Chapter 4: Censored Regression Model in Japanese Case
Following the results got from European model, this study sets censored regression model in domestic Japan. After gathering the socioeconomic information of Japanese prefectures, the author will properly choose limitation for censored regression model basing distance or ship size conditions those suitable for introducing new RORO shipping networks.

Chapter 5: Combination between Japan and China for Possible Port Networks of RORO Shipping
In this chapter, firstly the author will choose suitable ports those suit for as coordinate one comparing with Japanese ports. Then by combination between Japanese and Chinese ports, this study will run the integrated pairs of ports' related information in censored regression model.

Chapter 6: Conclusions

As conclusion of this thesis, results show that port combinations between Japan and China conformed to introduce new RORO shipping port networks. This paper reports means of future expansion of the RORO shipping in East Asia market.

2. Censored Regression Model Characteristics

2.1. Continuous Demand for Shipping vs. Limited Shipping Service Supplied for Demand

According to the volume of socioeconomic activities in regions, demand for shipping is continuous, from non-existent to infinite. Shipping service for demand is limited by a minimum vessel utilization rate at which the break-even point of vessel operators is balanced. Therefore, although some demand below that rate potentially exists, only demand exceeding that rate might be serviced by the operators, as presented in Fig. 1.

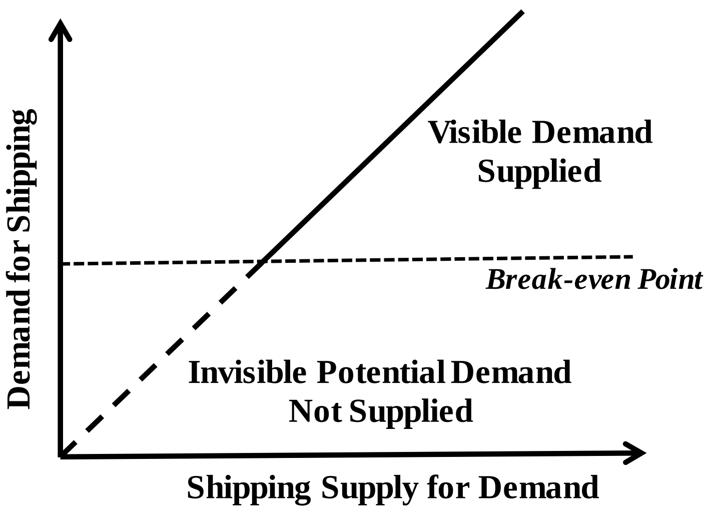


Fig. 1 Limited Shipping Supply for Demand.

When planning to invite new ports of call to regions for which no shipping service is available, one cannot simply analyze estimation directly between present demand shipped and vessel capacity supplied in other regions. Such data might merely represent the portion of trade above the minimum vessel utilization rate, as presented in Fig. 1.

One might rationally infer that such limitations are hiding somewhere among the visual data. A censored regression model is appropriate to solve this problem because the limited dependent variable is assumed as presented in the following sections.

2.2. Limited dependent variable

Fig. 2 presents an ordinary non-limited relation between an independent variable and a dependent variable derived from the following conditions.

$W=100x-600-\epsilon$ (1)
$x \sim N(10,1^2)$
$\epsilon \sim N(0,100^2)$
Number of samples: 200.

Therein, ϵ denotes error and N is a normal distribution that causes a random disturbance W on and x.

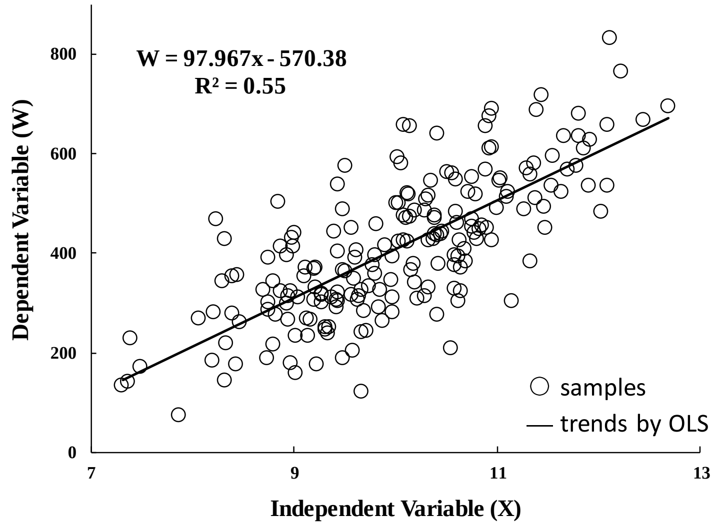


Fig. 2 Example of a Non-Limited Dependent Variable.

A lower region exists with either no value or a value less-related to the dependent variable. Only values above that region are significant, as depicted in Fig. 3. Presumably, the region in Fig. 2 is adversely affected by a limitation of 400 on the dependent variable.

Therefore, samples below the limit in the hatched part might be meaningless. The possibly

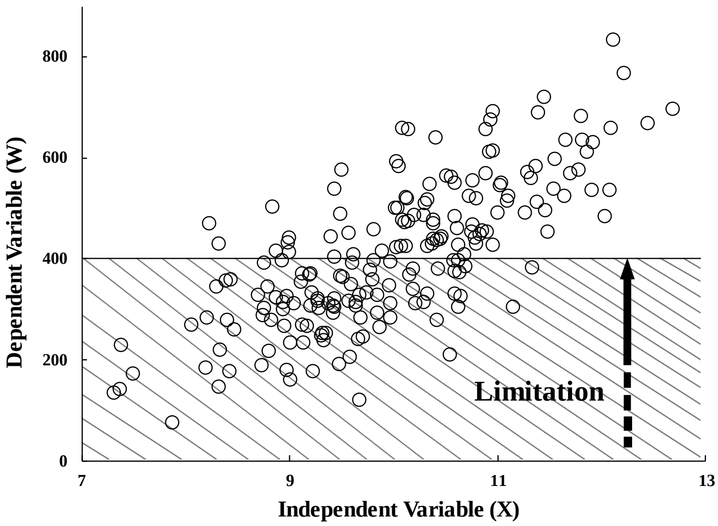


Fig. 3 Concept of Limited Dependent Variable.

meaningless samples in the hatched part have no effect on the dependent variable. They exist only as independent variables. It is reasonable for such limited samples to be shifted upward to the limit on the dependent variable, maintaining the location of the independent variable, as portrayed in Fig. 4.

The specific character of Fig. 4 is created by existence of the limit, which occurs in the figure at a value of 400 of the dependent variable. However, samples above the limit remain unaffected by existence of the limit. Accordingly, no change occurs with the independent variables either. Therefore, all observations of the dependent variables below the limit retain the same underlying relation as the linear combination (1). That is true even though it is not possible to represent a physical value of the dependent variable any further because the value of R^2 obtained by ordinary least square regression (OLS) in Fig. 4 is smaller than that in Fig. 2, missing the physical value of the limited samples.

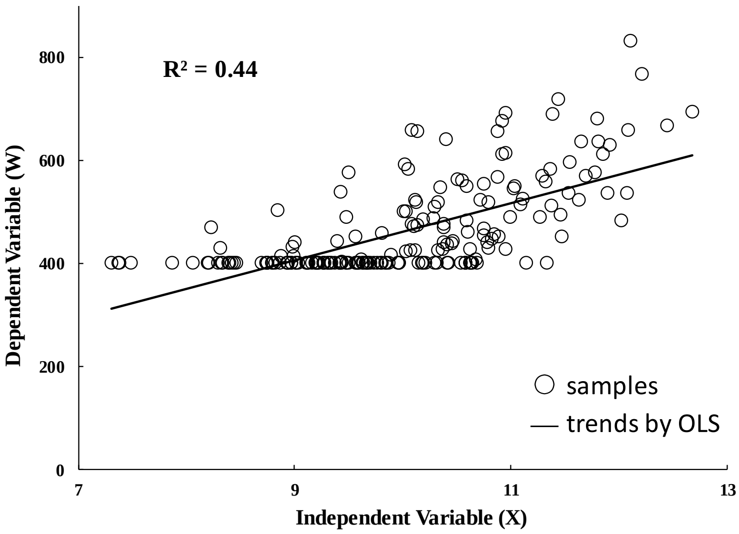


Fig. 4 Observation of Limited Dependent Variable.

2.3. Censored Regression Model

For such situations as those portrayed in Fig. 4, showing the mechanism described for Fig. 1, one can infer that the behavior of samples of the dependent variable depends on the probability according to the linear combination (1), but that behavior can only be represented at and above the limit. If a sample has probability sufficient to exist above the limit, then it will probably extend up from the limit. However, if a sample has certain probability indicating that it should extend below the limit, as if no limit existed, then it will most likely be on the limit.

These inferences can be described using a limited dependent variable W, a limit L, and the linear combination Y as shown below.

$$
\begin{aligned}
&Y = \beta_0 + \textstyle\sum_i^m \beta_i x_i \quad (i = 1, \cdots, m) \qquad (2)\\
&W = L \qquad\qquad\qquad (Y - \epsilon < L)\\
&W = Y - \epsilon \qquad\qquad (Y - \epsilon \geq L)
\end{aligned}
$$

In those equations, x_i denotes independent variables, β_0 and β_i denote unknown parameters, and ϵ represents the disturbance as a random variable. Any kind of probability distribution might be used, but a normal distribution was used in earlier studies by Tobin. We assumed it as (1) for the present study. Therefore, ϵ can be drawn from $N(0, \sigma^2)$ with standard deviation σ. For convenience, we represent a value of the unit normal distribution at x as $P(x)$, $Q(x) = 1 - P(x)$ and a value of the unit normal probability density at x as $Z(x)$. According to the description presented above, the probability and behavior of the dependent variable are expressed as shown below.

$$Prob.(W = L|Y, L) = Prob.(\epsilon > Y - L) = Q\left(\frac{Y-L}{\sigma}\right), \quad (3)$$

$$Prob.(W > x \geq L|Y, L) = Prob.(Y - \epsilon > x) = Prob.(\epsilon < Y - x) = P\left(\frac{Y-x}{\sigma}\right), \quad (4)$$

When Y and L are given, then the distribution and density function for W, represented respectively by F and f, are the following.

$$\begin{aligned} &F(x; Y, L) = 0 && (x < L), \\ &F(L; Y, L) = Q\left(\frac{Y-L}{\sigma}\right), && \\ &F(x; Y, L) = Q\left(\frac{Y-x}{\sigma}\right) && (x > L), \\ &f(x; Y, L) = \frac{1}{\sigma} Z\left(\frac{Y-x}{\sigma}\right) && (x > L), \end{aligned} \quad (5)$$

Maximum likelihood estimation (MLE) is principally used to estimate the unknown parameters of the censored regression model because MLE can accommodate nonlinear functions. Also, MLE is useful to treat probability functions. Although MLE is not the only possible method, this paper presents application of MLE to parameter estimation. The likelihood function $L(\beta)$ for the censored regression model is shown below.

$$L(\beta) = \prod_i^q F(L_i; Y_i, L_i) \prod_j^r f(W_j; Y_j, L_j) = \prod_i^q Q\left(\frac{Y_i - L_i}{\sigma}\right) \left\{\frac{1}{\sigma} \prod_j^r Z\left(\frac{Y_j - W_j}{\sigma}\right)\right\}, \quad (6)$$

$$(i = 1, \cdots, q.\ j = 1, \cdots, r.).$$

Both probability distribution F and density function f are included in (6) simultaneously because the differential has no effect on maximizing the parameter values. Subscript i denotes samples on limit L; j refers to those above L. When taking the natural log of $L(\beta)$, several approximation methods can be applied with some iterative calculations to reach the maximization point: Newton–Raphson is the most popular.

Fig. 5 and Table 1 present results obtained using censored regression model analysis applied to the samples in Fig. 4. Estimated parameters of the linear combination shown in the table can be regarded as found precisely for real values because of their equivalence to those derived from non-limited dependent variables in Fig. 2.

The most powerful capability of censored regression is estimation of the variance of the dependent variable (σ^2 in Table 1), which is not truncated by the limitation. For example, original data derived from the linear combination (*1*) have variance of 10,000 (100^2) because of ϵ. The censored regression in Table 1 estimated it as 8934.57, which achieved more than 89.4% precision compared to 10,000 although half of the samples had no information related to the dependent variable fixed on limit (L), as portrayed in Fig. 4. This capability of the censored regression is valuable to measure how much potential on the dependent variable is

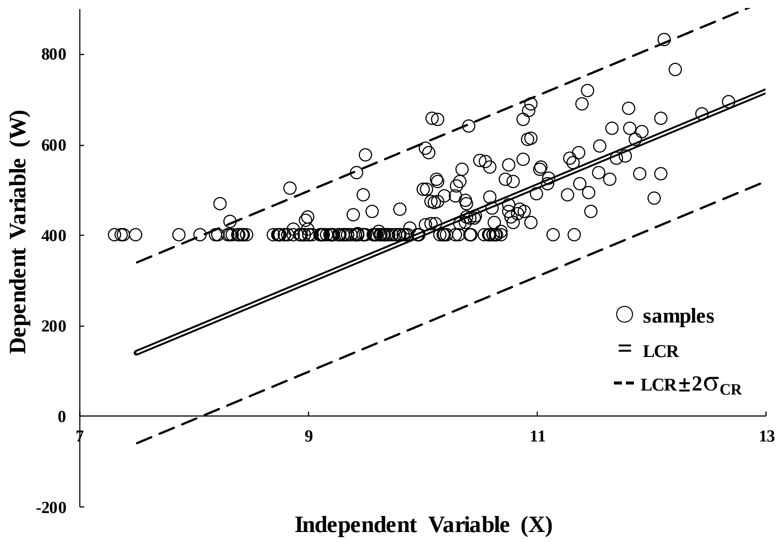


Fig. 5 Censored Regression Model (CR).

presumed to exist even though nothing is apparent on it, i.e. to measure the degree to which censored regression can show the depth below *L* by the variance. In marked contrast, whether the R^2 value is higher, OLS cannot be applied if the data for it are truncated as portrayed in Fig. 4.

Table 1 Censored Regression Model Estimation in Fig. 5 by MLE Procedure

Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
X	105.160	9.313	11.29174*
constant	-648.120	97.933	-10.70247*
σ^2	8934.570	773.699	11.54785*
Auxiliary statistics	At convergence	Initial (estimated by OLS)	-2(log likelihood ratio)
log likelihood	-650.486	-727.999	155.026*

*: 1% significance cleared

2.4. *Evaluation of Log Likelihood Ratio*

Fitness of the censored regression is popularly evaluated using the log likelihood ratio derived from MLE applied to the chi-squared test as

$$-2(L_{ac}-L_i) > x^2, \tag{7}$$

Where $L_{ac} - L_i$ stands for the log likelihood ratio, L_{ac} signifies the log likelihood at the final convergence in iterating calculations by which CR is assumed for estimating parameter (β), L_i denotes the log likelihood at the initial in iterating calculations by which OLS is assumed for estimating parameter (β), and x^2 represents the chi-square distribution.

Moreover, one must ascertain whether outcomes differ between CR and OLS. Therefore, testing of both sides on a chi-square distribution should be applied for (7).

3. Censored Regression Model in European Case

3.1. Limited Demand for Short Sea Shipping in Europe

3.1.1. Few port networks between neighboring regions

Short sea shipping can contribute greatly to connection of regional activities with neighboring regions. Because a short sea shipping operator might not cover all regions, ports of call compete and discriminate. However, shipping operations must utilize the fleet capacity offering a level of freight demand sufficient to maintain profitability. Consequently, ports called and not-called are intermingled in short distances. The certain properties of ports in practical networks can be used to simplify port network analysis.

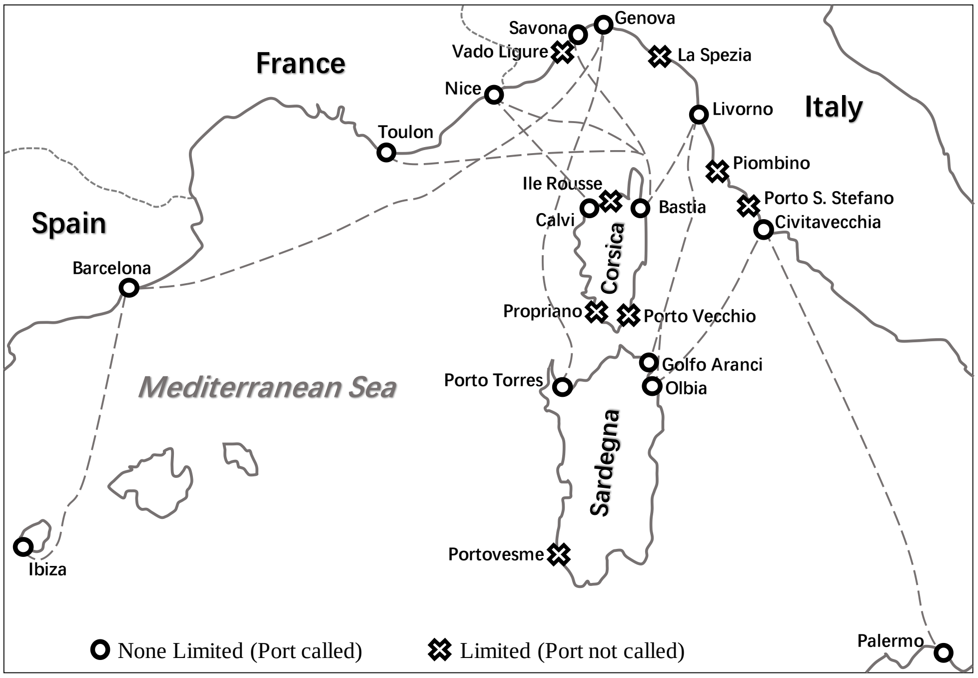


Fig. 6 Inter-regional limited port networks for Short Sea Shipping.
Source: ref. Ferrylines.com, Direct Ferries, Grandi Navi Veloci, Trasmediterranea, Corsica Ferries and Sardinia Ferries, Moby Lines, Tirrenia, Corsica Linea, (2016).

Fig. 6 shows such limited port networks (Ports not called) of short sea shipping in northeastern Mediterranean regions serving France, Italy, and Spain. Six major ferry operators serve the region: Grandi Navi Veloci, Trasmediterranea, Corsica Sardinia Ferries, Moby Lines, Tirrenia, and Corsica Linea. Circle symbols are ports called by the operators. Cross symbol ports are not called by them. The dashed line shows port networks between pairs of ports on routes by the operators. Within short distances, ports that are called and not called exist. The former might have few or no restrictions on ports of call, whereas the latter might be adversely affected by some unknown limitation of calls.

3.1.2. Definitions of limited port networks for Short Sea Shipping

Table 2 Definitions of limited port networks for Short Sea Shipping in the Mediterranean

NO		1		2			3					4		5	6	7	8	9	10	11
Region		Corsica, France		Provence-Alpes-Cote d'Azur, France			Sardegna, Italy					Liguria, Italy		Toscana, Italy	Lazio, Italy	Campa nia, Italy	Sicilia, Italy	Cataluna, Spain	Comunidad Valenciana, Spain	IIles Balears, Spain
NO	Port	Bastia	Aja ccio	Toulon	Nice	Marsei lle	Olbia	Golfo Aranci	Arba tax	Porto Torres	Caglia ri	Savo na	Genoa	Livor no	Civita vecchia	Naples	Paler mo	Barce lona	Valen cia	Ibiza
1	Bastia																			
	Ajaccio																			
2	Toulon	○	○																	
	Nice	○	○																	
	Marseille	○	○																	
3	Olbia	—	—	—	—	—														
	Golfo Aranci	—	—	—	—	—														
	Arbatax	—	—	—	—	—														
	Porto Torres	—	—	—	—	—														
	Cagliari	—	—	—	—	—			○											
4	Savona	○		—	—	—														
	Genoa			—	—	—	○			○										
5	Livorno	○		—	—	—	○	○				—	—							
6	Civitavecchia	—	—	—	—	—	○		○		○	—	—	—						
7	Naples	—	—	—	—	—					○	—	—	—	—					
8	Palermo	—	—	—	—	—					○	—	—	—	—	○				
9	Barcelona	—	—	—	—	—	—	—	—	—	—		○	—	—	—	—			
10	Valencia	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
11	Ibiza	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	○	○	

Regional Connection

NO	1	2	3	4	5	6	7	8	9	10	11
1											
2	◇										
3			◇								
4	◇		◇								
5	◇		◇								
6			◇								
7			◇								
8			◇				◇				
9				◇							
10											
11									◇	◇	

○ **Port Called**   ☐ **Port not Called**   — **Region not Called**   ◇ **Region Called**

Source: ref. Ferrylines.com, Direct Ferries, Grandi Navi Veloci, Trasmediterranea, Corsica Ferries and Sardinia Ferries, Moby Lines, Tirrenia, Corsica Linea, (2016).

Fig. 6 portrays limited port networks for the short sea shipping port networks shown in Table 2, as an example in Mediterranean regions. The networks include 11 regions of 3 countries and 19 ports located throughout the regions. First, one must examine specifically whether interregional connections exist by short sea shipping because neither competition nor discrimination by operators occurs if no interregional connection exists, i.e. no potential is left to establish an interregional business by short sea shipping. Road transportation offers many benefits in a region because of shorter distances and quicker deliveries by a single mode. Therefore, port networks in a region should be excluded from definitions if no port of call is made within the region by any operator. This fact is presented in the smaller table shown at the right of Table 2. The rhombus symbols signify that interregional connections exist for one or more port networks. Exceptionally, one region (region No. 3) has an inner regional network because 13 combinations of regions were adopted as the base to distinguish the limited port networks.

The lower left part of the diagonal of Table 2 presents the final definitions of limited port networks. Combinations of ports denoted by bars are excluded because no regional connection exists, as shown in the upper right sub-table. Combinations of ports located on gray blanks are also excluded because of their own combinations of ports on the diagonal. An exception is No. 3 because the port of call existed internally, as described above.

Finally, neither the denoted bar nor colored combinations of ports are adopted as limited port networks or as non-limited ones. The combinations of ports that are not colored are limited port networks having no port of call, although region combinations exist. The combinations denoted by circles are the non-limited port networks having at least one port of call. The number of the limited port networks is 26. The number of the non-limited ones is 22. Therefore, the total number of samples including both is 48, which is generally sufficient for application of a normal distribution.

3.1.3. Short sea shipping freight demand and regional socioeconomic activities

To those 19 selected ports, macro information related to freight demand and regional socioeconomic activities were assigned as shown in Table 3. Freight tonnage surveyed at each port represents the demand for short sea shipping. Population, gross domestic product (GDP), and the number of tourists surveyed at each region represent the socioeconomic activities for short sea shipping at each port of the region. These variables were formally selected because they are generally recognized and globally available as standardized data among nations. This paper is intended to present potential demand for short sea shipping in limited port networks. Therefore, these four variables are not limited to any other research for short sea shipping such as a precise demand forecasting model to predict a certain future market. Each port on a port network is physically distant from others. Therefore, sailing distance should be used as a variable representing a geographical location between the ports.

3.1.4. Limited vs. Non-limited demand for short sea shipping

Table 3 Information on freight demand and regional socioeconomic activities for ports

NO	Country	Region	Port	Freight Tonnage (thousand tonnes)	Population (inhabitants)	GDP (Euro)	Number of Tourist
1	France	Corsica	Bastia	1,544	316,257	25,600	1,746,324
2			Ajaccio				
3		Provence-Alpes-Cote d'Azur	Toulon	82,805	4,935,576	29,200	11,004,030
4			Nice				
5			Marseille				
6	Italy	Sardegna	Olbia	52,133	1,637,846	19,700	1,247,003
7			Golfo Aranci				
8			Arbatax				
9			Porto Torres				
10			Cagliari				
11		Liguria	Savona	69,359	1,567,339	27,200	2,215,890
12			Genoa				
13		Toscana	Livorno	30,770	3,667,780	28,200	5,489,961
14		Lazio	Civitavecchia	17,765	5,500,022	29,900	3,634,164
15		Campania	Naples	18,258	5,764,424	16,000	2,734,344
16		Sicilia	Palermo	79,053	4,999,854	16,600	2,548,463
17	Spain	Cataluna	Barcelona	67,908	7,514,991	26,600	8,346,741
18		Comunidad Valenciana	Valencia	68,559	5,009,650	19,900	5,536,438
19		IIles Balears	Ibiza	6,871	1,100,715	23,800	1,362,008

Source: Table 2, ref. Eurostat, (2012).

In Table 4, non-limited port networks are listed as Nos. 1–22. Limited port networks are listed as Nos. 23–48. On a limited port network, no visible freight tonnage exists even though each port at the edge of the network might show freight tonnage because such demand can be created by other non-limited port networks. In this regard, no freight tonnage can be assigned to limited port networks as the initial value for censored regression, as defined in Section 3.1.1, although both the freight tonnage at the origin port and the destination port added together might be assigned to non-limited port networks.

However, all socioeconomic activities of the respective regions exist independently whether the port networks connected there are limited or non-limited. Therefore, the socioeconomic activities of both regions between port networks added together might be assigned to the port network. As *Kuik, O. et al. (2019)* presents the gravity model that trade flow from country *o* (origin) to country *d* (destination) is positively linked to the economic sizes of the two countries (usually expressed in Gross Domestic Product (GDP)), M_o and M_d and negatively linked to the distance between them D_{od} (which refers to geographical distance but also other trade barriers). Basing on the interaction between each pair of ports may be existed, getting the summation values within all port networks is necessary in this study.

Table 4 presents a re-arrangement of the port network data in Table 3, based on the assumption presented above. The order of each port network is sorted by larger freight tonnage.

3.2. Censored Regression Model for Short Sea Shipping in Europe

3.2.1. Assumption of minimum visible limited demand for short sea shipping

As explained by Fig. 3 and Fig. 4 in Section 2.2, a certain minimum visible limited demand

Table 4 Data arrangement of the port networks for Censored Regression

No.	Port Networks	Freight Tonnage (thousand tonnes)	Population (inhabitants)	GDP (Euro)	Number of Tourist	Distance (km)
1	Barcelona-Genoa	137,267	9,082,330	53,800	10,562,631	663.02
2	Cagliari-Palermo	131,186	6,637,700	36,300	3,795,466	413.00
3	Genoa-Porto Torres	121,492	3,205,185	46,900	3,462,893	398.18
4	Genoa-Olbia	121,492	3,205,185	46,900	3,462,893	405.59
5	Arbatax-Cagliari	104,266	3,275,693	39,400	2,494,006	166.68
6	Napoli-Palermo	97,311	10,764,278	32,600	5,282,807	312.99
7	Ajaccio-Nice	84,349	5,251,833	54,800	12,750,354	621.68
8	Ajaccio-Toulon	84,349	5,251,833	54,800	12,750,354	572.53
9	Bastia-Nice	84,349	5,251,833	54,800	12,750,354	463.04
10	Bastia-Toulon	84,349	5,251,833	54,800	12,750,354	716.85
11	Marseille-Bastia	84,349	5,251,833	54,800	12,750,354	424.11
12	Marseille-Ajaccio	84,349	5,251,833	54,800	12,750,354	348.18
13	Livorno-Golfo Aranci	82,903	5,305,626	47,900	6,736,964	671.61
14	Livorno-Olbia	82,903	5,305,626	47,900	6,736,964	311.14
15	Ibiza-Valencia	75,430	6,110,365	43,700	6,898,446	190.76
16	Barcelona-Ibiza	74,779	8,615,706	50,400	9,708,749	312.99
17	Bastia-Savona	70,903	1,883,596	52,800	3,962,214	547.06
18	Napoli-Cagliari	70,391	7,402,270	35,700	3,981,347	501.89
19	Civitavecchia-Olbia	69,898	7,137,868	49,600	4,881,167	231.50
20	Civitavecchia-Arbatax	69,898	7,137,868	49,600	4,881,167	300.02
21	Civitavecchia-Cagliari	69,898	7,137,868	49,600	4,881,167	437.07
22	Bastia-Livorno	32,314	3,984,037	53,800	7,236,285	124.08
23	Bastia-Genoa	0	1,883,596	52,800	3,962,214	205.57
24	Ajaccio-Savona	0	1,883,596	52,800	3,962,214	290.76
25	Ajaccio-Genoa	0	1,883,596	52,800	3,962,214	303.73
26	Ajaccio-Livorno	0	3,984,037	53,800	7,236,285	281.50
27	Olbia-Savona	0	3,205,185	46,900	3,462,893	411.14
28	Olbia-Napoli	0	7,402,270	35,700	3,981,347	416.70
29	Olbia-Palermo	0	6,637,700	36,300	3,795,466	479.67
30	Golfo Aranci-Savona	0	3,205,185	46,900	3,462,893	403.74
31	Golfo Aranci-Genoa	0	3,205,185	46,900	3,462,893	400.03
32	Golfo Aranci-Civitavecchia	0	7,137,869	49,600	4,881,167	225.94
33	Golfo Aranci-Napoli	0	7,402,270	35,700	3,981,347	409.29
34	Golfo Aranci-Palermo	0	6,637,700	36,300	3,795,466	474.11
35	Arbatax-Savona	0	3,205,185	46,900	3,462,893	520.41
36	Arbatax-Genoa	0	3,205,185	46,900	3,462,893	516.71
37	Arbatax-Livorno	0	5,305,626	47,900	6,736,964	418.55
38	Arbatax-Napoli	0	7,402,270	35,700	3,981,347	405.59
39	Arbatax-Palermo	0	6,637,700	36,300	3,795,466	392.62
40	Porto Torres-Savona	0	3,205,185	46,900	3,462,893	383.36
41	Porto Torres-Livorno	0	5,305,626	47,900	6,736,964	361.14
42	Porto Torres-Civitavecchia	0	7,137,869	49,600	4,881,167	322.25
43	Porto Torres-Napoli	0	7,402,270	35,700	3,981,347	535.23
44	Porto Torres-Palermo	0	6,637,700	36,300	3,795,466	613.01
45	Cagliari-Savona	0	3,205,185	46,900	3,462,893	666.72
46	Cagliari-Genoa	0	3,205,185	46,900	3,462,893	663.02
47	Cagliari-Livorno	0	5,305,626	47,900	6,736,964	564.86
48	Savona-Barcelona	0	9,082,330	53,800	10,562,631	685.24

Source: Table 3, Netpas Distance, (2016).

should be assumed for short sea shipping in Table 4, on which all limited demand is fixed on the limit but only distributed on independent variables. Fig. 7 shows the freight tonnage distributed by the population as an independent variable. It is apparent that there should be the minimum visible limited demand set somewhere around 60,000 thousand tons because no distribution of samples appears except for a single sample distributed far below the limit. When one follows the general concept of normal distribution theory, such a limit might be distinguished by a range of a mean with a few standard deviations. The bold line shows the mean of the freight tonnage. The dashed line is the mean minus one standard deviation. The latter nicely separates limited demand from non-limited demand. In this respect, for these analyses, we assume the minimum visible limited demand as follows.

$\mu - \sigma_{FT}$ represents the minimum visible limited demand for short sea shipping (= 63,273); μ denotes mean demand; σ_{FT} stands for the standard deviation of the demand.

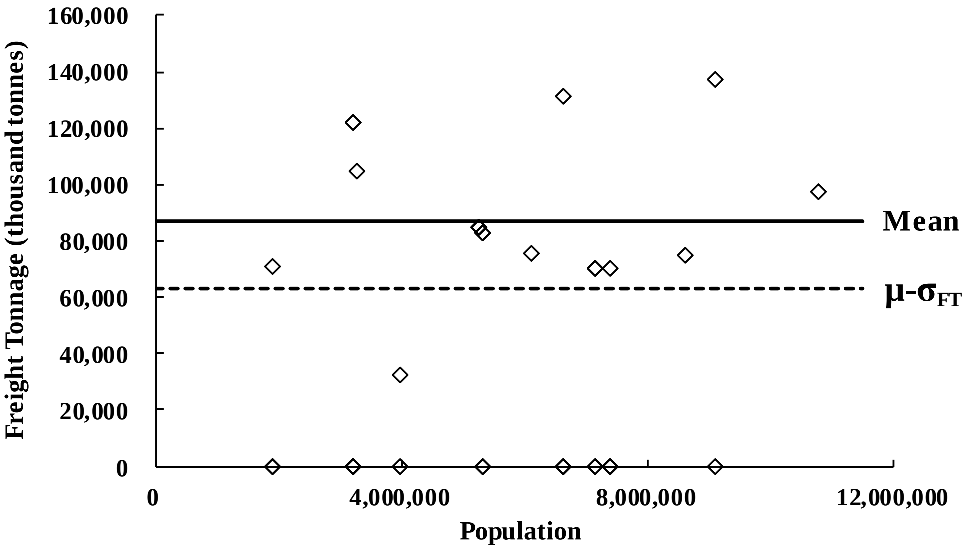


Fig. 7 Correlation with Freight Tonnage to Population.
Source: Table 4

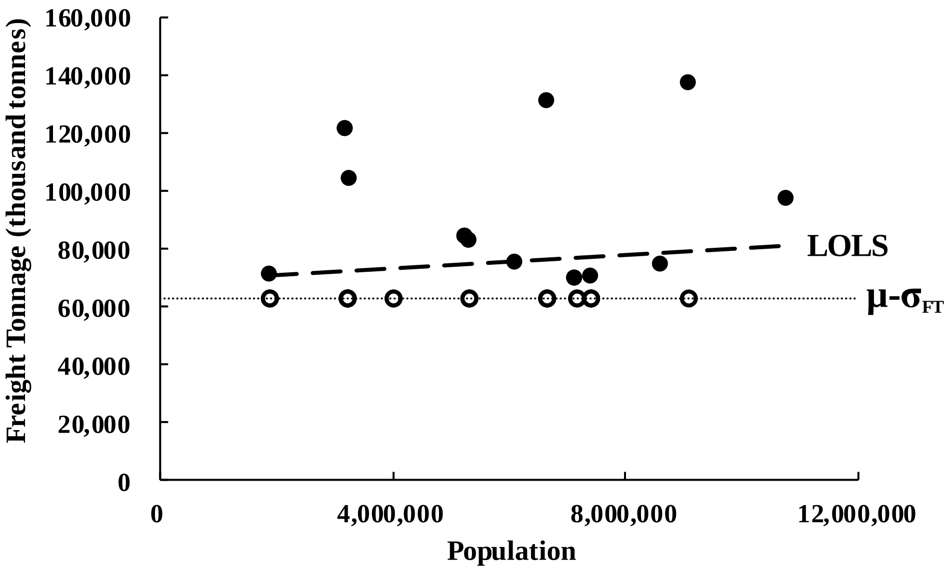


Fig. 8 Limited for Censored Regression on Population.
Source: Table 4

Fig. 8 presents the replaced locations of all limited demand (freight tonnage), including exceptional demand from those in Fig. 7. The ordinary least squares assumption, as represented by the linear combination abbreviated to LOLS, is no longer appropriate for application to the limited samples in the figure.

3.2.2. Censored regression model estimation for short sea shipping

Table 5 presents results of estimations obtained using the censored regression model for the data of Table 4 together with the minimum visible limited demand assumed above. These estimations were done for each pair of freight tonnage and socioeconomic variables with distance. The fitness of the censored regression by chi-squared test can be found for the log likelihood ratio, as explained in Section 2.4. It shows sufficient significance for all results of respective independent variables. Only the two independent variables, which are the number of tourists and the variance of the linear combination, can be adopted because of their significance demonstrated by *t*-test results.

3.2.3. Censored regression model performance for potential demand

Fig. 9 depicts the censored regression performance for the four variables (population, GDP, number of tourists, and distance) to the freight tonnage. Dashed lines show linear combinations derived from ordinary least squares (LOLS). Double lines are linear combinations derived from censored regression (LCR). Broken lines show the double standard deviation range around the censored regression, as abbreviated to LCR $\pm 2\sigma_{CR}$. Solid thin lines show the limit demand level set at 63,273 of the freight tonnage for short sea shipping (Limitation), which is the same as $\mu - \sigma_{FT}$ in Fig. 8.

Most samples are distributed neatly between the linear combinations derived from the censored regression and the double standard deviation range above them. It is generally presumed that about 95.4% of samples exist between the double standard deviation range above and below the mean because the lower range of the linear combinations and the double standard deviation range (gray shadow) imply that the potential demand as the freight tonnage for short sea shipping exists somewhere in the lower range, although nothing of the sort is apparent. This performance of sounding the potential demand by censored regression might be used practically when some socioeconomic change occurs in the future. For example, the limit demand level (Limitation) will decrease if governmental subsidies are given to shipping operators. Consequently, new visible demand will appear in the lower range. This analysis cannot be performed using ordinary least squares estimation only for visible samples, as shown by dotted lines in graphs of Fig. 9-1 to Fig. 9-4.

Another important aspect of censored regression performance is its detection of the original linear combination if no limitation exists on the dependent variable. Fig. 2 shows that ordinary least squares estimation can perform well under such conditions to detect the original linear combination. This performance might be found in the graphs of the population to freight tonnage and number of tourists to freight tonnage because the angles of the linear combination

Table 5 Result of Censored Regression in European Case.

Result of Population			
Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
X	3.471E-03	2.793E-03	1.243
constant	3.867E+04	1.751E+04	-1.405
σ²	1.236E+09	4.270E+08	2.89418**
Auxiliary statistics	At convergence	Initial (estimated by OLS)	-2(log likelihood ratio)
log likelihood	-266.181	-301.787	-71.212**
Result of GDP			
Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
X	7.152E-01	0.878	0.814
constant	2.393E+04	4.249E+04	-0.926
σ²	1.270E+09	4.394E+08	2.88954**
Auxiliary statistics	At convergence	Initial (estimated by OLS)	-2(log likelihood ratio)
log likelihood	-266.634	-307.355	-81.441**
Result of Tourist			
Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
X	3.895E-03	1.752E-03	2.22294*
constant	3.381E+04	1.388E+04	-2.12199*
σ²	1.175E+09	4.062E+08	2.89356**
Auxiliary statistics	At convergence	Initial (estimated by OLS)	-2(log likelihood ratio)
log likelihood	-264.279	-307.207	-85.856**
Result of Distance			
Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
X	13.007	39.288	0.331
constant	5.210E+04	1.822E+04	-0.613
σ²	1.265E+09	4.387E+08	2.88325**
Auxiliary statistics	At convergence	Initial (estimated by OLS)	-2(log likelihood ratio)
log likelihood	-266.918	-301.257	-68.679*
**: 1% , *: 5% Significance cleared			

of the censored regression are more numerous than those obtained using ordinary least squares. This study was conducted mainly to elucidate whether potential demand for short sea shipping was unobserved below the limit level, or not. Therefore, the general macro data were applied to independent variables for the censored regression. For that reason, not all the variables achieved higher performance to recover the original angle of the linear combinations.

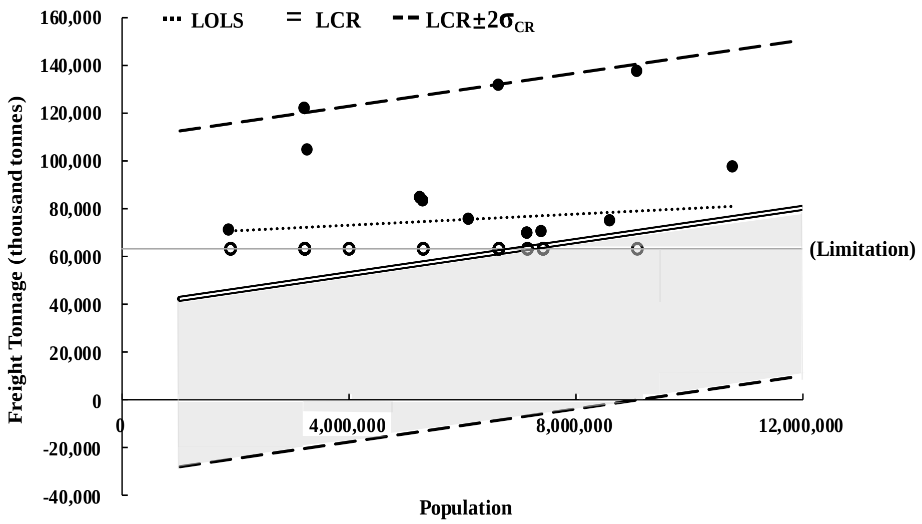


Fig. 9-1 Performance of Censored Regression on Population.

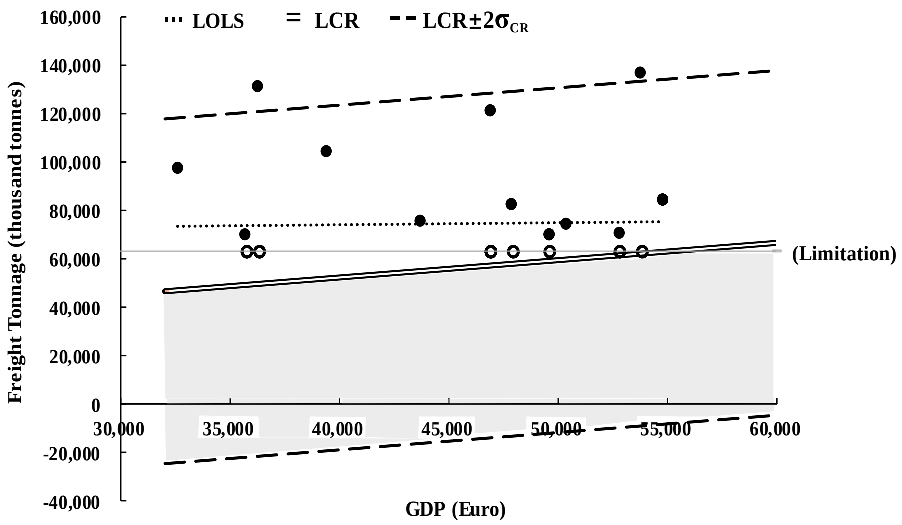


Fig. 9-2 Performance of Censored Regression on GDP.

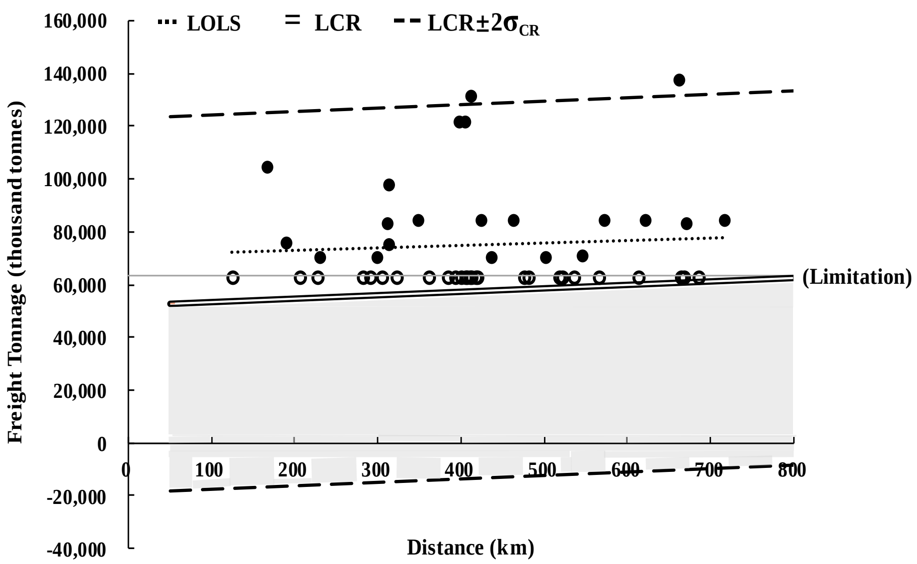


Fig. 9-3 Performance of Censored Regression on Distance.

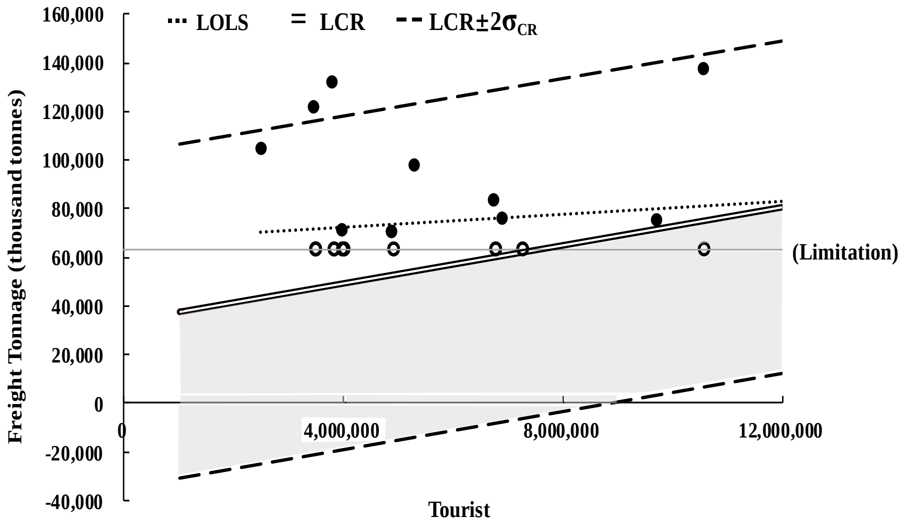


Fig. 9-4 Performance of Censored Regression on Tourist.

3.3. Results in European Case

Results of this case demonstrate that potential demand for freight tonnage for short sea shipping might exist but might remain unobserved: with nothing apparent in the lower range of population or numbers of tourists to freight tonnage. This performance of sounding the potential demand using censored regression might be used practically when some socioeconomic change occurs and might be used eventually to model a precise demand forecasting model to characterize or predict a certain short sea shipping market.

4. Censored Regression Model in Japanese Case

4.1. Information Collection in Domestic Japan

Basing the results already got in European case, it shown the potential of this study which help us to introduce censored regression model in Japanese area. There are many shipping operators service for short sea shipping in domestic Japan, and Fig. 10 is one of the servicing ship on Tomakomai - Oarai route, *Sunflower Furano.*

Fig. 10 Domestic Japan short sea shipping ship *Sunflower Furano*.
Source: MOL Ferry Co., Ltd, (2018).

The prefectural information of average car carrying ship size, popular, GDP and tourist are gathering as the aspects for censored regression. What's more, there are 47 official prefectures in domestic Japan which are including 39 prefectures those owned ports and 8 inland prefectures. As this study target for introducing potential new short sea shipping route, the related information on represent port of prefecture and Japanese prefectural socioeconomic activities are shown in Table 6.

The resource data are gathering from government's public information. The units of each aspect are as follows: automobile is freight tonnage (F/T), average car carrying ship size is ton, population is thousand persons, GDP is billion yen and tourist is person. For unifying newest data information on all session, this study chooses the year of 2016 as the analysing destination. Since the different updating period by system on public information, nearly year information on GDP and tourist is gathered by 2014 and 2017. The represent amount of prefectural automobile is chosen from the top port's data by the list of each prefecture. Meanwhile, the represent ports are also using for distance those are sourced from *Distance Table for World Shipping*, and part of information is gathering from the website of *The shortest sailing distance off the coast of Japan*.

Table 6 Information on Present port of prefecture and Japanese Prefectural socioeconomic activities

NO	Port	Automobile (F/T, 2016)	Average Car Carrying Ship Size (ton, 2016)	Population (thousand No., 2016)	GDP (billion yen, 2014)	Tourist (No., 2017)
1	Hokkaido, Tomakomai	93,902,380	5,207	5,352	18,485	3,630,950
2	Aomori, Aomori	35,307,435	4,885	1,293	4,428	436,930
3	Akita, Akita	2,608,485	20,353	1,010	3,459	282,700
4	Iwate, Ofunato	**0**	**0**	1,268	4,647	511,990
5	Yamagata, Sakata	**0**	**0**	1,113	3,755	497,120
6	Miyagi, Sendai Shiogama	9,010,850	4,682	2,330	8,896	743,840
7	Fukushima, Onahama	**0**	**0**	1,901	7,400	958,480
8	Niigata, Niigata	13,958,235	7,869	2,286	8,699	994,100
9	Toyama, Fushiki-Toyama	**0**	**0**	1,061	4,453	320,580
10	Ishikawa, Kanazawa	**0**	**0**	1,151	4,588	724,310
11	Fukui, Tsuruga	8,382,325	17,741	782	3,130	307,290
12	Ibaraki, Oarai	12,446,345	12,530	2,905	11,612	504,120
13	Tokyo, Tokyo	9,130,670	5,739	13,624	94,902	5,159,770
14	Kanagawa, Yokohama	1,530,350	3,466	9,145	30,322	1,709,650
15	Chiba, Chiba	1,530,350	3,466	6,236	20,045	2,157,630
16	Shizuoka, Shimizu	875,905	1,458	3,688	15,443	1,934,190
17	Aichi, Nagoya	5,683,065	1,599	7,507	35,990	1,590,380
18	Mie, Yokkaichi	1,091,265	850	1,808	7,656	719,880
19	Kyoto, Maizuru	4,906,420	16,810	2,605	10,054	1,524,380
20	Hyogo, Kobe	28,892,930	4,668	5,520	19,788	1,183,920
21	Osaka, Osaka	42,228,005	11,849	8,833	37,934	2,808,730
22	Wakayama, Wakayama-Shimotsu	3,118,455	2,612	954	3,579	477,870
23	Tottori, Sakaiminato	119,610	2,345	570	1,779	286,000
24	Shimane, Saigo	2,106,370	1,186	690	2,382	267,830
25	Hiroshima, Kure	26,897,360	247	2,837	11,238	828,230
26	Okayama, Mizushima	11,005,625	591	1,915	7,243	476,270
27	Kagawa, Takamatsu	29,941,275	810	972	3,672	317,120
28	Tokushima, Tokushima-Komatsushima	5,430,320	3,583	750	3,012	191,400
29	Ehime, Yawatahama	36,549,680	575	1,375	4,756	347,460
30	Kochi, Susaki	441,220	999	721	2,350	238,750
31	Yamaguchi, Tokuyama-Kudamatsu	4,941,625	532	1,394	5,969	356,060
32	Fukuoka, Moji	45,580,680	4,492	5,104	18,112	1,435,280

NO	Port	Automobile (F/T, 2016)	Average Car Carrying Ship Size (ton, 2016)	Population (thousand No., 2016)	GDP (billion yen, 2014)	Tourist (No., 2017)
33	Saga, Karatsu	760,105	858	828	2,737	260,860
34	Oita, Oita	21,876,040	1,432	1,160	4,143	544,230
35	Kumamoto, Nagasu	10,238,510	600	1,774	5,600	614,850
36	Nagasaki, Shimabara	15,260,835	640	1,367	4,310	642,880
37	Miyazaki, Miyazaki	5,719,340	11,932	1,096	3,643	317,340
38	Kagoshima, Kagoshima	62,625,100	1,500	1,637	5,330	676,470
39	Okinawa, Naha	4,331,330	911	1,439	4,051	2,041,400

Source: ref. Ministry of Land, Infrastructure, Transport and Tourism, Statistics of Japan, Ministry of Internal Affairs and Communications, Cabinet Office, (2014, 2016, 2017).

As we known, serviced short sea shipping routes are associated with both connected ports socioeconomic activities. Thus, the socioeconomic activities of both prefectures between port networks added together might be distributed to the port network.

Table 7 to Table 12 present a re-arrangement of the port network data in Table 6, those are the data arrangement of the prefectural port information on automobile, average car carrying ship size, popular, GDP, tourist and distance between represented ports. There are 741 combinations of each aspect for port networks, and some zero values come in automobile and average car carrying ship size because of none automobile shipping services happened within those 5 prefectures (Iwate, Yamagata, Fukushima, Toyama and Ishikawa).

Table 7 Data arrangement of the prefectural port information for censored regression on automobile (F/T, 2016)

NO	Port	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1	Hokkaido, Tomakomai																																							
2	Aomori, Aomori	129,209,815																																						
3	Akita, Akita	96,510,865	37,915,920																																					
4	Iwate, Ofunato	0	0	0																																				
5	Yamagata, Sakata	0	0	0	0																																			
6	Miyagi, Sendai Shiogama	102,913,230	44,318,285	11,619,335	0	0																																		
7	Fukushima, Onahama	0	0	0	0	0	0																																	
8	Niigata, Niigata	107,860,615	49,265,670	16,566,720	0	0	22,969,085	0																																
9	Toyama, Fushiki-Toyama	0	0	0	0	0	0	0	0																															
10	Ishikawa, Kanazawa	0	0	0	0	0	0	0	0	0																														
11	Fukui, Tsuruga	102,284,705	43,689,760	10,990,810	0	0	17,393,175	0	22,340,560	0	0																													
12	Ibaraki, Oarai	106,348,725	47,753,780	15,054,830	0	0	21,457,195	0	26,404,580	0	0	20,828,670																												
13	Tokyo, Tokyo	103,033,050	44,438,105	11,739,155	0	0	18,141,520	0	23,088,905	0	0	17,512,995	21,577,015																											
14	Kanagawa, Yokohama	95,432,730	36,837,785	4,138,835	0	0	10,541,200	0	15,488,585	0	0	9,912,675	13,976,695	10,661,020																										
15	Chiba, Chiba	95,432,730	36,837,785	4,138,835	0	0	10,541,200	0	15,488,585	0	0	9,912,675	13,976,695	10,661,020	3,060,700																									
16	Shizuoka, Shimizu	94,778,285	36,183,340	3,484,390	0	0	9,886,755	0	14,834,140	0	0	9,258,230	13,322,250	10,006,575	2,406,255	2,406,255																								
17	Aichi, Nagoya	99,585,445	40,990,500	8,291,550	0	0	14,693,915	0	19,641,300	0	0	14,065,390	18,129,410	14,813,735	7,213,415	7,213,415	6,558,970																							
18	Mie, Yokkaichi	94,993,645	36,398,700	3,699,750	0	0	10,102,115	0	15,049,500	0	0	9,473,590	13,537,610	10,221,935	2,621,615	2,621,615	1,967,170	6,774,330																						
19	Kyoto, Maizuru	98,808,800	40,213,855	7,514,905	0	0	13,917,270	0	18,864,655	0	0	13,288,745	17,352,765	14,037,090	6,436,770	6,436,770	5,782,325	10,589,485	5,997,685																					
20	Hyogo, Kobe	122,795,310	64,200,365	31,501,415	0	0	37,903,780	0	42,851,165	0	0	37,275,255	41,339,275	38,023,600	30,423,280	30,423,280	29,768,835	34,575,995	29,984,195	33,799,350																				
21	Osaka, Osaka	136,130,385	77,535,440	44,836,490	0	0	51,238,855	0	56,186,240	0	0	50,610,330	54,674,350	51,358,675	43,758,355	43,758,355	43,103,910	47,911,070	43,319,270	47,134,425	71,120,935																			
22	Wakayama, Wakayama-Shimotsu	97,020,835	38,425,890	5,726,940	0	0	12,129,305	0	17,076,690	0	0	11,500,780	15,564,800	12,249,125	4,648,805	4,648,805	3,994,360	8,801,520	4,209,720	8,024,875	32,011,385	45,346,460																		
23	Tottori, Sakaiminato	94,021,990	35,427,045	2,728,095	0	0	9,130,460	0	14,077,845	0	0	8,501,935	12,565,955	9,250,280	1,649,960	1,649,960	995,515	5,802,675	1,210,875	5,026,030	29,012,540	42,347,615	3,238,065																	
24	Shimane, Saigo	96,008,750	37,413,805	4,714,855	0	0	11,117,220	0	16,064,605	0	0	10,488,695	14,552,715	11,237,040	3,636,720	3,636,720	2,982,275	7,789,435	3,197,635	7,012,790	30,999,300	44,334,375	5,224,825	2,225,980																
25	Hiroshima, Kure	120,799,740	62,204,795	29,505,845	0	0	35,908,210	0	40,855,595	0	0	35,279,685	39,343,705	36,028,030	28,427,710	28,427,710	27,773,265	32,580,425	27,988,625	31,803,780	55,790,290	69,125,365	30,015,815	27,016,970	29,003,730															
26	Okayama, Mizushima	104,908,005	46,313,060	13,614,110	0	0	20,016,475	0	24,963,860	0	0	19,387,950	23,451,970	20,136,295	12,535,975	12,535,975	11,881,530	16,688,690	12,096,890	15,912,045	39,898,555	53,233,630	14,124,080	11,125,235	13,111,995	37,902,985														
27	Kagawa, Takamatsu	123,843,655	65,248,710	32,549,760	0	0	38,952,125	0	43,899,510	0	0	38,323,600	42,387,620	39,071,945	31,471,625	31,471,625	30,817,180	35,624,340	31,032,540	34,847,695	58,834,205	72,169,280	33,059,730	30,060,885	32,047,645	56,838,635	40,946,900													
28	Tokushima, Tokushima-Komatsushima	99,332,700	40,737,755	8,038,805	0	0	14,441,170	0	19,388,555	0	0	13,812,645	17,876,665	14,560,990	6,960,670	6,960,670	6,306,225	11,113,385	6,521,585	10,336,740	34,323,250	47,658,325	8,548,775	5,549,930	7,536,690	32,327,680	16,435,945	35,371,595												
29	Ehime, Yawatahama	130,452,060	71,857,115	39,158,165	0	0	45,560,530	0	50,507,915	0	0	44,932,005	48,996,025	45,680,350	38,080,030	38,080,030	37,425,585	42,232,745	37,640,945	41,456,100	65,442,610	78,777,685	39,668,135	36,669,290	38,656,050	63,447,040	47,555,305	66,490,955	41,980,000											
30	Kochi, Susaki	94,343,600	35,748,655	3,049,705	0	0	9,452,070	0	14,399,455	0	0	8,823,545	12,887,565	9,571,890	1,971,570	1,971,570	1,317,125	6,124,285	1,532,485	5,347,640	29,334,150	42,669,225	3,559,675	560,830	2,547,590	27,338,580	11,446,845	30,382,495	5,871,540	36,990,900										
31	Yamaguchi, Tokuyamakudamatsu	98,844,005	40,249,060	7,550,110	0	0	13,952,475	0	18,899,860	0	0	13,323,950	17,387,970	14,072,295	6,471,975	6,471,975	5,817,530	10,624,690	6,032,890	9,848,045	33,834,555	47,169,630	8,060,080	5,061,235	7,047,995	31,838,985	15,947,250	34,882,900	10,371,945	41,491,305	5,382,845									
32	Fukuoka, Moji	139,483,060	80,888,115	48,189,165	0	0	54,591,530	0	59,538,915	0	0	53,963,005	58,027,025	54,711,350	47,111,030	47,111,030	46,456,585	51,263,745	46,671,945	50,487,100	74,473,610	87,808,685	48,699,135	45,700,290	47,687,050	72,478,040	56,586,305	75,521,955	51,011,000	82,130,360	46,021,900	50,522,305								
33	Saga, Karatsu	94,662,485	36,067,540	3,368,590	0	0	9,770,955	0	14,718,340	0	0	9,142,430	13,206,450	9,890,775	2,290,455	2,290,455	1,636,010	6,443,170	1,851,370	5,666,525	29,653,035	42,988,110	3,878,560	879,715	2,866,475	27,657,465	11,765,730	30,701,380	6,190,425	37,309,785	1,201,325	5,701,730	46,340,785							
34	Oita, Oita	115,778,420	57,183,475	24,484,525	0	0	30,886,890	0	35,834,275	0	0	30,258,365	34,322,385	31,006,710	23,406,390	23,406,390	22,751,945	27,559,105	22,967,305	26,782,460	50,768,970	64,104,045	24,994,495	21,995,650	23,982,410	48,773,400	32,881,665	51,817,315	27,306,360	58,425,720	22,317,260	26,817,665	67,456,720	22,636,145						
35	Kumamoto, Nagasu	104,140,890	45,545,945	12,846,995	0	0	19,249,360	0	24,196,745	0	0	18,620,835	22,684,855	19,369,180	11,768,860	11,768,860	11,114,415	15,921,575	11,329,775	15,144,930	39,131,440	52,466,515	13,356,965	10,358,120	12,344,880	37,135,870	21,244,135	40,179,785	15,668,830	46,788,190	10,679,730	15,180,135	55,819,190	10,998,615	32,114,550					
36	Nagasaki, Shimabara	109,163,215	50,568,270	17,869,320	0	0	24,271,685	0	29,219,070	0	0	23,643,160	27,707,180	24,391,505	16,791,185	16,791,185	16,136,740	20,943,900	16,352,100	20,167,255	44,153,765	57,488,840	18,379,290	15,380,445	17,367,205	42,158,195	26,266,460	45,202,110	20,691,155	51,810,515	15,702,055	20,202,460	60,841,515	16,020,940	37,136,875	25,499,345				
37	Miyazaki, Miyazaki	99,621,720	41,026,775	8,327,825	0	0	14,730,190	0	19,677,575	0	0	14,101,665	18,165,685	14,850,010	7,249,690	7,249,690	6,595,245	11,402,405	6,810,605	10,625,760	34,612,270	47,947,345	8,837,795	5,838,950	7,825,710	32,616,700	16,724,965	35,660,615	11,149,660	42,269,020	6,160,560	10,660,965	51,300,020	6,479,445	27,595,380	15,957,850	20,980,175			
38	Kagoshima, Kagoshima	156,527,480	97,932,535	65,233,585	0	0	71,635,950	0	76,583,335	0	0	71,007,425	75,071,445	71,755,770	64,155,450	64,155,450	63,501,005	68,308,165	63,716,365	67,531,520	91,518,030	104,853,105	65,743,555	62,744,710	64,731,470	89,522,460	73,630,725	92,566,375	68,055,420	99,174,780	63,066,320	67,566,725	108,205,780	63,385,205	84,501,140	72,863,610	77,885,935	68,344,440		
39	Okinawa, Naha	98,233,710	39,638,765	6,939,815	0	0	13,342,180	0	18,289,565	0	0	12,713,655	16,777,675	13,462,000	5,861,680	5,861,680	5,207,235	10,014,395	5,422,595	9,237,750	33,224,260	46,559,335	7,449,785	4,450,940	6,437,700	31,228,690	15,336,955	34,272,605	9,761,650	40,881,010	4,772,550	9,272,955	49,912,010	5,091,435	26,207,370	14,569,840	19,592,165	10,050,670	66,956,430	

Table 8 Data arrangement of the prefectural port information for censored regression on Average Car Carrying Ship Size (ton, 2016)

NO	Port	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1	Hokkaido, Tomakomai																																							
2	Aomori, Aomori	10,092																																						
3	Akita, Akita	25,560	25,238																																					
4	Iwate, Ofunato	0	0	0																																				
5	Yamagata, Sakata	0	0	0	0																																			
6	Miyagi, Sendai Shiogama	9,889	9,567	25,035	0	0																																		
7	Fukushima, Onahama	0	0	0	0	0	0																																	
8	Niigata, Niigata	13,076	12,754	28,222	0	0	12,551	0																																
9	Toyama, Fushiki-Toyama	0	0	0	0	0	0	0	0																															
10	Ishikawa, Kanazawa	0	0	0	0	0	0	0	0	0																														
11	Fukui, Tsuruga	22,948	22,626	38,094	0	0	22,423	0	25,610	0	0																													
12	Ibaraki, Oarai	17,737	17,415	32,883	0	0	17,212	0	20,399	0	0	30,271																												
13	Tokyo, Tokyo	10,946	10,624	26,092	0	0	10,421	0	13,608	0	0	23,480	18,269																											
14	Kanagawa, Yokohama	8,673	8,351	23,819	0	0	8,148	0	11,335	0	0	21,207	15,996	9,205																										
15	Chiba, Chiba	8,673	8,351	23,819	0	0	8,148	0	11,335	0	0	21,207	15,996	9,205	6,932																									
16	Shizuoka, Shimizu	6,665	6,343	21,811	0	0	6,140	0	9,327	0	0	19,199	13,988	7,197	4,924	4,924																								
17	Aichi, Nagoya	6,806	6,484	21,952	0	0	6,281	0	9,468	0	0	19,340	14,129	7,338	5,065	5,065	3,057																							
18	Mie, Yokkaichi	6,057	5,735	21,203	0	0	5,532	0	8,719	0	0	18,591	13,380	6,589	4,316	4,316	2,308	2,449																						
19	Kyoto, Maizuru	22,017	21,695	37,163	0	0	21,492	0	24,679	0	0	34,551	29,340	22,549	20,276	20,276	18,268	18,409	17,660																					
20	Hyogo, Kobe	9,875	9,553	25,021	0	0	9,350	0	12,537	0	0	22,409	17,198	10,407	8,134	8,134	6,126	6,267	5,518	21,478																				
21	Osaka, Osaka	17,056	16,734	32,202	0	0	16,531	0	19,718	0	0	29,590	24,379	17,588	15,315	15,315	13,307	13,448	12,699	28,659	16,517																			
22	Wakayama, Wakayama-Shimotsu	7,819	7,497	22,965	0	0	7,294	0	10,481	0	0	20,353	15,142	8,351	6,078	6,078	4,070	4,211	3,462	19,422	7,280	14,461																		
23	Tottori, Sakaiminato	7,552	7,230	22,698	0	0	7,027	0	10,214	0	0	20,086	14,875	8,084	5,811	5,811	3,803	3,944	3,195	19,155	7,013	14,194	4,957																	
24	Shimane, Saigo	6,393	6,071	21,539	0	0	5,868	0	9,055	0	0	18,927	13,716	6,925	4,652	4,652	2,644	2,785	2,036	17,996	5,854	13,035	3,798	3,531																
25	Hiroshima, Kure	5,454	5,132	20,600	0	0	4,929	0	8,116	0	0	17,988	12,777	5,986	3,713	3,713	1,705	1,846	1,097	17,057	4,915	12,096	2,859	2,592	1,433															
26	Okayama, Mizushima	5,798	5,476	20,944	0	0	5,273	0	8,460	0	0	18,332	13,121	6,330	4,057	4,057	2,049	2,190	1,441	17,401	5,259	12,440	3,203	2,936	1,777	838														
27	Kagawa, Takamatsu	6,017	5,695	21,163	0	0	5,492	0	8,679	0	0	18,551	13,340	6,549	4,276	4,276	2,268	2,409	1,660	17,620	5,478	12,659	3,422	3,155	1,996	1,057	1,401													
28	Tokushima, Tokushima-Komatsushima	8,790	8,468	23,936	0	0	8,265	0	11,452	0	0	21,324	16,113	9,322	7,049	7,049	5,041	5,182	4,433	20,393	8,251	15,432	6,195	5,928	4,769	3,830	4,174	4,393												
29	Ehime, Yawatahama	5,782	5,460	20,928	0	0	5,257	0	8,444	0	0	18,316	13,105	6,314	4,041	4,041	2,033	2,174	1,425	17,385	5,243	12,424	3,187	2,920	1,761	822	1,166	1,385	4,158											
30	Kochi, Susaki	6,206	5,884	21,352	0	0	5,681	0	8,868	0	0	18,740	13,529	6,738	4,465	4,465	2,457	2,598	1,849	17,809	5,667	12,848	3,611	3,344	2,185	1,246	1,590	1,809	4,582	1,574										
31	Yamaguchi, Tokuyamakudamatsu	5,739	5,417	20,885	0	0	5,214	0	8,401	0	0	18,273	13,062	6,271	3,998	3,998	1,990	2,131	1,382	17,342	5,200	12,381	3,144	2,877	1,718	779	1,123	1,342	4,115	1,107	1,531									
32	Fukuoka, Moji	9,699	9,377	24,845	0	0	9,174	0	12,361	0	0	22,233	17,022	10,231	7,958	7,958	5,950	6,091	5,342	21,302	9,160	16,341	7,104	6,837	5,678	4,739	5,083	5,302	8,075	5,067	5,491	5,024								
33	Saga, Karatsu	6,065	5,743	21,211	0	0	5,540	0	8,727	0	0	18,599	13,388	6,597	4,324	4,324	2,316	2,457	1,708	17,668	5,526	12,707	3,470	3,203	2,044	1,105	1,449	1,668	4,441	1,433	1,857	1,390	5,350							
34	Oita, Oita	6,639	6,317	21,785	0	0	6,114	0	9,301	0	0	19,173	13,962	7,171	4,898	4,898	2,890	3,031	2,282	18,242	6,100	13,281	4,044	3,777	2,618	1,679	2,023	2,242	5,015	2,007	2,431	1,964	5,924	2,290						
35	Kumamoto, Nagasu	5,807	5,485	20,953	0	0	5,282	0	8,469	0	0	18,341	13,130	6,339	4,066	4,066	2,058	2,199	1,450	17,410	5,268	12,449	3,212	2,945	1,786	847	1,191	1,410	4,183	1,175	1,599	1,132	5,092	1,458	2,032					
36	Nagasaki, Shimabara	5,847	5,525	20,993	0	0	5,322	0	8,509	0	0	18,381	13,170	6,379	4,106	4,106	2,098	2,239	1,490	17,450	5,308	12,489	3,252	2,985	1,826	887	1,231	1,450	4,223	1,215	1,639	1,172	5,132	1,498	2,072	1,240				
37	Miyazaki, Miyazaki	17,139	16,817	32,285	0	0	16,614	0	19,801	0	0	29,673	24,462	17,671	15,398	15,398	13,390	13,531	12,782	28,742	16,600	23,781	14,544	14,277	13,118	12,179	12,523	12,742	15,515	12,507	12,931	12,464	16,424	12,790	13,364	12,532	12,572			
38	Kagoshima, Kagoshima	6,707	6,385	21,853	0	0	6,182	0	9,369	0	0	19,241	14,030	7,239	4,966	4,966	2,958	3,099	2,350	18,310	6,168	13,349	4,112	3,845	2,686	1,747	2,091	2,310	5,083	2,075	2,499	2,032	5,992	2,358	2,932	2,100	2,140	13,432		
39	Okinawa, Naha	6,118	5,796	21,264	0	0	5,593	0	8,780	0	0	18,652	13,441	6,650	4,377	4,377	2,369	2,510	1,761	17,721	5,579	12,760	3,523	3,256	2,097	1,158	1,502	1,721	4,494	1,486	1,910	1,443	5,403	1,769	2,343	1,511	1,551	12,843	2,411	

Table 9 Data arrangement of the prefectural port information for censored regression on population (thousand No., 2016)

NO	Prefecture / Port	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1	Hokkaido, Tomakomai																																							
2	Aomori, Aomori	6,645																																						
3	Akita, Akita	6,362	2,303																																					
4	Iwate, Ofunato	6,620	2,561	2,278																																				
5	Yamagata, Sakata	6,465	2,406	2,123	2,381																																			
6	Miyagi, Sendai Shiogama	7,682	3,623	3,340	3,598	3,443																																		
7	Fukushima, Onahama	7,253	3,194	2,911	3,169	3,014	4,231																																	
8	Niigata, Niigata	7,638	3,579	3,296	3,554	3,399	4,616	4,187																																
9	Toyama, Fushiki-Toyama	6,413	2,354	2,071	2,329	2,174	3,391	2,962	3,347																															
10	Ishikawa, Kanazawa	6,503	2,444	2,161	2,419	2,264	3,481	3,052	3,437	2,212																														
11	Fukui, Tsuruga	6,134	2,075	1,792	2,050	1,895	3,112	2,683	3,068	1,843	1,933																													
12	Ibaraki, Oarai	8,257	4,198	3,915	4,173	4,018	5,235	4,806	5,191	3,966	4,056	3,687																												
13	Tokyo, Tokyo	18,976	14,917	14,634	14,892	14,737	15,954	15,525	15,910	14,685	14,775	14,406	16,529																											
14	Kanagawa, Yokohama	14,497	10,438	10,155	10,413	10,258	11,475	11,046	11,431	10,206	10,296	9,927	12,050	22,769																										
15	Chiba, Chiba	11,588	7,529	7,246	7,504	7,349	8,566	8,137	8,522	7,297	7,387	7,018	9,141	19,860	15,381																									
16	Shizuoka, Shimizu	9,040	4,981	4,698	4,956	4,801	6,018	5,589	5,974	4,749	4,839	4,470	6,593	17,312	12,833	9,924																								
17	Aichi, Nagoya	12,859	8,800	8,517	8,775	8,620	9,837	9,408	9,793	8,568	8,658	8,289	10,412	21,131	16,652	13,743	11,195																							
18	Mie, Yokkaichi	7,160	3,101	2,818	3,076	2,921	4,138	3,709	4,094	2,869	2,959	2,590	4,713	15,432	10,953	8,044	5,496	9,315																						
19	Kyoto, Maizuru	7,957	3,898	3,615	3,873	3,718	4,935	4,506	4,891	3,666	3,756	3,387	5,510	16,229	11,750	8,841	6,293	10,112	4,413																					
20	Hyogo, Kobe	10,872	6,813	6,530	6,788	6,633	7,850	7,421	7,806	6,581	6,671	6,302	8,425	19,144	14,665	11,756	9,208	13,027	7,328	8,125																				
21	Osaka, Osaka	14,185	10,126	9,843	10,101	9,946	11,163	10,734	11,119	9,894	9,984	9,615	11,738	22,457	17,978	15,069	12,521	16,340	10,641	11,438	14,353																			
22	Wakayama, Wakayama-Shimotsu	6,306	2,247	1,964	2,222	2,067	3,284	2,855	3,240	2,015	2,105	1,736	3,859	14,578	10,099	7,190	4,642	8,461	2,762	3,559	6,474	9,787																		
23	Tottori, Sakaiminato	5,922	1,863	1,580	1,838	1,683	2,900	2,471	2,856	1,631	1,721	1,352	3,475	14,194	9,715	6,806	4,258	8,077	2,378	3,175	6,090	9,403	1,524																	
24	Shimane, Saigo	6,042	1,983	1,700	1,958	1,803	3,020	2,591	2,976	1,751	1,841	1,472	3,595	14,314	9,835	6,926	4,378	8,197	2,498	3,295	6,210	9,523	1,644	1,260																
25	Hiroshima, Kure	8,189	4,130	3,847	4,105	3,950	5,167	4,738	5,123	3,898	3,988	3,619	5,742	16,461	11,982	9,073	6,525	10,344	4,645	5,442	8,357	11,670	3,791	3,407	3,527															
26	Okayama, Mizushima	7,267	3,208	2,925	3,183	3,028	4,245	3,816	4,201	2,976	3,066	2,697	4,820	15,539	11,060	8,151	5,603	9,422	3,723	4,520	7,435	10,748	2,869	2,485	2,605	4,752														
27	Kagawa, Takamatsu	6,324	2,265	1,982	2,240	2,085	3,302	2,873	3,258	2,033	2,123	1,754	3,877	14,596	10,117	7,208	4,660	8,479	2,780	3,577	6,492	9,805	1,926	1,542	1,662	3,809	2,887													
28	Tokushima, Tokushima-Komatsushima	6,102	2,043	1,760	2,018	1,863	3,080	2,651	3,036	1,811	1,901	1,532	3,655	14,374	9,895	6,986	4,438	8,257	2,558	3,355	6,270	9,583	1,704	1,320	1,440	3,587	2,665	1,722												
29	Ehime, Yawatahama	6,727	2,668	2,385	2,643	2,488	3,705	3,276	3,661	2,436	2,526	2,157	4,280	14,999	10,520	7,611	5,063	8,882	3,183	3,980	6,895	10,208	2,329	1,945	2,065	4,212	3,290	2,347	2,125											
30	Kochi, Susaki	6,073	2,014	1,731	1,989	1,834	3,051	2,622	3,007	1,782	1,872	1,503	3,626	14,345	9,866	6,957	4,409	8,228	2,529	3,326	6,241	9,554	1,675	1,291	1,411	3,558	2,636	1,693	1,471	2,096										
31	Yamaguchi, Tokuyamakudamatsu	6,746	2,687	2,404	2,662	2,507	3,724	3,295	3,680	2,455	2,545	2,176	4,299	15,018	10,539	7,630	5,082	8,901	3,202	3,999	6,914	10,227	2,348	1,964	2,084	4,231	3,309	2,366	2,144	2,769	2,115									
32	Fukuoka, Moji	10,456	6,397	6,114	6,372	6,217	7,434	7,005	7,390	6,165	6,255	5,886	8,009	18,728	14,249	11,340	8,792	12,611	6,912	7,709	10,624	13,937	6,058	5,674	5,794	7,941	7,019	6,076	5,854	6,479	5,825	6,498								
33	Saga, Karatsu	6,180	2,121	1,838	2,096	1,941	3,158	2,729	3,114	1,889	1,979	1,610	3,733	14,452	9,973	7,064	4,516	8,335	2,636	3,433	6,348	9,661	1,782	1,398	1,518	3,665	2,743	1,800	1,578	2,203	1,549	2,222	5,932							
34	Oita, Oita	6,512	2,453	2,170	2,428	2,273	3,490	3,061	3,446	2,221	2,311	1,942	4,065	14,784	10,305	7,396	4,848	8,667	2,968	3,765	6,680	9,993	2,114	1,730	1,850	3,997	3,075	2,132	1,910	2,535	1,881	2,554	6,264	1,988						
35	Kumamoto, Nagasu	7,126	3,067	2,784	3,042	2,887	4,104	3,675	4,060	2,835	2,925	2,556	4,679	15,398	10,919	8,010	5,462	9,281	3,582	4,379	7,294	10,607	2,728	2,344	2,464	4,611	3,689	2,746	2,524	3,149	2,495	3,168	6,878	2,602	2,934					
36	Nagasaki, Shimabara	6,719	2,660	2,377	2,635	2,480	3,697	3,268	3,653	2,428	2,518	2,149	4,272	14,991	10,512	7,603	5,055	8,874	3,175	3,972	6,887	10,200	2,321	1,937	2,057	4,204	3,282	2,339	2,117	2,742	2,088	2,761	6,471	2,195	2,527	3,141				
37	Miyazaki, Miyazaki	6,448	2,389	2,106	2,364	2,209	3,426	2,997	3,382	2,157	2,247	1,878	4,001	14,720	10,241	7,332	4,784	8,603	2,904	3,701	6,616	9,929	2,050	1,666	1,786	3,933	3,011	2,068	1,846	2,471	1,817	2,490	6,200	1,924	2,256	2,870	2,463			
38	Kagoshima, Kagoshima	6,989	2,930	2,647	2,905	2,750	3,967	3,538	3,923	2,698	2,788	2,419	4,542	15,261	10,782	7,873	5,325	9,144	3,445	4,242	7,157	10,470	2,591	2,207	2,327	4,474	3,552	2,609	2,387	3,012	2,358	3,031	6,741	2,465	2,797	3,411	3,004	2,733		
39	Okinawa, Naha	6,791	2,732	2,449	2,707	2,552	3,769	3,340	3,725	2,500	2,590	2,221	4,344	15,063	10,584	7,675	5,127	8,946	3,247	4,044	6,959	10,272	2,393	2,009	2,129	4,276	3,354	2,411	2,189	2,814	2,160	2,833	6,543	2,267	2,599	3,213	2,806	2,535	3,076	

Table 10 Data arrangement of the prefectural port information for censored regression on GDP (billion yen, 2014)

NO	Port	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1	Hokkaido, Tomakomai																																							
2	Aomori, Aomori	22,913																																						
3	Akita, Akita	21,944	7,887																																					
4	Iwate, Ofunato	23,132	9,075	8,106																																				
5	Yamagata, Sakata	22,240	8,183	7,214	8,402																																			
6	Miyagi, Sendai Shiogama	27,381	13,324	12,355	13,543	12,651																																		
7	Fukushima, Onahama	25,885	11,828	10,859	12,047	11,155	16,296																																	
8	Niigata, Niigata	27,184	13,127	12,158	13,346	12,454	17,595	16,099																																
9	Toyama, Fushiki-Toyama	22,938	8,881	7,912	9,100	8,208	13,349	11,853	13,152																															
10	Ishikawa, Kanazawa	23,073	9,016	8,047	9,235	8,343	13,484	11,988	13,287	9,041																														
11	Fukui, Tsuruga	21,615	7,558	6,589	7,777	6,885	12,026	10,530	11,829	7,583	7,718																													
12	Ibaraki, Oarai	30,097	16,040	15,071	16,259	15,367	20,508	19,012	20,311	16,065	16,200	14,742																												
13	Tokyo, Tokyo	113,387	99,330	98,361	99,549	98,657	103,798	102,302	103,601	99,355	99,490	98,032	106,514																											
14	Kanagawa, Yokohama	48,807	34,750	33,781	34,969	34,077	39,218	37,722	39,021	34,775	34,910	33,452	41,934	125,224																										
15	Chiba, Chiba	38,530	24,473	23,504	24,692	23,800	28,941	27,445	28,744	24,498	24,633	23,175	31,657	114,947	50,367																									
16	Shizuoka, Shimizu	33,928	19,871	18,902	20,090	19,198	24,339	22,843	24,142	19,896	20,031	18,573	27,055	110,345	45,765	35,488																								
17	Aichi, Nagoya	54,475	40,418	39,449	40,637	39,745	44,886	43,390	44,689	40,443	40,578	39,120	47,602	130,892	66,312	56,035	51,433																							
18	Mie, Yokkaichi	26,141	12,084	11,115	12,303	11,411	16,552	15,056	16,355	12,109	12,244	10,786	19,268	102,558	37,978	27,701	23,099	43,646																						
19	Kyoto, Maizuru	28,539	14,482	13,513	14,701	13,809	18,950	17,454	18,753	14,507	14,642	13,184	21,666	104,956	40,376	30,099	25,497	46,044	17,710																					
20	Hyogo, Kobe	38,273	24,216	23,247	24,435	23,543	28,684	27,188	28,487	24,241	24,376	22,918	31,400	114,690	50,110	39,833	35,231	55,778	27,444	29,842																				
21	Osaka, Osaka	56,419	42,362	41,393	42,581	41,689	46,830	45,334	46,633	42,387	42,522	41,064	49,546	132,836	68,256	57,979	53,377	73,924	45,590	47,988	57,722																			
22	Wakayama, Wakayama-Shimotsu	22,064	8,007	7,038	8,226	7,334	12,475	10,979	12,278	8,032	8,167	6,709	15,191	98,481	33,901	23,624	19,022	39,569	11,235	13,633	23,367	41,513																		
23	Tottori, Sakaiminato	20,264	6,207	5,238	6,426	5,534	10,675	9,179	10,478	6,232	6,367	4,909	13,391	96,681	32,101	21,824	17,222	37,769	9,435	11,833	21,567	39,713	5,358																	
24	Shimane, Saigo	20,867	6,810	5,841	7,029	6,137	11,278	9,782	11,081	6,835	6,970	5,512	13,994	97,284	32,704	22,427	17,825	38,372	10,038	12,436	22,170	40,316	5,961	4,161																
25	Hiroshima, Kure	29,723	15,666	14,697	15,885	14,993	20,134	18,638	19,937	15,691	15,826	14,368	22,850	106,140	41,560	31,283	26,681	47,228	18,894	21,292	31,026	49,172	14,817	13,017	13,620															
26	Okayama, Mizushima	25,728	11,671	10,702	11,890	10,998	16,139	14,643	15,942	11,696	11,831	10,373	18,855	102,145	37,565	27,288	22,686	43,233	14,899	17,297	27,031	45,177	10,822	9,022	9,625	18,481														
27	Kagawa, Takamatsu	22,157	8,100	7,131	8,319	7,427	12,568	11,072	12,371	8,125	8,260	6,802	15,284	98,574	33,994	23,717	19,115	39,662	11,328	13,726	23,460	41,606	7,251	5,451	6,054	14,910	10,915													
28	Tokushima, Tokushima-Komatsushima	21,497	7,440	6,471	7,659	6,767	11,908	10,412	11,711	7,465	7,600	6,142	14,624	97,914	33,334	23,057	18,455	39,002	10,668	13,066	22,800	40,946	6,591	4,791	5,394	14,250	10,255	6,684												
29	Ehime, Yawatahama	23,241	9,184	8,215	9,403	8,511	13,652	12,156	13,455	9,209	9,344	7,886	16,368	99,658	35,078	24,801	20,199	40,746	12,412	14,810	24,544	42,690	8,335	6,535	7,138	15,994	11,999	8,428	7,768											
30	Kochi, Susaki	20,835	6,778	5,809	6,997	6,105	11,246	9,750	11,049	6,803	6,938	5,480	13,962	97,252	32,672	22,395	17,793	38,340	10,006	12,404	22,138	40,284	5,929	4,129	4,732	13,588	9,593	6,022	5,362	7,106										
31	Yamaguchi, Tokuyamakudamatsu	24,454	10,397	9,428	10,616	9,724	14,865	13,369	14,668	10,422	10,557	9,099	17,581	100,871	36,291	26,014	21,412	41,959	13,625	16,023	25,757	43,903	9,548	7,748	8,351	17,207	13,212	9,641	8,981	10,725	8,319									
32	Fukuoka, Moji	36,597	22,540	21,571	22,759	21,867	27,008	25,512	26,811	22,565	22,700	21,242	29,724	113,014	48,434	38,157	33,555	54,102	25,768	28,166	37,900	56,046	21,691	19,891	20,494	29,350	25,355	21,784	21,124	22,868	20,462	24,081								
33	Saga, Karatsu	21,222	7,165	6,196	7,384	6,492	11,633	10,137	11,436	7,190	7,325	5,867	14,349	97,639	33,059	22,782	18,180	38,727	10,393	12,791	22,525	40,671	6,316	4,516	5,119	13,975	9,980	6,409	5,749	7,493	5,087	8,706	20,849							
34	Oita, Oita	22,628	8,571	7,602	8,790	7,898	13,039	11,543	12,842	8,596	8,731	7,273	15,755	99,045	34,465	24,188	19,586	40,133	11,799	14,197	23,931	42,077	7,722	5,922	6,525	15,381	11,386	7,815	7,155	8,899	6,493	10,112	22,255	6,880						
35	Kumamoto, Nagasu	24,085	10,028	9,059	10,247	9,355	14,496	13,000	14,299	10,053	10,188	8,730	17,212	100,502	35,922	25,645	21,043	41,590	13,256	15,654	25,388	43,534	9,179	7,379	7,982	16,838	12,843	9,272	8,612	10,356	7,950	11,569	23,712	8,337	9,743					
36	Nagasaki, Shimabara	22,795	8,738	7,769	8,957	8,065	13,206	11,710	13,009	8,763	8,898	7,440	15,922	99,212	34,632	24,355	19,753	40,300	11,966	14,364	24,098	42,244	7,889	6,089	6,692	15,548	11,553	7,982	7,322	9,066	6,660	10,279	22,422	7,047	8,453	9,910				
37	Miyazaki, Miyazaki	22,128	8,071	7,102	8,290	7,398	12,539	11,043	12,342	8,096	8,231	6,773	15,255	98,545	33,965	23,688	19,086	39,633	11,299	13,697	23,431	41,577	7,222	5,422	6,025	14,881	10,886	7,315	6,655	8,399	5,993	9,612	21,755	6,380	7,786	9,243	7,953			
38	Kagoshima, Kagoshima	23,815	9,758	8,789	9,977	9,085	14,226	12,730	14,029	9,783	9,918	8,460	16,942	100,232	35,652	25,375	20,773	41,320	12,986	15,384	25,118	43,264	8,909	7,109	7,712	16,568	12,573	9,002	8,342	10,086	7,680	11,299	23,442	8,067	9,473	10,930	9,640	8,973		
39	Okinawa, Naha	22,536	8,479	7,510	8,698	7,806	12,947	11,451	12,750	8,504	8,639	7,181	15,663	98,953	34,373	24,096	19,494	40,041	11,707	14,105	23,839	41,985	7,630	5,830	6,433	15,289	11,294	7,723	7,063	8,807	6,401	10,020	22,163	6,788	8,194	9,651	8,361	7,694	9,381	

Table 11 Data arrangement of the prefectural port information for censored regression on tourist (No., 2017)

NO	Port	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1	Hokkaido, Tomakomai																																							
2	Aomori, Aomori	4,067,880																																						
3	Akita, Akita	3,913,650	719,630																																					
4	Iwate, Ofunato	4,142,940	948,920	794,690																																				
5	Yamagata, Sakata	4,128,070	934,050	779,820	1,009,110																																			
6	Miyagi, Sendai Shiogama	4,374,790	1,180,770	1,026,540	1,255,830	1,240,960																																		
7	Fukushima, Onahama	4,589,430	1,395,410	1,241,180	1,470,470	1,455,600	1,702,320																																	
8	Niigata, Niigata	4,625,050	1,431,030	1,276,800	1,506,090	1,491,220	1,737,940	1,952,580																																
9	Toyama, Fushiki-Toyama	3,951,530	757,510	603,280	832,570	817,700	1,064,420	1,279,060	1,314,680																															
10	Ishikawa, Kanazawa	4,355,260	1,161,240	1,007,010	1,236,300	1,221,430	1,468,150	1,682,790	1,718,410	1,044,890																														
11	Fukui, Tsuruga	3,938,240	744,220	589,990	819,280	804,410	1,051,130	1,265,770	1,301,390	627,870	1,031,600																													
12	Ibaraki, Oarai	4,135,070	941,050	786,820	1,016,110	1,001,240	1,247,960	1,462,600	1,498,220	824,700	1,228,430	811,410																												
13	Tokyo, Tokyo	8,790,720	5,596,700	5,442,470	5,671,760	5,656,890	5,903,610	6,118,250	6,153,870	5,480,350	5,884,080	5,467,060	5,663,890																											
14	Kanagawa, Yokohama	5,340,600	2,146,580	1,992,350	2,221,640	2,206,770	2,453,490	2,668,130	2,703,750	2,030,230	2,433,960	2,016,940	2,213,770	6,869,420																										
15	Chiba, Chiba	5,788,580	2,594,560	2,440,330	2,669,620	2,654,750	2,901,470	3,116,110	3,151,730	2,478,210	2,881,940	2,464,920	2,661,750	7,317,400	3,867,280																									
16	Shizuoka, Shimizu	5,565,140	2,371,120	2,216,890	2,446,180	2,431,310	2,678,030	2,892,670	2,928,290	2,254,770	2,658,500	2,241,480	2,438,310	7,093,960	3,643,840	4,091,820																								
17	Aichi, Nagoya	5,221,330	2,027,310	1,873,080	2,102,370	2,087,500	2,334,220	2,548,860	2,584,480	1,910,960	2,314,690	1,897,670	2,094,500	6,750,150	3,300,030	3,748,010	3,524,570																							
18	Mie, Yokkaichi	4,350,830	1,156,810	1,002,580	1,231,870	1,217,000	1,463,720	1,678,360	1,713,980	1,040,460	1,444,190	1,027,170	1,224,000	5,879,650	2,429,530	2,877,510	2,654,070	2,310,260																						
19	Kyoto, Maizuru	5,155,330	1,961,310	1,807,080	2,036,370	2,021,500	2,268,220	2,482,860	2,518,480	1,844,960	2,248,690	1,831,670	2,028,500	6,684,150	3,234,030	3,682,010	3,458,570	3,114,760	2,244,260																					
20	Hyogo, Kobe	4,814,870	1,620,850	1,466,620	1,695,910	1,681,040	1,927,760	2,142,400	2,178,020	1,504,500	1,908,230	1,491,210	1,688,040	6,343,690	2,893,570	3,341,550	3,118,110	2,774,300	1,903,800	2,708,300																				
21	Osaka, Osaka	6,439,680	3,245,660	3,091,430	3,320,720	3,305,850	3,552,570	3,767,210	3,802,830	3,129,310	3,533,040	3,116,020	3,312,850	7,968,500	4,518,380	4,966,360	4,742,920	4,399,110	3,528,610	4,333,110	3,992,650																			
22	Wakayama, Wakayama-Shimotsu	4,108,820	914,800	760,570	989,860	974,990	1,221,710	1,436,350	1,471,970	798,450	1,202,180	785,160	981,990	5,637,640	2,187,520	2,635,500	2,412,060	2,068,250	1,197,750	2,002,250	1,661,790	3,286,600																		
23	Tottori, Sakaiminato	3,916,950	722,930	568,700	797,990	783,120	1,029,840	1,244,480	1,280,100	606,580	1,010,310	593,290	790,120	5,445,770	1,995,650	2,443,630	2,220,190	1,876,380	1,005,880	1,810,380	1,469,920	3,094,730	763,870																	
24	Shimane, Saigo	3,898,780	704,760	550,530	779,820	764,950	1,011,670	1,226,310	1,261,930	588,410	992,140	575,120	771,950	5,427,600	1,977,480	2,425,460	2,202,020	1,858,210	987,710	1,792,210	1,451,750	3,076,560	745,700	553,830																
25	Hiroshima, Kure	4,459,180	1,265,160	1,110,930	1,340,220	1,325,350	1,572,070	1,786,710	1,822,330	1,148,810	1,552,540	1,135,520	1,332,350	5,988,000	2,537,880	2,985,860	2,762,420	2,418,610	1,548,110	2,352,610	2,012,150	3,636,960	1,306,100	1,114,230	1,096,060															
26	Okayama, Mizushima	4,107,220	913,200	758,970	988,260	973,390	1,220,110	1,434,750	1,470,370	796,850	1,200,580	783,560	980,390	5,636,040	2,185,920	2,633,900	2,410,460	2,066,650	1,196,150	2,000,650	1,660,190	3,285,000	954,140	762,270	744,100	1,304,500														
27	Kagawa, Takamatsu	3,948,070	754,050	599,820	829,110	814,240	1,060,960	1,275,600	1,311,220	637,700	1,041,430	624,410	821,240	5,476,890	2,026,770	2,474,750	2,251,310	1,907,500	1,037,000	1,841,500	1,501,040	3,125,850	794,990	603,120	584,950	1,145,350	793,390													
28	Tokushima, Tokushima-Komatsushima	3,822,350	628,330	474,100	703,390	688,520	935,240	1,149,880	1,185,500	511,980	915,710	498,690	695,520	5,351,170	1,901,050	2,349,030	2,125,590	1,781,780	911,280	1,715,780	1,375,320	3,000,130	669,270	477,400	459,230	1,019,630	667,670	508,520												
29	Ehime, Yawatahama	3,978,410	784,390	630,160	859,450	844,580	1,091,300	1,305,940	1,341,560	668,040	1,071,770	654,750	851,580	5,507,230	2,057,110	2,505,090	2,281,650	1,937,840	1,067,340	1,871,840	1,531,380	3,156,190	825,330	633,460	615,290	1,175,690	823,730	664,580	538,860											
30	Kochi, Susaki	3,869,700	675,680	521,450	750,740	735,870	982,590	1,197,230	1,232,850	559,330	963,060	546,040	742,870	5,398,520	1,948,400	2,396,380	2,172,940	1,829,130	958,630	1,763,130	1,422,670	3,047,480	716,620	524,750	506,580	1,066,980	715,020	555,870	430,150	586,210										
31	Yamaguchi, Tokuyamakudamatsu	3,987,010	792,990	638,760	868,050	853,180	1,099,900	1,314,540	1,350,160	676,640	1,080,370	663,350	860,180	5,515,830	2,065,710	2,513,690	2,290,250	1,946,440	1,075,940	1,880,440	1,539,980	3,164,790	833,930	642,060	623,890	1,184,290	832,330	673,180	547,460	703,520	594,810									
32	Fukuoka, Moji	5,066,230	1,872,210	1,717,980	1,947,270	1,932,400	2,179,120	2,393,760	2,429,380	1,755,860	2,159,590	1,742,570	1,939,400	6,595,050	3,144,930	3,592,910	3,369,470	3,025,660	2,155,160	2,959,660	2,619,200	4,244,010	1,913,150	1,721,280	1,703,110	2,263,510	1,911,550	1,752,400	1,626,680	1,782,740	1,674,030	1,791,340								
33	Saga, Karatsu	3,891,810	697,790	543,560	772,850	757,980	1,004,700	1,219,340	1,254,960	581,440	985,170	568,150	764,980	5,420,630	1,970,510	2,418,490	2,195,050	1,851,240	980,740	1,785,240	1,444,780	3,069,590	738,730	546,860	528,690	1,089,090	737,130	577,980	452,260	608,320	499,610	616,920	1,696,140							
34	Oita, Oita	4,175,180	981,160	826,930	1,056,220	1,041,350	1,288,070	1,502,710	1,538,330	864,810	1,268,540	851,520	1,048,350	5,704,000	2,253,880	2,701,860	2,478,420	2,134,610	1,264,110	2,068,610	1,728,150	3,352,960	1,022,100	830,230	812,060	1,372,460	1,020,500	861,350	735,630	891,690	782,980	900,290	1,979,510	805,090						
35	Kumamoto, Nagasu	4,245,800	1,051,780	897,550	1,126,840	1,111,970	1,358,690	1,573,330	1,608,950	935,430	1,339,160	922,140	1,118,970	5,774,620	2,324,500	2,772,480	2,549,040	2,205,230	1,334,730	2,139,230	1,798,770	3,423,580	1,092,720	900,850	882,680	1,443,080	1,091,120	931,970	806,250	962,310	853,600	970,910	2,050,130	875,710	1,159,080					
36	Nagasaki, Shimabara	4,273,830	1,079,810	925,580	1,154,870	1,140,000	1,386,720	1,601,360	1,636,980	963,460	1,367,190	950,170	1,147,000	5,802,650	2,352,530	2,800,510	2,577,070	2,233,260	1,362,760	2,167,260	1,826,800	3,451,610	1,120,750	928,880	910,710	1,471,110	1,119,150	960,000	834,280	990,340	881,630	998,940	2,078,160	903,740	1,187,110	1,257,730				
37	Miyazaki, Miyazaki	3,948,290	754,270	600,040	829,330	814,460	1,061,180	1,275,820	1,311,440	637,920	1,041,650	624,630	821,460	5,477,110	2,026,990	2,474,970	2,251,530	1,907,720	1,037,220	1,841,720	1,501,260	3,126,070	795,210	603,340	585,170	1,145,570	793,610	634,460	508,740	664,800	556,090	673,400	1,752,620	578,200	861,570	932,190	960,220			
38	Kagoshima, Kagoshima	4,307,420	1,113,400	959,170	1,188,460	1,173,590	1,420,310	1,634,950	1,670,570	997,050	1,400,780	983,760	1,180,590	5,836,240	2,386,120	2,834,100	2,610,660	2,266,850	1,396,350	2,200,850	1,860,390	3,485,200	1,154,340	962,470	944,300	1,504,700	1,152,740	993,590	867,870	1,023,930	915,220	1,032,530	2,111,750	937,330	1,220,700	1,291,320	1,319,350	993,810		
39	Okinawa, Naha	5,672,350	2,478,330	2,324,100	2,553,390	2,538,520	2,785,240	2,999,880	3,035,500	2,361,980	2,765,710	2,348,690	2,545,520	7,201,170	3,751,050	4,199,030	3,975,590	3,631,780	2,761,280	3,565,780	3,225,320	4,850,130	2,519,270	2,327,400	2,309,230	2,869,630	2,517,670	2,358,520	2,232,800	2,388,860	2,280,150	2,397,460	3,476,680	2,302,260	2,585,630	2,656,250	2,684,280	2,358,740	2,717,870	

Table 12 Data arrangement of the prefectural port information for censored regression on distance (mile, 2018)

N.P	Port	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1	Hokkaido, Tomakomai																																							
2	Aomori, Aomori	119																																						
3	Akita, Akita	221	161																																					
4	Iwate, Ofunato	239	241	340																																				
5	Yamagata, Sakata	256	195	52	379																																			
6	Miyagi, Sendai Shiogama	313	316	415	95	454																																		
7	Fukushima, Onahama	358	369	484	143	507	102																																	
8	Niigata, Niigata	316	255	119	450	67	514	567																																
9	Toyama, Fushiki-Toyama	417	356	238	540	181	615	678	122																															
10	Ishikawa, Kanazawa	441	381	262	564	222	639	692	167	134																														
11	Fukui, Tsuruga	509	448	329	632	290	707	760	236	202	75																													
12	Ibaraki, Oarai	398	409	508	183	547	125	41	607	708	732	800																												
13	Tokyo, Tokyo	552	575	662	344	701	283	203	773	871	897	875	171																											
14	Kanagawa, Yokohama	541	552	651	331	690	284	198	760	858	884	876	160	10																										
15	Chiba, Chiba	565	569	668	343	707	300	209	767	874	892	881	177	12	12																									
16	Shizuoka, Shimizu	592	607	701	376	740	327	242	803	901	833	801	210	126	113	129																								
17	Aichi, Nagoya	690	690	789	464	828	410	330	923	884	782	746	298	224	211	227	134																							
18	Mie, Yokkaichi	678	701	788	463	827	423	337	890	883	781	745	297	223	210	217	130	7																						
19	Kyoto, Maizuru	527	466	347	650	308	725	778	244	220	95	51	818	867	854	857	779	731	698																					
20	Hyogo, Kobe	837	836	829	610	794	562	488	737	714	602	567	444	371	358	374	286	238	234	545																				
21	Osaka, Osaka	840	855	843	616	804	577	482	742	716	614	572	450	374	361	377	289	241	237	550	13																			
22	Wakayama, Wakayama-Shimotsu	795	806	832	580	793	526	446	738	705	603	567	414	328	317	345	250	199	202	543	41	45																		
23	Tottori, Sakaiminato	596	550	417	734	392	809	862	309	304	182	146	834	748	739	754	288	619	618	123	433	438	440																	
24	Shimane, Saigo	608	547	428	731	389	806	859	334	301	179	143	840	754	743	760	676	625	624	119	447	457	446	44																
25	Hiroshima, Kure	861	800	696	709	657	744	575	635	569	467	431	543	457	533	463	379	410	406	443	189	195	149	304	310															
26	Okayama, Mizushima	856	864	760	641	721	587	507	668	633	531	495	475	440	378	443	311	306	259	471	90	95	81	368	374	75														
27	Kagawa, Takamatsu	839	850	771	624	732	570	490	677	644	542	506	458	372	361	378	294	243	242	482	68	75	64	379	385	88	20													
28	Tokushima, Tokushima-Komatsushima	798	809	864	583	779	529	449	724	691	589	553	417	343	330	337	255	207	203	529	50	56	30	426	432	135	67	50												
29	Ehime, Yawatahama	854	793	689	740	650	686	606	595	562	460	424	574	488	477	494	410	359	358	400	244	234	223	297	303	94	151	162	209											
30	Kochi, Susaki	855	866	787	640	748	586	506	693	660	558	522	474	388	377	394	310	259	258	498	155	161	126	395	401	192	181	164	122	131										
31	Yamaguchi, Tokuyamakudamatsu	809	748	644	760	605	706	626	550	517	415	379	594	534	497	514	450	398	378	355	209	211	200	252	258	64	128	139	186	69	167									
32	Fukuoka, Moji	757	696	592	800	553	746	666	498	465	363	327	634	548	537	554	470	419	418	303	241	251	240	200	206	104	168	179	226	97	195	52								
33	Saga, Karatsu	789	728	624	874	585	820	753	535	497	395	352	708	639	623	628	544	503	499	335	317	322	314	231	238	215	242	254	300	171	269	126	74							
34	Oita, Oita	831	772	668	751	629	697	617	574	541	439	403	585	499	488	576	485	370	433	379	217	224	213	276	282	80	140	152	199	44	142	48	76	150						
35	Kumamoto, Nagasu	900	839	735	951	696	897	817	641	608	506	470	785	699	688	705	621	570	569	446	426	436	425	343	349	289	353	364	411	282	349	237	185	128	261					
36	Nagasaki, Shimabara	904	843	739	947	700	893	813	645	612	510	474	781	695	684	701	617	566	565	450	430	440	429	347	353	293	357	368	415	286	345	241	189	132	265	9				
37	Miyazaki, Miyazaki	928	867	763	754	724	700	620	669	636	534	498	588	502	491	508	424	373	369	474	271	277	242	371	377	168	225	236	238	109	145	143	171	245	118	222	218			
38	Kagoshima, Kagoshima	1005	944	840	855	801	801	721	746	713	611	575	689	603	597	609	525	474	473	551	380	1134	350	448	454	320	347	358	342	231	253	265	290	233	238	165	161	126		
39	Okinawa, Naha	1284	1223	1098	1138	1080	1093	1004	996	992	890	854	972	892	879	895	797	757	744	814	657	661	633	704	733	573	630	641	624	514	536	548	569	500	523	444	440	409	366	

4.2. Suitable Limited Conditions for Short Sea Shipping in Domestic Japan

As built 741 combinations among 39 represented ports of prefectures, we should set appropriate limitation of these data for censored regression model. Basing on the practical circumstances and suitable for introducing new short sea shipping route in East Asia, two aspects as principal consideration are utilizing in this study.

Firstly, the existed RORO shipping route between Japan and China is Shanghai – Hakata, and the services distance on this route is 540 miles as shown in Fig. 11. Thus, we approximately set limitation on 500 miles as minimum value of distance for censored regression model in East Asia.

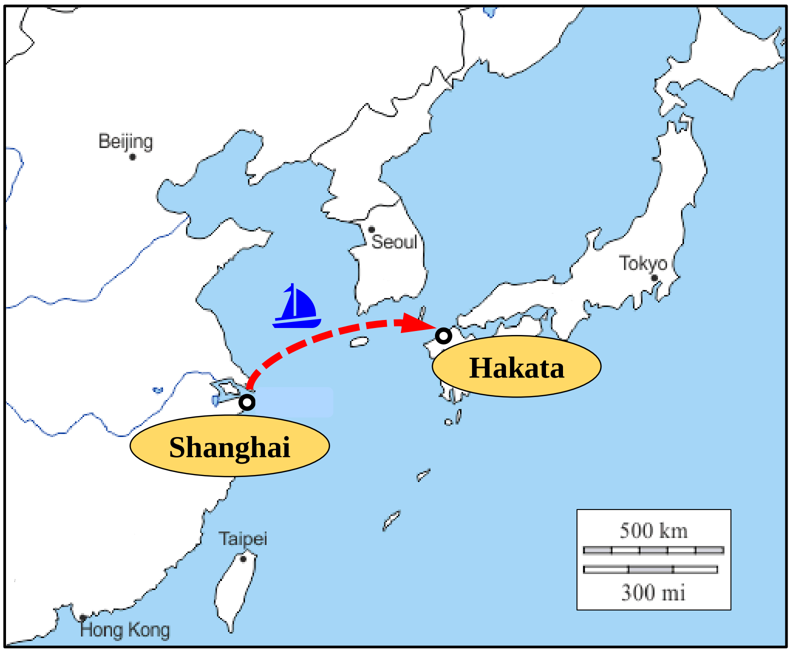


Fig. 11 RORO Shipping on Shanghai-Hakata route

Basing on the chosen minimum distance limitation, the combinations those below 500 miles on distance aspect is meaningless for RORO shipping in East Asia. Therefore, this study ignores the meaningless combinations and analyses left 344 combinations for censored regression model.

What's more, this study collects the information of ship size those ships serviced on domestic Japanese routes. According the normal distribution and standard deviation of ship size values shown in Fig. 12, 104 ship size values are above 70% within the over 5,000 tons ship size range. Therefore, we set the ship size limitation on 5,000 tons which matches to RORO shipping in East Asia for censored regression model. Hence, this study assigns the automobile value been zero on the below 5,000 tons ship size combinations (from NO. 186) as shown in Table 13.

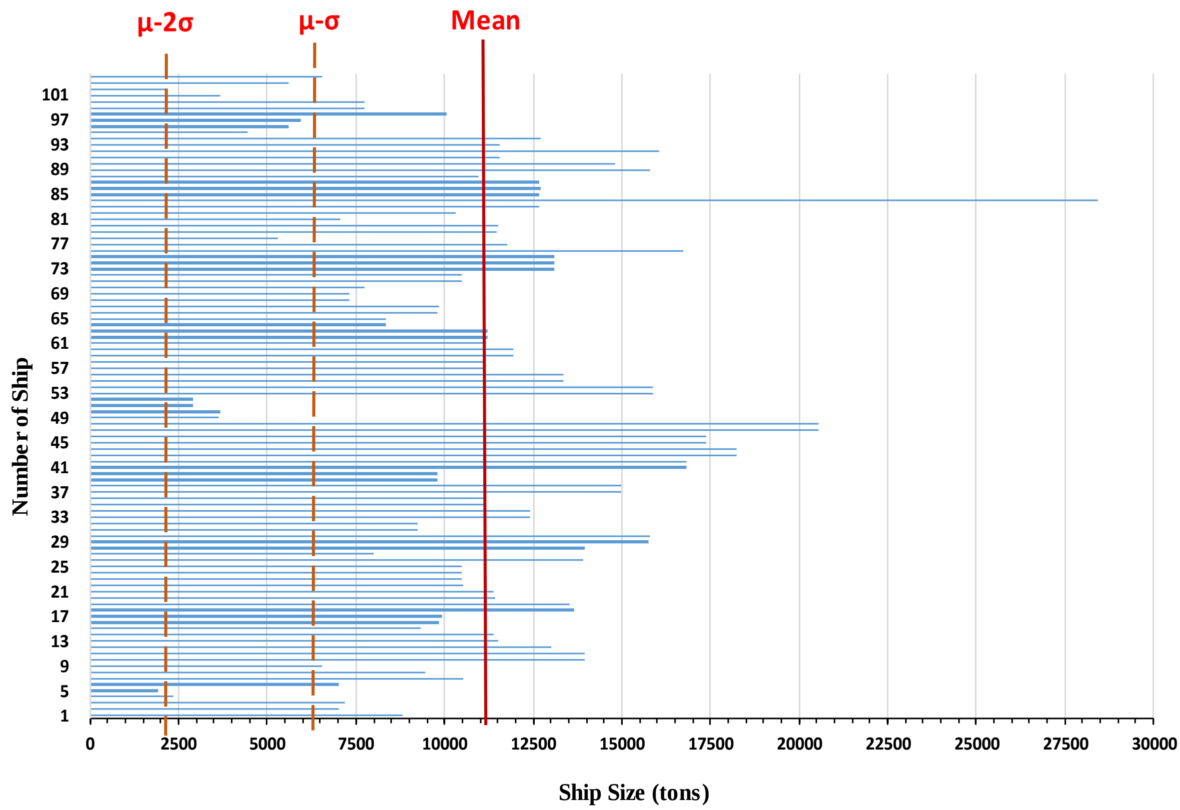


Fig. 12 Ship size of domestic Japan services ship by normal distribution
Source: Domestic Japanese ferry operators, (2018).

Table 13 Information of domestic Japanese routes combinations

NO	Automobile (F/T, 2016)	Average Car Carrying Ship Size (ton, 2016)	Population (thousand No., 2016)	GDP (billion yen, 2014)	Tourist (No., 2017)	Distance (mile, 2018)
1	15,054,830	32,883	3,915	15,071	786,820	508
2	8,327,825	32,285	2,106	7,102	600,040	763
3	44,836,490	32,202	9,843	41,393	3,091,430	843
4	20,828,670	30,271	3,687	14,742	811,410	800
5	50,610,330	29,590	9,615	41,064	3,116,020	572
6	17,352,765	29,340	5,510	21,666	2,028,500	818
7	47,134,425	28,659	11,438	47,988	4,333,110	550
8	11,739,155	26,092	14,634	98,361	5,442,470	662
9	31,501,415	25,021	6,530	23,247	1,466,620	829
10	48,189,165	24,845	6,114	21,571	1,717,980	592
11	18,165,685	24,462	4,001	15,255	821,460	588
12	8,038,805	23,936	1,760	6,471	474,100	864
13	4,138,835	23,819	7,246	23,504	2,440,330	668
14	4,138,835	23,819	10,155	33,781	1,992,350	651
15	17,512,995	23,480	14,406	98,032	5,467,060	875
16	5,726,940	22,965	1,964	7,038	760,570	832
17	102,284,705	22,948	6,134	21,615	3,938,240	509
18	14,037,090	22,549	16,229	104,956	6,684,150	867
19	17,393,175	22,423	3,112	12,026	1,051,130	707
20	37,275,255	22,409	6,302	22,918	1,491,210	567
21	98,808,800	22,017	7,957	28,539	5,155,330	527
22	8,291,550	21,952	8,517	39,449	1,873,080	789
23	65,233,585	21,853	2,647	8,789	959,170	840
24	3,484,390	21,811	4,698	18,902	2,216,890	701
25	24,484,525	21,785	2,170	7,602	826,930	668

NO	Automobile (F/T, 2016)	Average Car Carrying Ship Size (ton, 2016)	Population (thousand No., 2016)	GDP (billion yen, 2014)	Tourist (No., 2017)	Distance (mile, 2018)
26	13,917,270	21,492	4,935	18,950	2,268,220	725
27	33,799,350	21,478	8,125	29,842	2,708,300	545
28	3,049,705	21,352	1,731	5,809	521,450	787
29	13,812,645	21,324	1,532	6,142	498,690	553
30	6,939,815	21,264	2,449	7,510	2,324,100	1098
31	3,368,590	21,211	1,838	6,196	543,560	624
32	9,912,675	21,207	7,018	23,175	2,464,920	881
33	9,912,675	21,207	9,927	33,452	2,016,940	876
34	3,699,750	21,203	2,818	11,115	1,002,580	788
35	32,549,760	21,163	1,982	7,131	599,820	771
36	17,869,320	20,993	2,377	7,769	925,580	739
37	12,846,995	20,953	2,784	9,059	897,550	735
38	13,614,110	20,944	2,925	10,702	758,970	760
39	39,158,165	20,928	2,385	8,215	630,160	689
40	7,550,110	20,885	2,404	9,428	638,760	644
41	29,505,845	20,600	3,847	14,697	1,110,930	696
42	26,404,580	20,399	5,191	20,311	1,498,220	607
43	10,336,740	20,393	3,355	13,066	1,715,780	529
44	11,500,780	20,353	1,736	6,709	785,160	567
45	6,436,770	20,276	8,841	30,099	3,682,010	857
46	6,436,770	20,276	11,750	40,376	3,234,030	854
47	19,677,575	19,801	3,382	12,342	1,311,440	669
48	56,186,240	19,718	11,119	46,633	3,802,830	742
49	8,024,875	19,422	3,559	13,633	2,002,250	543
50	14,065,390	19,340	8,289	39,120	1,897,670	746
51	71,007,425	19,241	2,419	8,460	983,760	575
52	9,258,230	19,199	4,470	18,573	2,241,480	801
53	8,823,545	18,740	1,503	5,480	546,040	522
54	12,713,655	18,652	2,221	7,181	2,348,690	854
55	9,473,590	18,591	2,590	10,786	1,027,170	745
56	38,323,600	18,551	1,754	6,802	624,410	506
57	10,589,485	18,409	10,112	46,044	3,114,760	731
58	67,531,520	18,310	4,242	15,384	2,200,850	551
59	5,782,325	18,268	6,293	25,497	3,458,570	779
60	9,237,750	17,721	4,044	14,105	3,565,780	814
61	14,850,010	17,671	14,720	98,545	5,477,110	502
62	5,997,685	17,660	4,413	17,710	2,244,260	698
63	99,621,720	17,139	6,448	22,128	3,948,290	928
64	136,130,385	17,056	14,185	56,419	6,439,680	840
65	58,027,025	17,022	8,009	29,724	1,939,400	634
66	41,026,775	16,817	2,389	8,071	754,270	867
67	77,535,440	16,734	10,126	42,362	3,245,660	855
68	14,730,190	16,614	3,426	12,539	1,061,180	700
69	51,238,855	16,531	11,163	46,830	3,552,570	577
70	7,249,690	15,398	7,332	23,688	2,474,970	508
71	12,565,955	14,875	3,475	13,391	790,120	834
72	75,071,445	14,030	4,542	16,942	1,180,590	689
73	34,322,385	13,962	4,065	15,755	1,048,350	585
74	14,552,715	13,716	3,595	13,994	771,950	840
75	23,088,905	13,608	15,910	103,601	6,153,870	773
76	16,777,675	13,441	4,344	15,663	2,545,520	972
77	13,206,450	13,388	3,733	14,349	764,980	708
78	104,853,105	13,349	10,470	43,264	3,485,200	1134
79	27,707,180	13,170	4,272	15,922	1,147,000	781
80	22,684,855	13,130	4,679	17,212	1,118,970	785
81	48,996,025	13,105	4,280	16,368	851,580	574
82	17,387,970	13,062	4,299	17,581	860,180	594
83	39,343,705	12,777	5,742	22,850	1,332,350	543

NO	Automobile (F/T, 2016)	Average Car Carrying Ship Size (ton, 2016)	Population (thousand No., 2016)	GDP (billion yen, 2014)	Tourist (No., 2017)	Distance (mile, 2018)
84	46,559,335	12,760	10,272	41,985	4,850,130	661
85	22,969,085	12,551	4,616	17,595	1,737,940	514
86	42,851,165	12,537	7,806	28,487	2,178,020	737
87	19,388,555	11,452	3,036	11,711	1,185,500	724
88	15,488,585	11,335	8,522	28,744	3,151,730	767
89	15,488,585	11,335	11,431	39,021	2,703,750	760
90	103,033,050	10,946	18,976	113,387	8,790,720	552
91	44,438,105	10,624	14,917	99,330	5,596,700	575
92	17,076,690	10,481	3,240	12,278	1,471,970	738
93	54,711,350	10,231	18,728	113,014	6,595,050	548
94	122,795,310	9,875	10,872	38,273	4,814,870	837
95	139,483,060	9,699	10,456	36,597	5,066,230	757
96	64,200,365	9,553	6,813	24,216	1,620,850	836
97	19,641,300	9,468	9,793	44,689	2,584,480	923
98	80,888,115	9,377	6,397	22,540	1,872,210	696
99	76,583,335	9,369	3,923	14,029	1,670,570	746
100	37,903,780	9,350	7,850	28,684	1,927,760	562
101	14,834,140	9,327	5,974	24,142	2,928,290	803
102	35,834,275	9,301	3,446	12,842	1,538,330	574
103	54,591,530	9,174	7,434	27,008	2,179,120	746
104	14,399,455	8,868	3,007	11,049	1,232,850	693
105	99,332,700	8,790	6,102	21,497	3,822,350	798
106	18,289,565	8,780	3,725	12,750	3,035,500	996
107	14,718,340	8,727	3,114	11,436	1,254,960	535
108	15,049,500	8,719	4,094	16,355	1,713,980	890
109	43,899,510	8,679	3,258	12,371	1,311,220	677
110	95,432,730	8,673	11,588	38,530	5,788,580	565
111	95,432,730	8,673	14,497	48,807	5,340,600	541
112	29,219,070	8,509	3,653	13,009	1,636,980	645
113	24,196,745	8,469	4,060	14,299	1,608,950	641
114	40,737,755	8,468	2,043	7,440	628,330	809
115	24,963,860	8,460	4,201	15,942	1,470,370	668
116	50,507,915	8,444	3,661	13,455	1,341,560	595
117	18,899,860	8,401	3,680	14,668	1,350,160	550
118	36,837,785	8,351	7,529	24,473	2,594,560	569
119	36,837,785	8,351	10,438	34,750	2,146,580	552
120	14,441,170	8,265	3,080	11,908	935,240	529
121	40,855,595	8,116	5,123	19,937	1,822,330	635
122	9,250,280	8,084	14,194	96,681	5,445,770	748
123	47,111,030	7,958	11,340	38,157	3,592,910	554
124	47,111,030	7,958	14,249	48,434	3,144,930	537
125	97,020,835	7,819	6,306	22,064	4,108,820	795
126	94,021,990	7,552	5,922	20,264	3,916,950	596
127	38,425,890	7,497	2,247	8,007	914,800	806
128	12,129,305	7,294	3,284	12,475	1,221,710	526
129	71,755,770	7,239	15,261	100,232	5,836,240	603
130	35,427,045	7,230	1,863	6,207	722,930	550
131	9,130,460	7,027	2,900	10,675	1,029,840	809
132	11,237,040	6,925	14,314	97,284	5,427,600	754
133	99,585,445	6,806	12,859	54,475	5,221,330	690
134	156,527,480	6,707	6,989	23,815	4,307,420	1005
135	94,778,285	6,665	9,040	33,928	5,565,140	592
136	13,462,000	6,650	15,063	98,953	7,201,170	892
137	115,778,420	6,639	6,512	22,628	4,175,180	831
138	9,890,775	6,597	14,452	97,639	5,420,630	639
139	40,990,500	6,484	8,800	40,418	2,027,310	690
140	96,008,750	6,393	6,042	20,867	3,898,780	608
141	97,932,535	6,385	2,930	9,758	1,113,400	944

NO	Automobile (F/T, 2016)	Average Car Carrying Ship Size (ton, 2016)	Population (thousand No., 2016)	GDP (billion yen, 2014)	Tourist (No., 2017)	Distance (mile, 2018)
142	24,391,505	6,379	14,991	99,212	5,802,650	695
143	36,183,340	6,343	4,981	19,871	2,371,120	607
144	19,369,180	6,339	15,398	100,502	5,774,620	699
145	57,183,475	6,317	2,453	8,571	981,160	772
146	14,072,295	6,271	15,018	100,871	5,515,830	534
147	94,343,600	6,206	6,073	20,835	3,869,700	855
148	71,635,950	6,182	3,967	14,226	1,420,310	801
149	98,233,710	6,118	6,791	22,536	5,672,350	1284
150	30,886,890	6,114	3,490	13,039	1,288,070	697
151	37,413,805	6,071	1,983	6,810	704,760	547
152	94,662,485	6,065	6,180	21,222	3,891,810	789
153	94,993,645	6,057	7,160	26,141	4,350,830	678
154	123,843,655	6,017	6,324	22,157	3,948,070	839
155	35,748,655	5,884	2,014	6,778	675,680	866
156	11,117,220	5,868	3,020	11,278	1,011,670	806
157	109,163,215	5,847	6,719	22,795	4,273,830	904
158	1,649,960	5,811	6,806	21,824	2,443,630	754
159	1,649,960	5,811	9,715	32,101	1,995,650	739
160	104,140,890	5,807	7,126	24,085	4,245,800	900
161	104,908,005	5,798	7,267	25,728	4,107,220	856
162	39,638,765	5,796	2,732	8,479	2,478,330	1223
163	130,452,060	5,782	6,727	23,241	3,978,410	854
164	36,067,540	5,743	2,121	7,165	697,790	728
165	98,844,005	5,739	6,746	24,454	3,987,010	809
166	36,398,700	5,735	3,101	12,084	1,156,810	701
167	65,248,710	5,695	2,265	8,100	754,050	850
168	9,452,070	5,681	3,051	11,246	982,590	586
169	13,342,180	5,593	3,769	12,947	2,785,240	1093
170	33,224,260	5,579	6,959	23,839	3,225,320	657
171	9,770,955	5,540	3,158	11,633	1,004,700	820
172	50,568,270	5,525	2,660	8,738	1,079,810	843
173	38,952,125	5,492	3,302	12,568	1,060,960	570
174	45,545,945	5,485	3,067	10,028	1,051,780	839
175	46,313,060	5,476	3,208	11,671	913,200	864
176	71,857,115	5,460	2,668	9,184	784,390	793
177	120,799,740	5,454	8,189	29,723	4,459,180	861
178	40,249,060	5,417	2,687	10,397	792,990	748
179	49,912,010	5,403	6,543	22,163	3,476,680	569
180	24,271,685	5,322	3,697	13,206	1,386,720	893
181	19,249,360	5,282	4,104	14,496	1,358,690	897
182	20,016,475	5,273	4,245	16,139	1,220,110	587
183	45,560,530	5,257	3,705	13,652	1,091,300	686
184	13,952,475	5,214	3,724	14,865	1,099,900	706
185	62,204,795	5,132	4,130	15,666	1,265,160	800
186	0	4,966	7,873	25,375	2,834,100	609
187	0	4,966	10,782	35,652	2,386,120	597
188	0	4,929	5,167	20,134	1,572,070	744
189	0	4,898	7,396	24,188	2,701,860	576
190	0	4,652	6,926	22,427	2,425,460	760
191	0	4,652	9,835	32,704	1,977,480	743
192	0	4,494	2,189	7,063	2,232,800	624
193	0	4,377	7,675	24,096	4,199,030	895
194	0	4,377	10,584	34,373	3,751,050	879
195	0	4,324	7,064	22,782	2,418,490	628
196	0	4,324	9,973	33,059	1,970,510	623
197	0	4,106	7,603	24,355	2,800,510	701
198	0	4,106	10,512	34,632	2,352,530	684
199	0	4,066	8,010	25,645	2,772,480	705

NO	Automobile (F/T, 2016)	Average Car Carrying Ship Size (ton, 2016)	Population (thousand No., 2016)	GDP (billion yen, 2014)	Tourist (No., 2017)	Distance (mile, 2018)
200	0	4,066	10,919	35,922	2,324,500	688
201	0	3,998	7,630	26,014	2,513,690	514
202	0	3,944	8,077	37,769	1,876,380	619
203	0	3,713	11,982	41,560	2,537,880	533
204	0	3,523	2,393	7,630	2,519,270	633
205	0	3,256	2,009	5,830	2,327,400	704
206	0	3,195	2,378	9,435	1,005,880	618
207	0	2,958	5,325	20,773	2,610,660	525
208	0	2,785	8,197	38,372	1,858,210	625
209	0	2,644	4,378	17,825	2,202,020	676
210	0	2,510	8,946	40,041	3,631,780	757
211	0	2,457	8,335	38,727	1,851,240	503
212	0	2,369	5,127	19,494	3,975,590	797
213	0	2,343	2,599	8,194	2,585,630	523
214	0	2,316	4,516	18,180	2,195,050	544
215	0	2,239	8,874	40,300	2,233,260	566
216	0	2,199	9,281	41,590	2,205,230	570
217	0	2,098	5,055	19,753	2,577,070	617
218	0	2,097	2,129	6,433	2,309,230	733
219	0	2,058	5,462	21,043	2,549,040	621
220	0	2,036	2,498	10,038	987,710	624
221	0	1,910	2,160	6,401	2,280,150	536
222	0	1,769	2,267	6,788	2,302,260	500
223	0	1,761	3,247	11,707	2,761,280	744
224	0	1,721	2,411	7,723	2,358,520	641
225	0	1,502	3,354	11,294	2,517,670	630
226	0	1,490	3,175	11,966	1,362,760	565
227	0	1,486	2,814	8,807	2,388,860	514
228	0	1,450	3,582	13,256	1,334,730	569
229	0	1,443	2,833	10,020	2,397,460	548
230	0	1,158	4,276	15,289	2,869,630	573
231	0	0	2,707	8,698	2,553,390	1138
232	0	0	2,552	7,806	2,538,520	1080
233	0	0	3,340	11,451	2,999,880	1004
234	0	0	2,500	8,504	2,361,980	992
235	0	0	3,042	10,247	1,126,840	951
236	0	0	2,635	8,957	1,154,870	947
237	0	0	4,749	19,896	2,254,770	901
238	0	0	14,775	99,490	5,884,080	897
239	0	0	7,387	24,633	2,881,940	892
240	0	0	2,590	8,639	2,765,710	890
241	0	0	8,568	40,443	1,910,960	884
242	0	0	10,296	34,910	2,433,960	884
243	0	0	2,869	12,109	1,040,460	883
244	0	0	2,096	7,384	772,850	874
245	0	0	7,297	24,498	2,478,210	874
246	0	0	14,685	99,355	5,480,350	871
247	0	0	2,471	9,179	1,244,480	862
248	0	0	2,591	9,782	1,226,310	859
249	0	0	10,206	34,775	2,030,230	858
250	0	0	2,905	9,977	1,188,460	855
251	0	0	4,839	20,031	2,658,500	833
252	0	0	8,620	39,745	2,087,500	828
253	0	0	2,921	11,411	1,217,000	827
254	0	0	3,675	13,000	1,573,330	817
255	0	0	3,268	11,710	1,601,360	813
256	0	0	9,946	41,689	3,305,850	804
257	0	0	2,750	9,085	1,173,590	801

NO	Automobile (F/T, 2016)	Average Car Carrying Ship Size (ton, 2016)	Population (thousand No., 2016)	GDP (billion yen, 2014)	Tourist (No., 2017)	Distance (mile, 2018)
258	0	0	6,372	22,759	1,947,270	800
259	0	0	6,633	23,543	1,681,040	794
260	0	0	2,067	7,334	974,990	793
261	0	0	8,658	40,578	2,314,690	782
262	0	0	2,959	12,244	1,444,190	781
263	0	0	1,863	6,767	688,520	779
264	0	0	4,506	17,454	2,482,860	778
265	0	0	2,662	10,616	868,050	760
266	0	0	2,683	10,530	1,265,770	760
267	0	0	2,364	8,290	829,330	754
268	0	0	2,729	10,137	1,219,340	753
269	0	0	2,428	8,790	1,056,220	751
270	0	0	1,834	6,105	735,870	748
271	0	0	2,643	9,403	859,450	740
272	0	0	4,801	19,198	2,431,310	740
273	0	0	1,838	6,426	797,990	734
274	0	0	2,085	7,427	814,240	732
275	0	0	4,056	16,200	1,228,430	732
276	0	0	1,958	7,029	779,820	731
277	0	0	2,209	7,398	814,460	724
278	0	0	3,028	10,998	973,390	721
279	0	0	3,538	12,730	1,634,950	721
280	0	0	9,894	42,387	3,129,310	716
281	0	0	6,581	24,241	1,504,500	714
282	0	0	2,698	9,783	997,050	713
283	0	0	4,105	15,885	1,340,220	709
284	0	0	3,966	16,065	824,700	708
285	0	0	7,349	23,800	2,654,750	707
286	0	0	2,015	8,032	798,450	705
287	0	0	14,737	98,657	5,656,890	701
288	0	0	2,480	8,065	1,140,000	700
289	0	0	2,887	9,355	1,111,970	696
290	0	0	3,052	11,988	1,682,790	692
291	0	0	1,811	7,465	511,980	691
292	0	0	10,258	34,077	2,206,770	690
293	0	0	2,962	11,853	1,279,060	678
294	0	0	7,005	25,512	2,393,760	666
295	0	0	1,782	6,803	559,330	660
296	0	0	3,950	14,993	1,325,350	657
297	0	0	3,873	14,701	2,036,370	650
298	0	0	2,488	8,511	844,580	650
299	0	0	2,033	8,125	637,700	644
300	0	0	3,183	11,890	988,260	641
301	0	0	1,989	6,997	750,740	640
302	0	0	3,481	13,484	1,468,150	639
303	0	0	2,157	8,096	637,920	636
304	0	0	2,976	11,696	796,850	633
305	0	0	2,050	7,777	819,280	632
306	0	0	2,273	7,898	1,041,350	629
307	0	0	3,295	13,369	1,314,540	626
308	0	0	2,240	8,319	829,110	624
309	0	0	2,997	11,043	1,275,820	620
310	0	0	3,061	11,543	1,502,710	617
311	0	0	10,101	42,581	3,320,720	616
312	0	0	3,391	13,349	1,064,420	615
313	0	0	9,984	42,522	3,533,040	614
314	0	0	2,428	8,763	963,460	612
315	0	0	2,788	9,918	1,400,780	611

NO	Automobile (F/T, 2016)	Average Car Carrying Ship Size (ton, 2016)	Population (thousand No., 2016)	GDP (billion yen, 2014)	Tourist (No., 2017)	Distance (mile, 2018)
316	0	0	6,788	24,435	1,695,910	610
317	0	0	2,835	10,053	935,430	608
318	0	0	3,276	12,156	1,305,940	606
319	0	0	2,507	9,724	853,180	605
320	0	0	2,105	8,167	1,202,180	603
321	0	0	6,671	24,376	1,908,230	602
322	0	0	1,901	7,600	915,710	589
323	0	0	1,941	6,492	757,980	585
324	0	0	2,018	7,659	703,390	583
325	0	0	2,222	8,226	989,860	580
326	0	0	4,738	18,638	1,786,710	575
327	0	0	3,898	15,691	1,148,810	569
328	0	0	4,187	16,099	1,952,580	567
329	0	0	2,419	9,235	1,236,300	564
330	0	0	2,436	9,209	668,040	562
331	0	0	1,872	6,938	963,060	558
332	0	0	6,217	21,867	1,932,400	553
333	0	0	4,018	15,367	1,001,240	547
334	0	0	2,123	8,260	1,041,430	542
335	0	0	2,221	8,596	864,810	541
336	0	0	2,329	9,100	832,570	540
337	0	0	2,247	8,231	1,041,650	534
338	0	0	3,066	11,831	1,200,580	531
339	0	0	2,455	10,422	676,640	517
340	0	0	2,518	8,898	1,367,190	510
341	0	0	3,014	11,155	1,455,600	507
342	0	0	3,816	14,643	1,434,750	507
343	0	0	2,622	9,750	1,197,230	506
344	0	0	2,925	10,188	1,339,160	506

Source: Table 7 – Table 12

4.3. Censored Regression Model Estimation of Japanese Case for RORO Shipping in East Asia

Table 14 presents results of estimations obtained using the censored regression model for the data of Table 13. These estimations were done for each pair of automobile and socioeconomic variables with distance. The censored regression by chi-squared test shows sufficient significance for all results of respective independent variables. Combining with related ports' information, the results of Japanese case will be as the fundamental estimation model in East Asia.

Table 14 Result of Censored Regression in domestic Japan

Result of Population			
Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
X	4.017E+03	7.817E+02	5.13964**
constant	-1.883E+07	5.678E+06	-3.31585**
σ^2	2.511E+15	2.852E+14	8.80484**
Auxiliary statistics	At convergence	Initial (estimated by OLS)	-2(log likelihood ratio)
log likelihood	-3652.311	-3793.080	-281.53686**
Result of GDP			
Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
X	4.796E+02	133.496	3.59276**
constant	-7.950E+06	4.719E+06	-1.685
σ^2	2.661E+15	3.030E+14	8.78248**
Auxiliary statistics	At convergence	Initial (estimated by OLS)	-2(log likelihood ratio)
log likelihood	-3658.926	-3806.292	-294.73164*
Result of Tourist			
Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
X	1.353E+01	1.799E+00	7.52182**
constant	-2.462E+07	5.172E+06	-4.76079**
σ^2	2.177E+15	2.470E+14	8.81484**
Auxiliary statistics	At convergence	Initial (estimated by OLS)	-2(log likelihood ratio)
log likelihood	-3638.899	-3781.345	-284.8931**
Result of Distance			
Independent Variable	Estimated Coefficient	Standard Error	t-Statistic
X	70679.000	21943.700	3.22093**
constant	-4.684E+07	1.612E+07	-2.90553**
σ^2	2.662E+15	3.033E+14	8.77647**
Auxiliary statistics	At convergence	Initial (estimated by OLS)	-2(log likelihood ratio)
log likelihood	-3660.220	-3803.929	-287.41846*
**: 1% , *: 5% Significance cleared			

5. Combination between Japan and China for Possible Port Networks of RORO Shipping

5.1. Possible RORO Shipping Ports in China

In China, some main ports are served for domestic or overseas RORO shipping activities from east to south coast of mainland as shown in Fig. 13 (port color matches with latter section). Basing on the situation of few ports relate to overseas ports at present, possible ports are chosen to represent their province for RORO shipping in East Asia. According the port condition of each province, 7 ports (Dalian, Tianjin, Yantai, Lianyungang, Shanghai, Xiamen and Ningbo) are represent their province as possible RORO shipping ports in China.

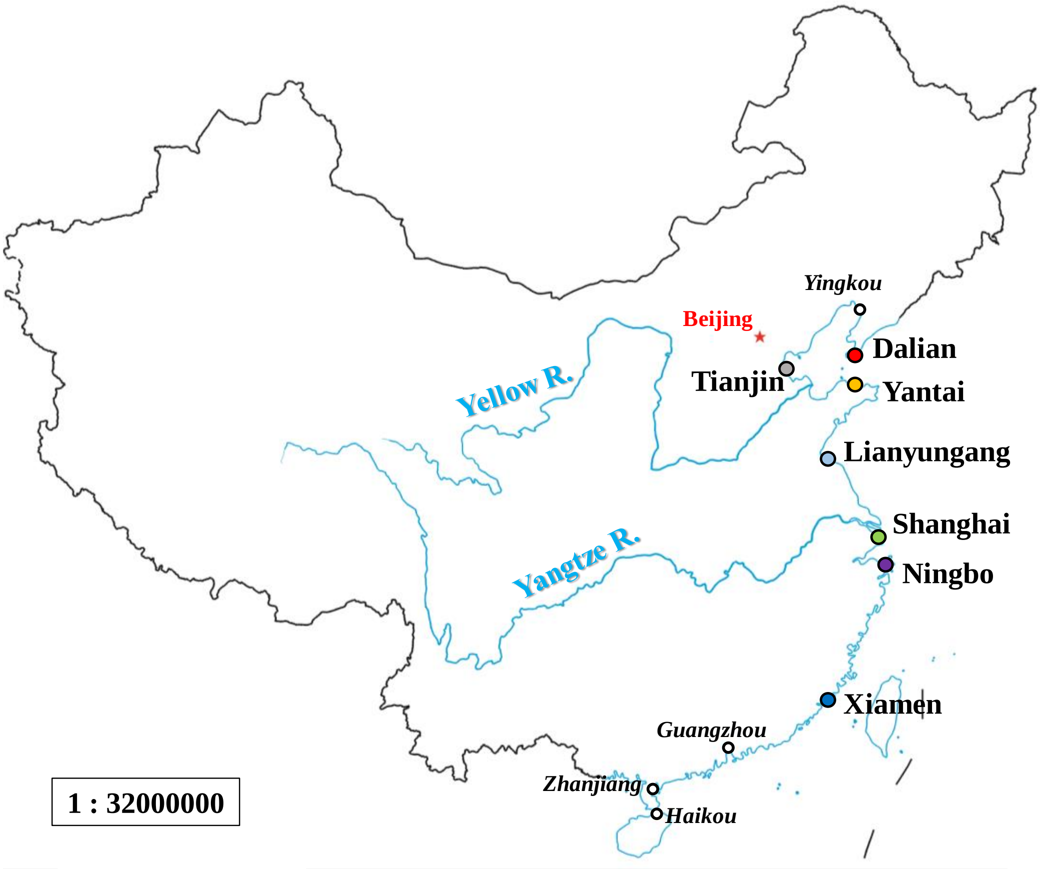


Fig. 13 RORO shipping activities in China
Source of Chinese Topographic Map: No. GS (2016) 1569.

5.2. Information Collection for Possible Ports in China

This study targets on introducing appropriate port networks in East Asia especially between Japan and China. Thus, it is necessary to find suitable one within 7 Chinese possible ports to build port networks combinations with Japanese ports. The information of Chinese possible ports socioeconomic activities is shown as Table 15.

Table 15 Information on Chinese possible ports socioeconomic activities.

NO	Port of China	Population (thousand No., 2016)	GDP (billion yuan, 2016)	Tourist (thousand No., 2016)
1	Dalian	5,956	673	77,382
2	Tianjin	10,444	1,789	183,770
3	Yantai	6,554	654	—
4	Lianyungang	5,340	241	30,110
5	Shanghai	14,500	2,818	144,160
6	Xiamen	2,206	378	67,702
7	Ningbo	5,910	869	—

Source: ref. National Bureau of Statistics of China, Shandong Statistical Yearbook, Bureau of Statistics of Lianyungang, Government of Dalian Tourism, Bureau of Statistics of Xiamen, (2016).

The information of population, GDP, tourist is gathered from public government statistics on 2016 as same as Japanese case. Because of the limitation of Chinese public governmental information, some ports' tourist information is blank in this case. Furthermore, the counting method on tourist is different by Chinese (person-time counted) and Japanese (overnight counted) government. Both counted ways are used in tourism, and person-time counted way includes all-sided situations those are also covering some percentage of tourists want to stay overnight for enjoying more during the sightseeing since the distance or time cost.

5.3. Combination of Ports between Japan and China

As shown in Japanese case (Section *4.1*), it is also necessary to build combinations between Chinese and Japanese ports for introducing RORO shipping in East Asia. According gathered information on population, GDP and tourist, port combinations of 7 Chinese ports combining with 39 Japanese ports are shown as Table 16 on population, Table 17 on GDP besides 5 available Chinese ports combining with 39 Japanese ports on tourist in Table 18. Meanwhile, in the case that nominal GDP estimates are commonly used to determine the economic performance of a whole country or region, and to make international comparisons, the different units yuan of Chinese and yen of Japanese are ignorable for trending the correlation in each combination on GDP to automobile of RORO shipping.

Table 16 Combination of Chinese and Japanese ports on population (thousand No., 2016)

Japan		China						
		1	2	3	4	5	6	7
NO	Port	Dalian	Tianjin	Yantai	Lianyungang	Shanghai	Xiamen	Ningbo
1	Hokkaido, Tomakomai	11,308	11,906	11,906	10,692	19,852	7,558	11,262
2	Aomori, Aomori	7,249	11,737	7,847	6,633	15,793	3,499	7,203
3	Akita, Akita	6,966	11,454	7,564	6,350	15,510	3,216	6,920
4	Iwate, Ofunato	7,224	11,712	7,822	6,608	15,768	3,474	7,178
5	Yamagata, Sakata	7,069	11,557	7,667	6,453	15,613	3,319	7,023
6	Miyagi, Sendai Shiogama	8,286	12,774	8,884	7,670	16,830	4,536	8,240
7	Fukushima, Onahama	7,857	12,345	8,455	7,241	16,401	4,107	7,811
8	Niigata, Niigata	8,242	12,730	8,840	7,626	16,786	4,492	8,196
9	Toyama, Fushiki-Toyama	7,017	11,505	7,615	6,401	15,561	3,267	6,971
10	Ishikawa, Kanazawa	7,107	11,595	7,705	6,491	15,651	3,357	7,061
11	Fukui, Tsuruga	6,738	11,226	7,336	6,122	15,282	2,988	6,692
12	Ibaraki, Oarai	8,861	13,349	9,459	8,245	17,405	5,111	8,815
13	Tokyo, Tokyo	19,580	24,068	20,178	18,964	28,124	15,830	19,534
14	Kanagawa, Yokohama	15,101	19,589	15,699	14,485	23,645	11,351	15,055
15	Chiba, Chiba	12,192	16,680	12,790	11,576	20,736	8,442	12,146
16	Shizuoka, Shimizu	9,644	14,132	10,242	9,028	18,188	5,894	9,598
17	Aichi, Nagoya	13,463	17,951	14,061	12,847	22,007	9,713	13,417
18	Mie, Yokkaichi	7,764	12,252	8,362	7,148	16,308	4,014	7,718
19	Kyoto, Maizuru	8,561	13,049	9,159	7,945	17,105	4,811	8,515
20	Hyogo, Kobe	11,476	15,964	12,074	10,860	20,020	7,726	11,430
21	Osaka, Osaka	14,789	19,277	15,387	14,173	23,333	11,039	14,743
22	Wakayama, Wakayama-Shimotsu	6,910	11,398	7,508	6,294	15,454	3,160	6,864
23	Tottori, Sakaiminato	6,526	11,014	7,124	5,910	15,070	2,776	6,480
24	Shimane, Saigo	6,646	11,134	7,244	6,030	15,190	2,896	6,600
25	Hiroshima, Kure	8,793	13,281	9,391	8,177	17,337	5,043	8,747
26	Okayama, Mizushima	7,871	12,359	8,469	7,255	16,415	4,121	7,825
27	Kagawa, Takamatsu	6,928	11,416	7,526	6,312	15,472	3,178	6,882
28	Tokushima, Tokushima-Komatsushima	6,706	11,194	7,304	6,090	15,250	2,956	6,660
29	Ehime, Yawatahama	7,331	11,819	7,929	6,715	15,875	3,581	7,285
30	Kochi, Susaki	6,677	11,165	7,275	6,061	15,221	2,927	6,631
31	Yamaguchi, Tokuyamakudamatsu	7,350	11,838	7,948	6,734	15,894	3,600	7,304
32	Fukuoka, Moji	11,060	15,548	11,658	10,444	19,604	7,310	11,014
33	Saga, Karatsu	6,784	11,272	7,382	6,168	15,328	3,034	6,738
34	Oita, Oita	7,116	11,604	7,714	6,500	15,660	3,366	7,070
35	Kumamoto, Nagasu	7,730	12,218	8,328	7,114	16,274	3,980	7,684
36	Nagasaki, Shimabara	7,323	11,811	7,921	6,707	15,867	3,573	7,277
37	Miyazaki, Miyazaki	7,052	11,540	7,650	6,436	15,596	3,302	7,006
38	Kagoshima, Kagoshima	7,593	12,081	8,191	6,977	16,137	3,843	7,547
39	Okinawa, Naha	7,395	11,883	7,993	6,779	15,939	3,645	7,349

Source: Table 6, Table 15.

Table 17 Combination of Chinese and Japanese ports on GDP (billion yuan, 2016; billion yen, 2014)

Japan		China						
		1	2	3	4	5	6	7
NO	Port	Dalian	Tianjin	Yantai	Lianyungang	Shanghai	Xiamen	Ningbo
1	Hokkaido, Tomakomai	19,634	19,615	19,615	19,202	21,779	19,339	19,830
2	Aomori, Aomori	5,213	6,329	5,194	4,781	7,358	4,918	5,409
3	Akita, Akita	4,040	5,156	4,021	3,608	6,185	3,745	4,236
4	Iwate, Ofunato	5,396	6,512	5,377	4,964	7,541	5,101	5,592
5	Yamagata, Sakata	4,627	5,743	4,608	4,195	6,772	4,332	4,823
6	Miyagi, Sendai Shiogama	10,155	11,271	10,136	9,723	12,300	9,860	10,351
7	Fukushima, Onahama	8,497	9,613	8,478	8,065	10,642	8,202	8,693
8	Niigata, Niigata	9,519	10,635	9,500	9,087	11,664	9,224	9,715
9	Toyama, Fushiki-Toyama	5,320	6,436	5,301	4,888	7,465	5,025	5,516
10	Ishikawa, Kanazawa	5,247	6,363	5,228	4,815	7,392	4,952	5,443
11	Fukui, Tsuruga	3,906	5,022	3,887	3,474	6,051	3,611	4,102
12	Ibaraki, Oarai	13,665	14,781	13,646	13,233	15,810	13,370	13,861
13	Tokyo, Tokyo	105,012	106,128	104,993	104,580	107,157	104,717	105,208
14	Kanagawa, Yokohama	34,592	35,708	34,573	34,160	36,737	34,297	34,788
15	Chiba, Chiba	20,892	22,008	20,873	20,460	23,037	20,597	21,088
16	Shizuoka, Shimizu	17,965	19,081	17,946	17,533	20,110	17,670	18,161
17	Aichi, Nagoya	40,232	41,348	40,213	39,800	42,377	39,937	40,428
18	Mie, Yokkaichi	8,960	10,076	8,941	8,528	11,105	8,665	9,156
19	Kyoto, Maizuru	11,018	12,134	10,999	10,586	13,163	10,723	11,214
20	Hyogo, Kobe	21,168	22,284	21,149	20,736	23,313	20,873	21,364
21	Osaka, Osaka	39,780	40,896	39,761	39,348	41,925	39,485	39,976
22	Wakayama, Wakayama-Shimotsu	4,200	5,316	4,181	3,768	6,345	3,905	4,396
23	Tottori, Sakaiminato	2,428	3,544	2,409	1,996	4,573	2,133	2,624
24	Shimane, Saigo	3,239	4,355	3,220	2,807	5,384	2,944	3,435
25	Hiroshima, Kure	12,614	13,730	12,595	12,182	14,759	12,319	12,810
26	Okayama, Mizushima	8,461	9,577	8,442	8,029	10,606	8,166	8,657
27	Kagawa, Takamatsu	4,451	5,567	4,432	4,019	6,596	4,156	4,647
28	Tokushima, Tokushima-Komatsushima	3,757	4,873	3,738	3,325	5,902	3,462	3,953
29	Ehime, Yawatahama	5,589	6,705	5,570	5,157	7,734	5,294	5,785
30	Kochi, Susaki	3,073	4,189	3,054	2,641	5,218	2,778	3,269
31	Yamaguchi, Tokuyamakudamatsu	6,543	7,659	6,524	6,111	8,688	6,248	6,739
32	Fukuoka, Moji	19,534	20,650	19,515	19,102	21,679	19,239	19,730
33	Saga, Karatsu	3,429	4,545	3,410	2,997	5,574	3,134	3,625
34	Oita, Oita	5,051	6,167	5,032	4,619	7,196	4,756	5,247
35	Kumamoto, Nagasu	6,238	7,354	6,219	5,806	8,383	5,943	6,434
36	Nagasaki, Shimabara	5,055	6,171	5,036	4,623	7,200	4,760	5,251
37	Miyazaki, Miyazaki	4,307	5,423	4,288	3,875	6,452	4,012	4,503
38	Kagoshima, Kagoshima	6,061	7,177	6,042	5,629	8,206	5,766	6,257
39	Okinawa, Naha	4,815	5,931	4,796	4,383	6,960	4,520	5,011

Source: Table 6, Table 15.

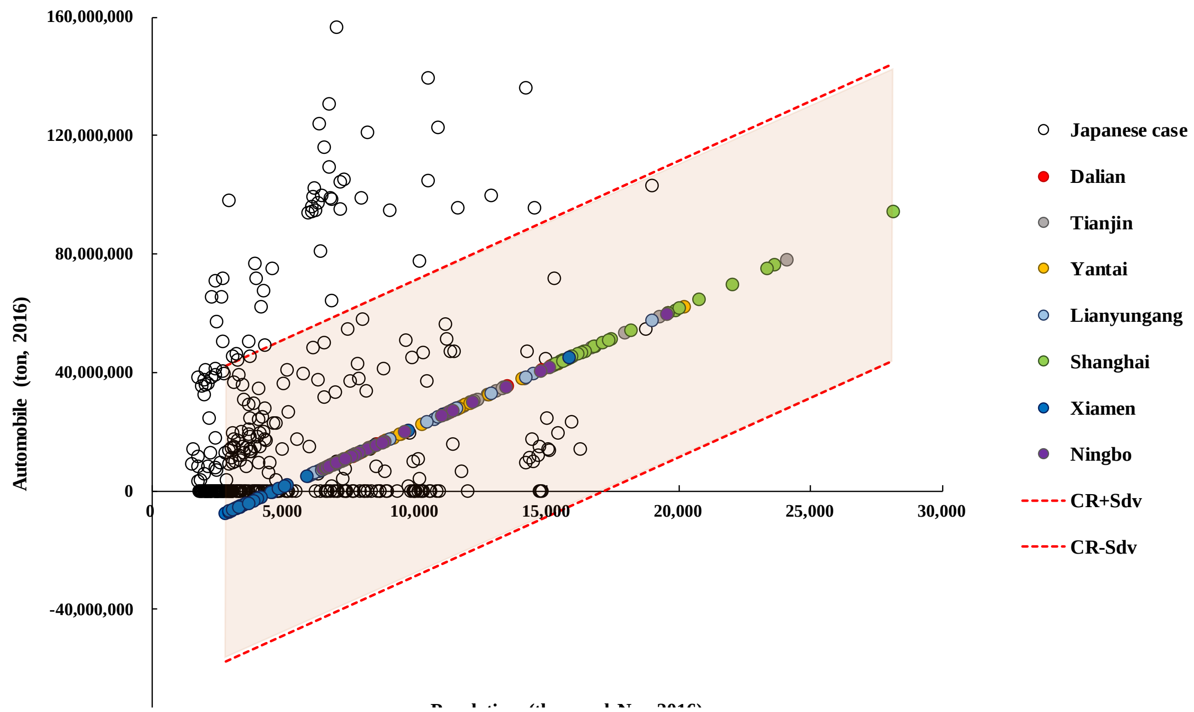
Table 18 Combination of Chinese and Japanese ports on tourist (No., 2016, 2017)

Japan		China				
		1	2	3	4	5
NO	Port	Dalian	Tianjin	Lianyungang	Shanghai	Xiamen
1	Hokkaido, Tomakomai	81,012,950	187,400,950	33,740,950	147,790,950	71,332,950
2	Aomori, Aomori	77,818,930	184,206,930	30,546,930	144,596,930	68,138,930
3	Akita, Akita	77,664,700	184,052,700	30,392,700	144,442,700	67,984,700
4	Iwate, Ofunato	77,893,990	184,281,990	30,621,990	144,671,990	68,213,990
5	Yamagata, Sakata	77,879,120	184,267,120	30,607,120	144,657,120	68,199,120
6	Miyagi, Sendai Shiogama	78,125,840	184,513,840	30,853,840	144,903,840	68,445,840
7	Fukushima, Onahama	78,340,480	184,728,480	31,068,480	145,118,480	68,660,480
8	Niigata, Niigata	78,376,100	184,764,100	31,104,100	145,154,100	68,696,100
9	Toyama, Fushiki-Toyama	77,702,580	184,090,580	30,430,580	144,480,580	68,022,580
10	Ishikawa, Kanazawa	78,106,310	184,494,310	30,834,310	144,884,310	68,426,310
11	Fukui, Tsuruga	77,689,290	184,077,290	30,417,290	144,467,290	68,009,290
12	Ibaraki, Oarai	77,886,120	184,274,120	30,614,120	144,664,120	68,206,120
13	Tokyo, Tokyo	82,541,770	188,929,770	35,269,770	149,319,770	72,861,770
14	Kanagawa, Yokohama	79,091,650	185,479,650	31,819,650	145,869,650	69,411,650
15	Chiba, Chiba	79,539,630	185,927,630	32,267,630	146,317,630	69,859,630
16	Shizuoka, Shimizu	79,316,190	185,704,190	32,044,190	146,094,190	69,636,190
17	Aichi, Nagoya	78,972,380	185,360,380	31,700,380	145,750,380	69,292,380
18	Mie, Yokkaichi	78,101,880	184,489,880	30,829,880	144,879,880	68,421,880
19	Kyoto, Maizuru	78,906,380	185,294,380	31,634,380	145,684,380	69,226,380
20	Hyogo, Kobe	78,565,920	184,953,920	31,293,920	145,343,920	68,885,920
21	Osaka, Osaka	80,190,730	186,578,730	32,918,730	146,968,730	70,510,730
22	Wakayama, Wakayama-Shimotsu	77,859,870	184,247,870	30,587,870	144,637,870	68,179,870
23	Tottori, Sakaiminato	77,668,000	184,056,000	30,396,000	144,446,000	67,988,000
24	Shimane, Saigo	77,649,830	184,037,830	30,377,830	144,427,830	67,969,830
25	Hiroshima, Kure	78,210,230	184,598,230	30,938,230	144,988,230	68,530,230
26	Okayama, Mizushima	77,858,270	184,246,270	30,586,270	144,636,270	68,178,270
27	Kagawa, Takamatsu	77,699,120	184,087,120	30,427,120	144,477,120	68,019,120
28	Tokushima, Tokushima-Komatsushima	77,573,400	183,961,400	30,301,400	144,351,400	67,893,400
29	Ehime, Yawatahama	77,729,460	184,117,460	30,457,460	144,507,460	68,049,460
30	Kochi, Susaki	77,620,750	184,008,750	30,348,750	144,398,750	67,940,750
31	Yamaguchi, Tokuyamakudamatsu	77,738,060	184,126,060	30,466,060	144,516,060	68,058,060
32	Fukuoka, Moji	78,817,280	185,205,280	31,545,280	145,595,280	69,137,280
33	Saga, Karatsu	77,642,860	184,030,860	30,370,860	144,420,860	67,962,860
34	Oita, Oita	77,926,230	184,314,230	30,654,230	144,704,230	68,246,230
35	Kumamoto, Nagasu	77,996,850	184,384,850	30,724,850	144,774,850	68,316,850
36	Nagasaki, Shimabara	78,024,880	184,412,880	30,752,880	144,802,880	68,344,880
37	Miyazaki, Miyazaki	77,699,340	184,087,340	30,427,340	144,477,340	68,019,340
38	Kagoshima, Kagoshima	78,058,470	184,446,470	30,786,470	144,836,470	68,378,470
39	Okinawa, Naha	79,423,400	185,811,400	32,151,400	146,201,400	69,743,400

Source: Table 6, Table 15.

5.4. Censored regression model estimation of Combination Ports for RORO shipping in East Asia

According the port combinations, the integrated data put into the result of Japanese model (Table 14) for selecting expedient estimated one within all combinations. The correlation with estimated amount on automobile to population, GDP and tourist are shown as Fig. 14, Fig. 15



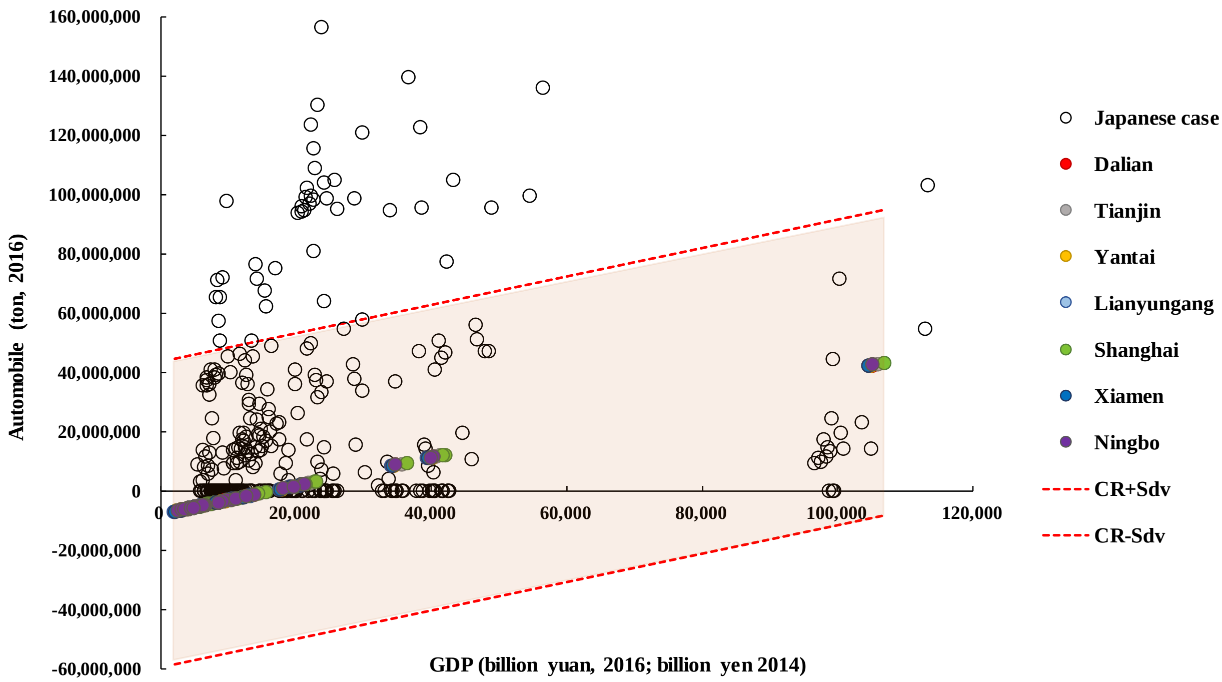


Fig. 15 Estimation automobile on combinate GDP by Japanese model result

Source: Table 6, Table 14, Table 17.

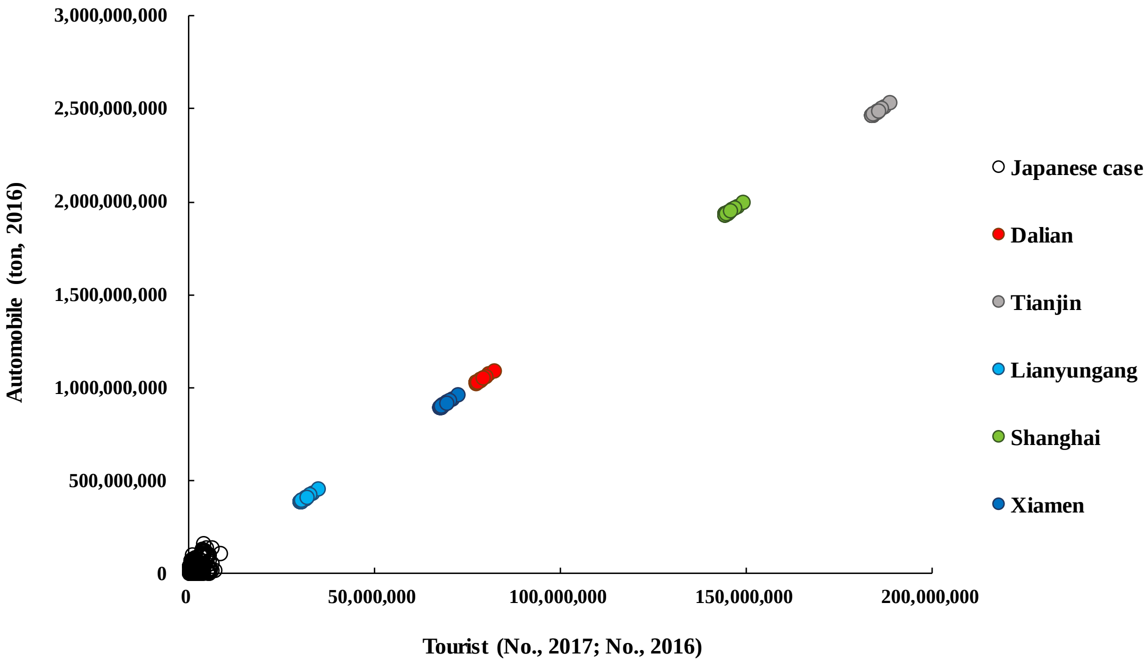


Fig. 16 Estimation automobile on combinate tourist by Japanese model result

Source: Table 6, Table 14, Table 18.

and Fig. 16. In these figures, different color represents different port as illustrated in Fig. 13, and the shadow is the potential range that 68% of samples may exist between one standard deviation (Sdv - red dashed) as estimated.

As the characteristic of combinations data show in Fig. 14 to Fig. 16, the correlation might be found on population to automobile and number of tourists to automobile. Because the performance of combinations on GDP is not like the population or tourist's data those are positive or apparently separated in groups by each port combinations, GDP will not be utilized for analyzing in this case. Basing on the unique data characteristic, tourist data will be recalculated in next section.

5.5. Recalculation on tourist data for censored regression model estimation

Since the Chinese tourist number is the total number including the overnight stay tourist number, it cannot directly apply to the censor regression models created by the Japanese data sets, which was established by the overnight stay tourist number. Therefore, it should be converted to fit the Japanese censored regression model.

There are three ways of conversion to be tested in this section as follows.

5.5.1. Estimating Chinese overnight tourists number based on exponential relationship between population and tourist

As the characteristic of tourist data in this study, we will try to find the exponential relationship between population and tourist.

Table 19 Information on population and tourist of Japanese and Chinese region

Japan	Population (thousand No., 2016)	Tourist (thousand No., 2017)	China	Population (thousand 2016)	Tourist (thousand 2016)
Hokkaido, Tomakomai	5,352	3,631	Beijing	21,730	615,190
Aomori, Aomori	1,293	437	Tianjin	15,620	183,770
Akita, Akita	1,010	283	Hebei	74,700	507,010
Iwate, Ofunato	1,268	512	Shanxi	36,820	263,740
Yamagata, Sakata	1,113	497	Inner Mongolia Autonomous Region	25,200	157,350
Miyagi, Sendai Shiogama	2,330	744	Liaoning	43,780	736,320
Fukushima, Onahama	1,901	958	Jilin	27,330	349,100
Niigata, Niigata	2,286	994	Heilongjiang	37,990	393,860
Toyama, Fushiki-Toyama	1,061	321	Shanghai	24,200	144,160
Ishikawa, Kanazawa	1,151	724	Jiangsu	79,990	1,335,800
Fukui, Tsuruga	782	307	Zhejiang	55,900	1,050,180
Ibaraki, Oarai	2,905	504	Anhui	61,960	811,060
Tokyo, Tokyo	13,624	5,160	Fujian	38,740	516,490
Kanagawa, Yokohama	9,145	1,710	Jiangxi	45,920	628,760
Chiba, Chiba	6,236	2,158	Shandong	99,470	634,630
Shizuoka, Shimizu	3,688	1,934	Henan	95,320	1,205,280
Aichi, Nagoya	7,507	1,590	Hubei	58,850	1,029,900
Mie, Yokkaichi	1,808	720	Hunan	68,220	1,217,600
Kyoto, Maizuru	2,605	1,524	Guangdong	109,990	1,303,450
Hyogo, Kobe	5,520	1,184	Guangxi Autonomous Region	48,380	486,990
Osaka, Osaka	8,833	2,809	Hainan	9,170	139,120
Wakayama, Wakayama-Shimotsu	954	478	Chongqing	30,480	612,550
Tottori, Sakaiminato	570	286	Sichuan	82,620	1,237,460
Shimane, Saigo	690	268	Guizhou	35,550	894,640
Hiroshima, Kure	2,837	828	Yunnan	47,710	465,190
Okayama, Mizushima	1,915	476	Xizang(Tibet) Autonomous Region	3,310	11,550
Kagawa, Takamatsu	972	317	Shaanxi	38,130	698,200
Tokushima, Tokushima-Komatsushima	750	191	Gansu	26,100	416,260
Ehime, Yawatahama	1,375	347	Qinghai	5,930	59,340
Kochi, Susaki	721	239	Ningxia Hui Autonomous Region	6,750	87,570
Yamaguchi, Tokuyama-Kudamatsu	1,394	356	Xinjiang Uygur Autonomous region	23,980	321,480
Fukuoka, Moji	5,104	1,435			
Saga, Karatsu	828	261			
Oita, Oita	1,160	544			
Kumamoto, Nagasu	1,774	615			
Nagasaki, Shimabara	1,367	643			
Miyazaki, Miyazaki	1,096	317			
Kagoshima, Kagoshima	1,637	676			
Okinawa, Naha	1,439	2,041			

Source: Table 6, ref. National Bureau of Statistics of China (2016).

Firstly, in general, some correlation may exist between regional population and tourist because of the economy and environment development following human being activities. The correlation between tourist and population on Chinese and Japanese case may describe as following equations:

$$\boldsymbol{Q}\text{ (JP-tourist)} = \boldsymbol{f}\text{ (JP-population)} = \boldsymbol{\alpha}\text{ (JP} - \text{population)}^{\boldsymbol{\beta}} \quad (8)$$

$$\boldsymbol{R}\text{ (CN-tourist)} = \boldsymbol{g}\text{ (CN-population)} = \boldsymbol{\delta}\text{(CN} - \text{population)}^{\boldsymbol{\gamma}} \quad (9)$$

As the information on regional population and tourist of Japanese (39 prefectures) and Chinese (31 provinces) in Table 19, the correlations are shown in Fig.17 to Fig. 19.

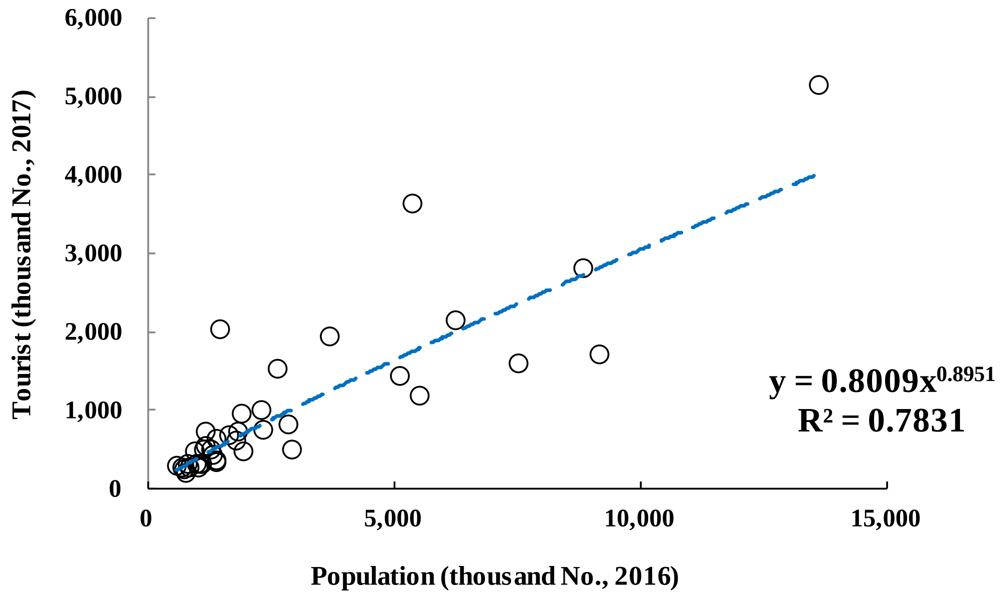


Fig. 17 Correlation between population and tourist on Japanese case

Fig. 18 Correlation between population and tourist on Chinese case

Source: Table 19.

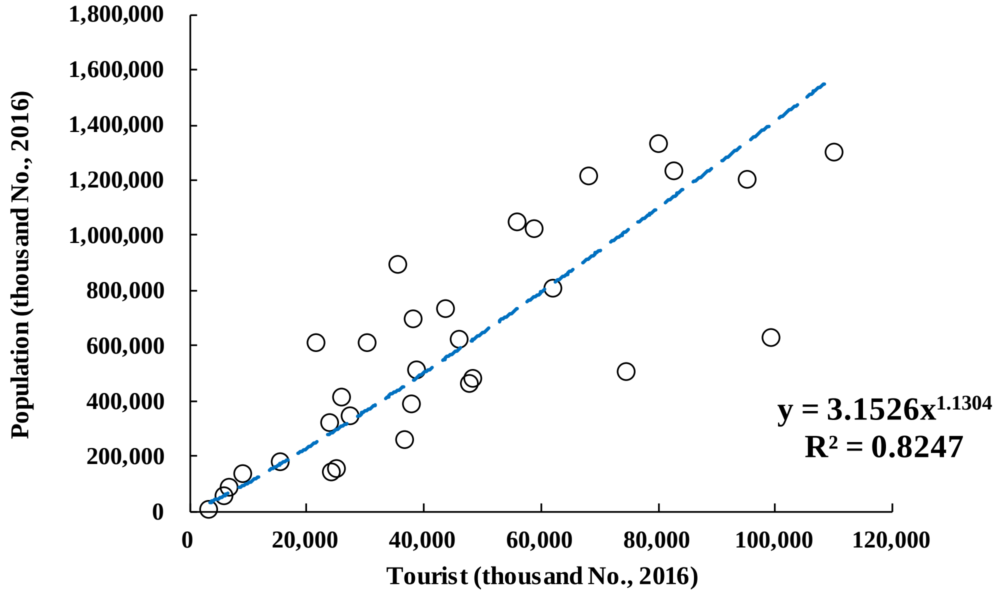


Fig. 19 Correlation between tourist and population on Chinese case

Source: Table 19.

According the equation (8) and (9) to unify the Chinese tourist to Japanese tourist counting system, the equation may exist

$$\boldsymbol{P}\text{ (CN-population)} = \boldsymbol{g}^{-1}\text{ (CN-tourist)} = \boldsymbol{\delta}'(\text{CN}-\text{tourist})^{\gamma'} \quad (10)$$

$$\boldsymbol{Q}\text{ (CN-tourist)} = \boldsymbol{\alpha}[\,\delta'(\text{CN}-\text{tourist})^{\gamma'}]^{\beta} \quad (11)$$

As the equations show in Fig. 17 to Fig. 19 on each correlation and equation (10) and (11), the presumption on Chinese tourist may as following:

$$\boldsymbol{Q}\text{ (CN-tourist)} = \boldsymbol{\alpha}[\,\delta'(\text{CN}-\text{tourist})^{\gamma'}]^{\beta}$$

$$= 0.8009[3.1526\,(\text{CN}-\text{tourist})^{1.1304}]^{0.8951} \quad (12)$$

By equation (12), we may presume Chinese tourist as shown in Table 20.

Table 20 Presumed Chinese tourist by equation

NO	Port of China	Tourist (thousand No., 2016)	Equation	Presumed Tourist (thousand No., 2016)
1	Dalian	77,382	$0.8009[3.1526\,(\text{CN}-\text{tourist})^{1.1304}]^{0.8951}$	197,863
2	Tianjin	183,770		474,723
3	Lianyungang	30,110		76,136
4	Shanghai	144,160		371,334
5	Xiamen	67,702		172,839

Source: Table 15.

As shown in Table 20, the presumed Chinese tourist data is hundred times comparing with Japanese tourist data. This performance on data is not appropriate for analyzing on combination case. Moreover, there is no demonstration exactly to support the correlation between regional population and tourist by current research. Thus, this presumption on Chinese tourist will be as a reference in this study.

5.5.2. Estimating Chinese overnight tourists number based on proportional relationship between population and tourist

An estimating parameter (***k***) is needed to help unifying two counting method. Basing on the stability and representativeness of population for countries, the correlation between domestic population with tourist may be following the formula (13) for countries.

$$\frac{a}{c} = \boldsymbol{k}\,\frac{b}{d} \qquad (13)$$

a: number of population of X country; b: number of population of Y country;
c: number of tourist of X country; d: number of tourist of Y country.

In this formula, a and b denotes different countries population, c and d denotes different countries tourist, and ***k*** represents the estimating parameter.

The information of Chinese and Japanese population and tourist on 2016 is gathering from government public statistics by unit thousand as shown in Table 21.

Table 21 Information on 2016 Chinese and Japanese population and tourist

Aspect	China	Japan
Population (thousand)	1,379,840	108,001
Tourist (thousand)	18,514,000	39,021

Source: Table 19.

According the formula (13) and the data from Table 21,

$\boldsymbol{k} = 0.0269$

Then, using the value of ***k*** calculates the value of estimation Chinese tourist (c) as shown in Table 22.

Table 22 Information on Chinese tourist by estimated

Port	(a) Chinese Population	(b) Japanese Population	(d) Japanese Tourist	(c) Chinese Tourist
Dalian	5,956	108,001	39,021	79,915
Tianjin	10,444	$c = \frac{ad}{kb}$		140,132
Lianyungang	5,340			71,649
Shanghai	14,500			194,554
Xiamen	2,206			29,599

Source: Table 19, Table 21.

As the fundamental tourist number counting system, it must follow:

T (total number) = ***T'*** (overnight number) + ***T''*** (others number)

Comparing the estimated tourist number and original, it is against the fundamental system. Thus, this estimated way will also be as a consequential reference in this study.

5.5.3. Estimating Chinese overnight tourists number based on z-score transformation

On the other way, in Fig. 16, tourist data are clearly set on different scales, and the concept of distance between the units in the data is often of considerable interest and importance for some multivariate techniques such as multidimensional scaling and cluster analysis. Standard score (**z**-score) may efficiently help to solve this problem to some extent. The formula is as following:

$$z = \frac{(x-\mu)}{\sigma} \quad (14)$$

z: standard score of a raw score x; μ: mean of the sample;
σ: standard deviation of the sample.

Following the formula (14), the **z**-score of Chinese and Japanese tourist are standardized into a common scale as illustrated in Fig. 20 and the **z**-score values of 195 Chinese and Japanese combination on tourist are shown in Table 23.

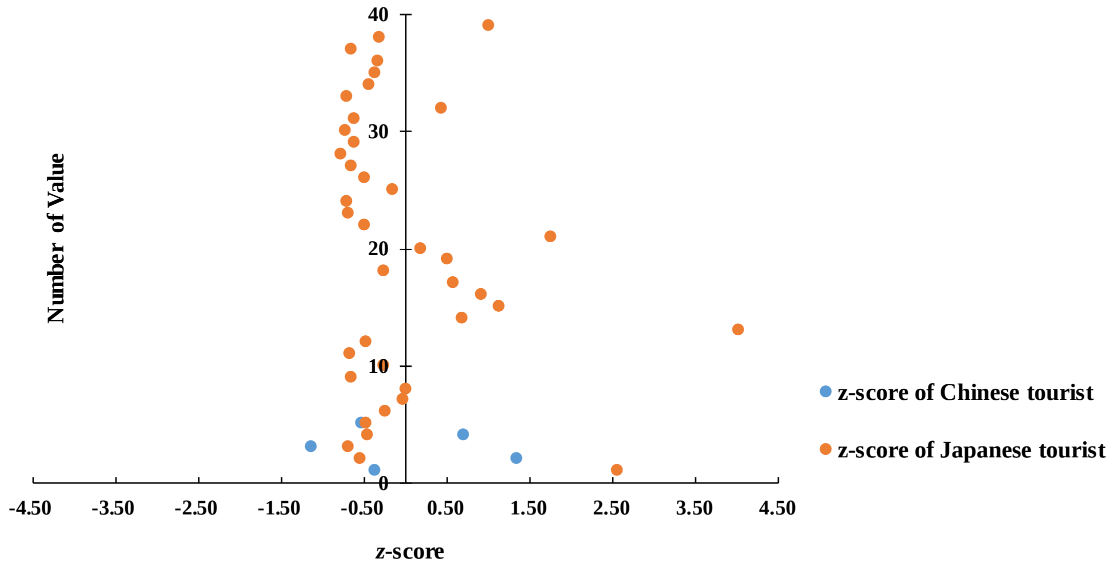


Fig. 20 *z*-score of Chinese and Japanese tourist
Source: Table 6, Table 15.

Through the information on Japanese case and formula (14), the Chinese and Japanese tourist combination value x_n may recalculated by follows:

$$x_n = z_n\sigma + \mu \quad (15)$$

z_n: standard score of Chinese and Japanese tourist combination;

$\boldsymbol{\sigma}$: standard deviation of Japanese case;
$\boldsymbol{\mu}$: mean of the Japanese case.

The renewed tourist combinations are shown as Table 24.

In this section, 5.5.1 was to test tendencies among population and tourist number; 5.5.2 was to test a scale factor based on the sum of population and tourist number; 5.5.3 was to test a statistical generality on the normal distribution.

In any case, the fundamental, which is $\boldsymbol{T}$ (total number) = $\boldsymbol{T'}$ (overnight number) + $\boldsymbol{T''}$ (others number), must be satisfied. Judging from results of testing in each sub sections, the author adopts the way of 5.5.3 to convert the Chinese tourist number to fit the Japanese censored regression models.

Table 23 ***z*****-score values of Chinese and Japanese combination on tourist**

z-score		China				
		1	2	3	4	5
NO	Japan	Dalian	Tianjin	Lianyungang	Shanghai	Xiamen
1	Hokkaido,Tomakomai	2.17	3.88	1.41	3.25	2.01
2	Aomori,Aomori	-0.92	0.79	-1.68	0.16	-1.08
3	Akita,Akita	-1.07	0.65	-1.83	0.01	-1.22
4	Iwate,Ofunato	-0.85	0.87	-1.61	0.23	-1.00
5	Yamagata, Sakata	-0.86	0.85	-1.62	0.21	-1.02
6	Miyagi,Sendai Shiogama	-0.62	1.09	-1.38	0.45	-0.78
7	Fukushima,Onahama	-0.42	1.30	-1.18	0.66	-0.57
8	Niigata,Niigata	-0.38	1.33	-1.14	0.70	-0.54
9	Toyama,Fushiki-Toyama	-1.03	0.68	-1.79	0.04	-1.19
10	Ishikawa,Kanazawa	-0.64	1.07	-1.40	0.43	-0.80
11	Fukui,Tsuruga	-1.04	0.67	-1.81	0.03	-1.20
12	Ibaraki,Oarai	-0.85	0.86	-1.62	0.22	-1.01
13	Tokyo,Tokyo	3.65	5.36	2.89	4.72	3.49
14	Kanagawa,Yokohama	0.31	2.03	-0.45	1.39	0.16
15	Chiba,Chiba	0.74	2.46	-0.02	1.82	0.59
16	Shizuoka,Shimizu	0.53	2.24	-0.23	1.60	0.37
17	Aichi,Nagoya	0.20	1.91	-0.57	1.27	0.04
18	Mie,Yokkaichi	-0.65	1.07	-1.41	0.43	-0.80
19	Kyoto,Maizuru	0.13	1.85	-0.63	1.21	-0.02
20	Hyogo,Kobe	-0.20	1.52	-0.96	0.88	-0.35
21	Osaka,Osaka	1.37	3.09	0.61	2.45	1.22
22	Wakayama,Wakayama-Shimotsu	-0.88	0.83	-1.64	0.20	-1.04
23	Tottori,Sakaiminato	-1.07	0.65	-1.83	0.01	-1.22
24	Shimane,Saigo	-1.08	0.63	-1.84	-0.01	-1.24
25	Hiroshima,Kure	-0.54	1.17	-1.30	0.53	-0.70
26	Okayama,Mizushima	-0.88	0.83	-1.64	0.19	-1.04
27	Kagawa,Takamatsu	-1.04	0.68	-1.80	0.04	-1.19
28	Tokushima,Tokushima-Komatsushima	-1.16	0.56	-1.92	-0.08	-1.31
29	Ehime,Yawatahama	-1.01	0.71	-1.77	0.07	-1.16
30	Kochi,Susaki	-1.11	0.60	-1.87	-0.04	-1.27
31	Yamaguchi,Tokuyamakudamatsu	-1.00	0.72	-1.76	0.08	-1.15
32	Fukuoka,Moji	0.05	1.76	-0.72	1.12	-0.11
33	Saga,Karatsu	-1.09	0.62	-1.85	-0.01	-1.25
34	Oita,Oita	-0.82	0.90	-1.58	0.26	-0.97
35	Kumamoto,Nagasu	-0.75	0.97	-1.51	0.33	-0.90
36	Nagasaki,Shimabara	-0.72	0.99	-1.48	0.36	-0.88
37	Miyazaki,Miyazaki	-1.04	0.68	-1.80	0.04	-1.19
38	Kagoshima,Kagoshima	-0.69	1.03	-1.45	0.39	-0.84
39	Okinawa,Naha	0.63	2.35	-0.13	1.71	0.48

Source: Fig. 20.

Table 24 Recalculated combination of Chinese and Japanese ports on tourist by **z**-score

x_n		China				
		1	2	3	4	5
NO	**Japan**	**Dalian**	**Tianjin**	**Lianyungang**	**Shanghai**	**Xiamen**
1	**Hokkaido,Tomakomai**	5,350,784	7,876,692	4,228,433	6,936,255	5,120,958
2	**Aomori,Aomori**	800,080	3,325,987	-322,271	2,385,550	570,253
3	**Akita,Akita**	580,339	3,106,246	-542,012	2,165,810	350,513
4	**Iwate,Ofunato**	907,022	3,432,929	-215,329	2,492,492	677,195
5	**Yamagata, Sakata**	885,836	3,411,743	-236,515	2,471,306	656,009
6	**Miyagi,Sendai Shiogama**	1,237,352	3,763,259	115,001	2,822,822	1,007,526
7	**Fukushima,Onahama**	1,543,162	4,069,069	420,811	3,128,632	1,313,336
8	**Niigata,Niigata**	1,593,912	4,119,819	471,561	3,179,382	1,364,085
9	**Toyama,Fushiki-Toyama**	634,309	3,160,216	-488,042	2,219,780	404,483
10	**Ishikawa,Kanazawa**	1,209,526	3,735,434	87,175	2,794,997	979,700
11	**Fukui,Tsuruga**	615,374	3,141,281	-506,977	2,200,845	385,548
12	**Ibaraki,Oarai**	895,809	3,421,716	-226,542	2,481,280	665,983
13	**Tokyo,Tokyo**	7,528,982	10,054,890	6,406,631	9,114,453	7,299,156
14	**Kanagawa,Yokohama**	2,613,397	5,139,305	1,491,046	4,198,868	2,383,571
15	**Chiba,Chiba**	3,251,660	5,777,567	2,129,309	4,837,131	3,021,834
16	**Shizuoka,Shimizu**	2,933,312	5,459,220	1,810,961	4,518,783	2,703,486
17	**Aichi,Nagoya**	2,443,466	4,969,374	1,321,115	4,028,937	2,213,640
18	**Mie,Yokkaichi**	1,203,215	3,729,122	80,864	2,788,685	973,388
19	**Kyoto,Maizuru**	2,349,432	4,875,340	1,227,081	3,934,903	2,119,606
20	**Hyogo,Kobe**	1,864,359	4,390,267	742,008	3,449,830	1,634,533
21	**Osaka,Osaka**	4,179,320	6,705,227	3,056,969	5,764,790	3,949,494
22	**Wakayama,Wakayama-Shimotsu**	858,409	3,384,316	-263,942	2,443,880	628,583
23	**Tottori,Sakaiminato**	585,041	3,110,948	-537,310	2,170,511	355,214
24	**Shimane,Saigo**	559,153	3,085,060	-563,198	2,144,624	329,327
25	**Hiroshima,Kure**	1,357,587	3,883,495	235,236	2,943,058	1,127,761
26	**Okayama,Mizushima**	856,130	3,382,037	-266,222	2,441,600	626,303
27	**Kagawa,Takamatsu**	629,379	3,155,287	-492,972	2,214,850	399,553
28	**Tokushima,Tokushima-Komatsushima**	450,259	2,976,166	-672,092	2,035,729	220,432
29	**Ehime,Yawatahama**	672,607	3,198,514	-449,745	2,258,077	442,780
30	**Kochi,Susaki**	517,721	3,043,628	-604,630	2,103,192	287,895
31	**Yamaguchi,Tokuyamakudamatsu**	684,859	3,210,767	-437,492	2,270,330	455,033
32	**Fukuoka,Moji**	2,222,486	4,748,394	1,100,135	3,807,957	1,992,660
33	**Saga,Karatsu**	549,223	3,075,130	-573,129	2,134,693	319,396
34	**Oita,Oita**	952,956	3,478,863	-169,395	2,538,427	723,130
35	**Kumamoto,Nagasu**	1,053,573	3,579,480	-68,779	2,639,043	823,746
36	**Nagasaki,Shimabara**	1,093,508	3,619,416	-28,843	2,678,979	863,682
37	**Miyazaki,Miyazaki**	629,693	3,155,600	-492,658	2,215,163	399,866
38	**Kagoshima,Kagoshima**	1,141,366	3,667,273	19,015	2,726,837	911,540
39	**Okinawa,Naha**	3,086,061	5,611,968	1,963,710	4,671,531	2,856,234

Source: Table 23.

5.6. Possible ports combinations for RORO shipping in East Asia

Basing on the recalculation of Chinese tourist number in section 5.5.3, the correlation to estimated automobile by Japanese result is shown in Fig.21. According the estimated on the amount of automobile by Japanese model result, the top 10 combinations of Chinese and Japanese on population and tourist are listed in Table 25.

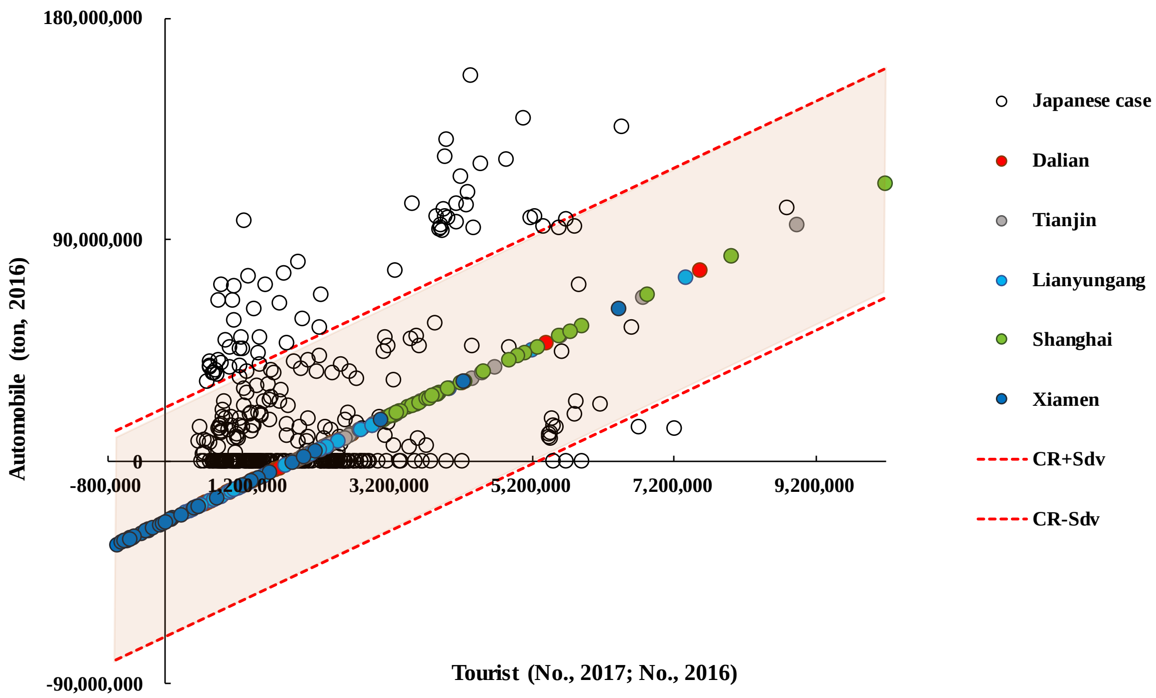


Fig. 21 Estimation automobile on combinate **z**-score tourist by Japanese model result
Source: Table 6, Table 14, Table 24.

Table 25 Top 10 combinations on population and tourist trends by estimated automobile

NO	Population	Tourist
1	Shanghai-Tokyo	Shanghai-Tokyo
2	Tianjin-Tokyo	Tianjin-Tokyo
3	Shanghai-Yokohama	Shanghai-Tomakomai
4	Shanghai-Osaka	Dalian-Tokyo
5	Shanghai-Nagoya	Lianyungang-Tokyo
6	Shanghai-Chiba	Shanghai-Osaka
7	Yantai-Tokyo	Tianjin-Tomakomai
8	Shanghai-Kobe	Xiamen-Tokyo
9	Shanghai-Tomakomai	Shanghai-Chiba
10	Shanghai-Moji	Shanghai-Naha

Source: Fig. 14, Fig. 21.

In present situation, some of the big ports which listed in the top 10 of the combinations are already serviced for container transportation for many years such as Tokyo, Yokohama, Osaka, Kobe and Nagoya, and it is not necessary to introduce RORO shipping in such a mature market.

From those big port's geographical location, the nearby prefecture's port will act as the potential RORO shipping port in such big port's region. Chiba will represent in Tokyo, Yokohama and Chiba region; Yokkaichi will represent in Nagoya and Yokkaichi region; Tokushima-Komatsushima will represent in Osaka, Kobe and Tokushima region. The potential combinations between Chinese and Japanese ports for RORO shipping are as shown in Table 26 and Table 27.

Table 26 Potential combinations between Chinese and Japanese on population

NO	Port	Tianjin	Yantai	Shanghai
1	Hokkaido,Tomakomai			O
2	Chiba,Chiba	O	O	O
3	Mie,Yokkaichi			O
4	Tokushima,Tokushima-Komatsushima			O
5	Fukuoka,Moji			O

Source: Table 23.

Table 27 Potential combinations between Chinese and Japanese on tourist

NO	Port	Dalian	Tianjin	Lianyungang	Shanghai	Xiamen
1	Hokkaido,Tomakomai		O		O	
2	Chiba,Chiba	O	O	O	O	O
3	Tokushima,Tokushima-Komatsushima				O	
4	Okinawa,Naha				O	

Source: Table 23.

6. Conclusions

By separated port networks in limited and non-limited, this study demonstrates that potential demand for freight tonnage of RORO shipping may correlated with some socioeconomic activities (population, number of tourists) in European case.

Basing on the result on European case, we build port combinations in domestic Japan for censored regression. By setting reasonable limitation on amount of automobile and distance, this study built correlation between automobile with prefectural population, GDP, number of tourist and distance. The result of Japanese case by censored regression efficiently helped us find that the RORO shipping may service among the potential ports in Japan (Tomakomai, Chiba, Yokkaichi, Tokushima, Moji and Naha) and China (Dalian, Tianjin, Yantai, Lianyungang, Shanghai and Xiamen).

By the characteristic of regional environment, local industry is depended on the advantage on geographical situation and development policy by government. For example, the Toyota Motor Corporation (TOYOTA) is one of the famous automobile makers which owns one of main factory located in prefecture Aichi. As a port city, Nagoya is actively servicing in RORO shipping because it is near to TOYOTA's factory within same prefecture. Basing on above, the development structure of local industry is significant for opening new RORO shipping service.

This paper mainly focuses on finding potential ports for RORO shipping in East Asia by the censored regression model. For further research, the estimated demand on combinations will be analyzed combined with regional industry characteristic for opening new RORO shipping market.

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