Economic Advantage/Disadvantage of Oversea Transshipment: Case of Japan-North American Container Cargo Transport Market

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Abstract: This paper aims to discuss the economic advantage/disadvantage of using oversea transshipment. We develop the aggregated Logit type shippers' route choice model using MLIT's survey data. Applying the model and then our results show that the total utility of Japanese shippers decreased from 2008 to 2013 with the decrease of direct call from Japan. Through the sensitivity analysis, we can say that reducing the oversea transshipment is useful for Japanese shippers in terms of reducing the additional cost relating to the oversea transshipment, but, on the other hand, it is very difficult to matching the utility to Port of Busan due to the high cost for improvement.

Keywords: Container Transport, Oversea Transshipment, Route Choice Model, Utility of Shippers

1. INTRODUCTION

1.1 Background and Motivation of This Research

Thirty years ago, Port of Kobe in Japan was the largest container cargo port in Asia and responsible for the gateway function of North American cargo. However, as shown in Table 1, the gateway function shifted to Port of Busan in Korea in the 2000. Busan is ranked higher than Kobe. Hence this may cause weakening the direct shipping function from Kobe.

Table 1. Container handling volume rankings

1980			2015		
	port	(TEU)		Port	(TEU)
1	New York	1,947,000	1	Shanghai	36,537,000
2	Rotterdam	1,900,707	2	Singapore	30,922,300
3	Hong Kong	1,464,961	3	Shenzhen	24,204,000
4	**Kobe**	1,456,048	4	Ningbo	20,620,000
5	Kaohsiung	979,015	5	Hong Kong	20,114,000
:			6	**Busan**	19,469,000
:			:		
16	**Busan**	634,208	:		
			:		
			59	**Kobe**	2,706,967

Source; Containerization International Yearbook (1982) and the data published by MLIT (2016)

The central government of Japan is trying to enhance the direct transport from Japan for the trunk lines by the strategy of "International Container Strategy Port" which is planned in 2010. However, as shown in Table 2, the number of sailing from Port of Kobe to North America decreased and the ratio of Port of Busan against Kobe on the North American direct route increases from 2.7 to 3.4 from 2008 to 2013.

Let us see the seaborne transport situation in detail. Table 3 shows the comparison of shipping routes. In Table 3, the share of Busan transshipment in routes of container cargo from Japan to North America decreases between 2008 and 2013. On the other hand, the direct shipping volume from Kobe increases and the direct shipping from other ports in Japan increases. From this comparison, the gateway function of Busan seems to be weakened and the service level of Kobe seems to be improved. However, what we see is just an overview related to major ports in Japan and then we need to have further studies why this transition occurs.

Table 2. Mothership frequency to North America

Year	Kobe (sailing/month)	Busan (sailing/month)	Busan/Kobe
2008	46	126	2.74
2013	34	116	3.41

Source; Ocean Commerce

Table 3. Container cargo volume from Japan to North America

route	2008		2013	
	volume (FT/month)	share	volume (FT/month)	share
Kobe direct	125,129	15.1%	130,041	13.4%
Other Japan port direct	620,179	74.6%	750,494	77.5%
Busan transshipment	70,158	8.4%	65,877	6.8%
Other Asia port transshipment	15,541	1.9%	21,526	2.2%
Total	831,007	100.0%	967,938	100.0%

Source; MLIT, Japan

Concerning the potential thread by the oversea transshipment, the government announced the comprehensive strategy named "International Container Strategy Port" in 2010. This strategy includes more positive tactics for attracting direct services of trunk line; however, unfortunately, we rarely see the arguments in the tactics done from the econometrics point of view. For policy/strategy evaluation, what we need to do is to measure the convenience/inconvenience from the economic point of view; especially from the shippers' point of view.

This paper aims to measure the convenience/inconvenience of overseas transshipment by the econometric method, and discuss the desirable direction of the port management policy of Port of Kobe.

1.2 Literature Review

The analysis of shippers' behavior has a long history. Most of the researches try to reveal the shippers' behavior by introducing the random utility theory, i.e. logit type approach.

Tiwari *et al* (2003) deal with the Chinese shippers' port choice behavior. They conclude that the distance, port congestion and fleet size are important for shippers' port choice. US export is done by Malchow and Kanafani (2004). They form four different types of multinomial logit model. They conclude that each model shows the inland distance and fleet size are still important factors, but sailing headway is also important for US shippers. Funabashi *et al* (2003) analyzed the flow of North American containerized cargo in East Asia region. They apply the disaggregated data provided by Ministry of Land, Infrastructure, and Transport of Japan/MLIT and find the fundamental characteristics of Japanese shippers and analyzed the port choice using a multinomial logit model. Tongzon (2009) studied the decision-making process on forwarders' port choice. These researches reveal the shippers' behavior in detail, but since their first aim is to reveal the shippers' behavior finely, their models include the physical factors such as distance. Of course, physical factors can be a crucial for shippers, but other factors, especially controllable factors by carriers and/or port authorities are desirable to be included when we apply the model to decision making relating to port management strategy under the port competition.

As for the port competition, many researches have been done. Veldman *et al* (2003) form the shippers' behavior model as a multinomial logit model and apply the model to evaluate the port expansion program of Rotterdam with competition among major ports between Antwerp-Hamburg range. Their model adopts the shipping cost, transit time, service frequency which are controllable by carriers. Kuroda *et al* (2005) propose the equilibrium model consisting of carriers' and shippers' behavior. Their model of shippers behavior is a deterministic user equilibrium model of which factors are sailing time, cost, and congestion due to the capacity constraint. Ishii *et al* (2013) directly deal with the competition between Port of Kobe and Port of Busan from the game theoretical point of view. Their approach is purely theoretical and then it is very simplified.

Our research aims to understand the shippers' route choice behavior reflecting the competitive situation between ports in Japan and the port in Korea. Then, we follow the Veldman's approach, but we will extend the model to the carrier-user interaction model (Takebayashi, 2013).

2. OVERVIEW OF DIRECT CARGO/TRANSSHIPMENT CARGO

Our research focuses on the transport condition relating to Port of Kobe, and then we choose the origin zones shipping to the US via Kobe. Figure 1 shows the origin zones and the locations of Kobe and Busan.

For the following analysis, we use the OD survey data by MLIT (2008). Based on the survey data, we define three types of regions in the figure: the regions in red means the regions in which the shippers prefer to use the direct services from Kobe; the region in blue means the regions in which the shippers prefer to use oversea transshipment services at Busan; in the rest of regions shippers prefer to use other services.

Table 4 shows OD flows and route shares. Table 4 suggests that the region where the share of Kobe direct route is high is Region No. 8 (Kinki-Japan Sea-side), No. 9 (Chugoku-Japan Sea-side), No. 12 (Shikoku-Pacific Ocean- side), No. 11 (Shikoku-Setouchi), No. 7 (Kinki). Region No. 8, No. 9, No. 11, No. 12 is regions where the total amount is less than 10,000 TEU/year, and No. 7 occupies a major part. On the other hand, Region No. 13 (Kyushu-North), No. 14 (Kyushu-South), No. 10 (Chugoku-Setouchi), where the usage of Busan transshipment is high. These regions seem to have some advantages of using Busan. In all regions, total cargo volume is over 10,000 TEU/year. The region where Kobe direct and Busan transshipment compete with each other is Region No. 10 (33% vs 55%) and No. 14 (35% vs 57%).

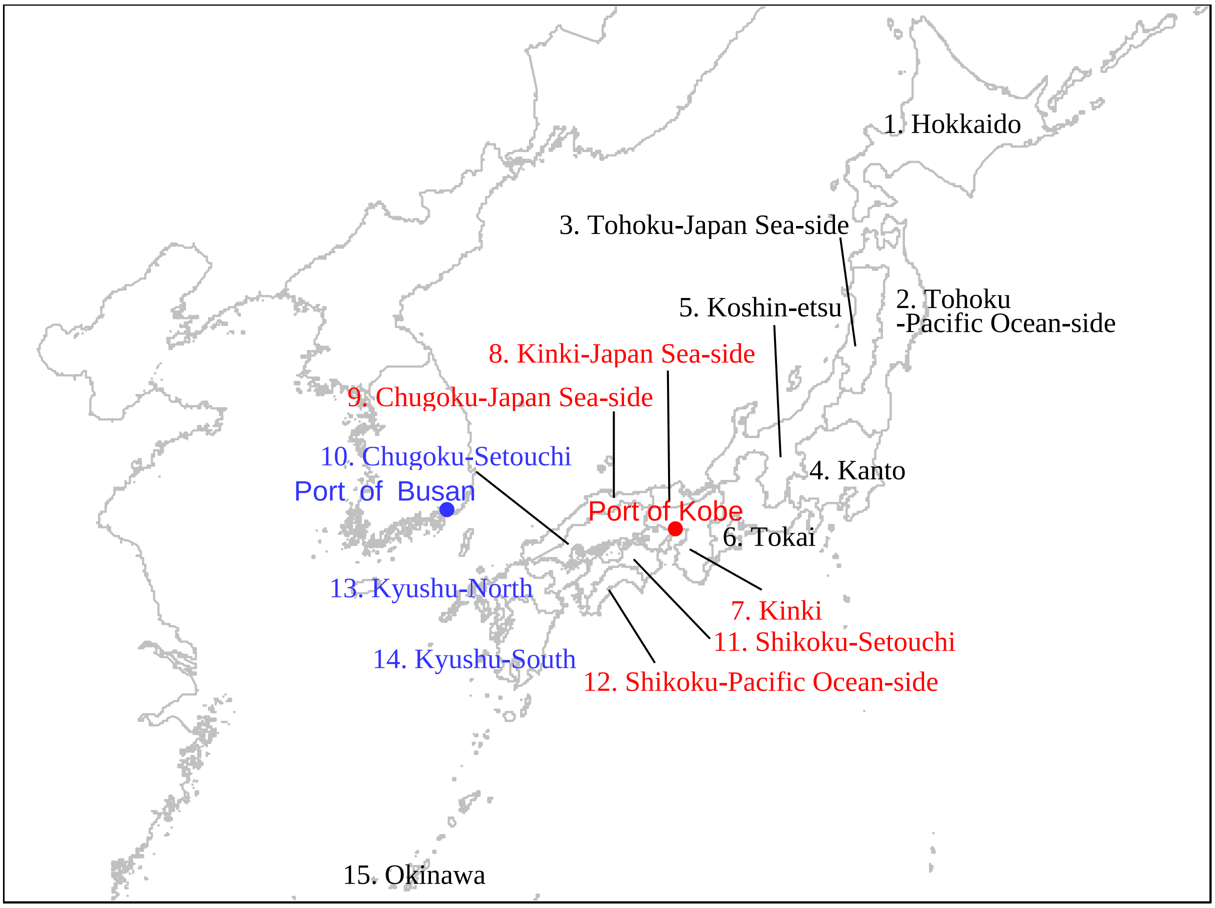

Figure 1. Regions of Japan

Table 4. Container cargo volume from Japan to North America (2008)

(unit : TEU/year)

			Total	Direct		Transshipment	
				Kobe	Other	Busan	Other
1	Hokkaido	volume	3,874	0	3,612	205	57
		regional share	100.0%	0.0%	93.2%	5.3%	1.5%
		total share	0.5%	0.0%	0.5%	0.0%	0.0%
2	Tohoku-Pacific	volume	30,885	0	29,030	1,855	0
		regional share	100.0%	0.0%	94.0%	6.0%	0.0%
		total share	4.2%	0.0%	4.0%	0.3%	0.0%
3	Tohoku-Japan Sea	volume	316	0	307	10	0
		regional share	100.0%	0.0%	96.9%	3.1%	0.0%
		total share	0.0%	0.0%	0.0%	0.0%	0.0%
4	Kanto	volume	188,494	2,798	183,843	525	1,327
		regional share	100.0%	1.5%	97.5%	0.3%	0.7%
		total share	25.8%	0.4%	25.2%	0.1%	0.2%
5	Koshinetsu	volume	11,523	63	8,928	2,427	105
		regional share	100.0%	0.5%	77.5%	21.1%	0.9%
		total share	1.6%	0.0%	1.2%	0.3%	0.0%
6	Tokai	volume	270,752	974	263,730	243	5,804
		regional share	100.0%	0.4%	97.4%	0.1%	2.1%
		total share	37.1%	0.1%	36.1%	0.0%	0.8%
7	Kinki	volume	135,937	81,612	50,594	1,737	1,994
		regional share	100.0%	60.0%	37.2%	1.3%	1.5%
		total share	18.6%	11.2%	6.9%	0.2%	0.3%
8	Kinki-Japan Sea	volume	258	258	0	0	0
		regional share	100.0%	100.0%	0.0%	0.0%	0.0%
		total share	0.0%	0.0%	0.0%	0.0%	0.0%
9	Chugoku-Japan Sea	volume	300	254	7	0	40
		regional share	100.0%	84.5%	2.3%	0.0%	13.2%
		total share	0.0%	0.0%	0.0%	0.0%	0.0%
10	Chugoku-Setouchi	volume	23,174	7,661	2,300	12,688	525
		regional share	100.0%	33.1%	9.9%	54.7%	2.3%
		total share	3.2%	1.0%	0.3%	1.7%	0.1%
11	Sikoku-Setouchi	volume	5,655	4,271	713	487	184
		regional share	100.0%	75.5%	12.6%	8.6%	3.2%
		total share	0.8%	0.6%	0.1%	0.1%	0.0%
12	Sikoku-Pacific	volume	533	432	44	57	0
		regional share	100.0%	81.1%	8.2%	10.7%	0.0%
		total share	0.1%	0.1%	0.0%	0.0%	0.0%
13	Kyushu-North	volume	26,983	1,074	1,910	23,349	650
		regional share	100.0%	4.0%	7.1%	86.5%	2.4%
		total share	3.7%	0.1%	0.3%	3.2%	0.1%
14	Kyushu-South	volume	31,461	11,103	1,963	18,044	351
		regional share	100.0%	35.3%	6.2%	57.4%	1.1%
		total share	4.3%	1.5%	0.3%	2.5%	0.0%
15	Okinawa	volume	18	0	0	18	0
		regional share	100.0%	0.0%	0.0%	100.0%	0.0%
		total share	0.0%	0.0%	0.0%	0.0%	0.0%
	All Japan	volume	730,164	110,501	546,982	61,644	11,037
		Share	100.0%	15.1%	74.9%	8.4%	1.5%

Source; MLIT, Japan

3. THE MODEL OF SHIPPERS' ROUTE CHOICE BEHAVIOR

3.1 Structure of Model

We develop the route choice model for container shipping from Japan to the US. We assume the choice structure shown in Figure 2; the model type is multiple-choice aggregate logit model. Since the previous researches adopt the logit model mentioned in 1.2, we follow these approaches. However, it is necessary to reflect the factors that are controllable by carries and have a big influence on the port management policy because we need to evaluate some port management policies affected by these controllable factors. Then, we choose some candidates of elements and finally we select the factors shown in the following subsection.

In order to deal with the shippers' route choice behavior, we need to define the structure of shippers' route choice; we assume that shippers have three alternatives for shipping to the US[1]: direct shipping service, connecting service transshipped at Busan, connecting service transshipped at other oversea ports.

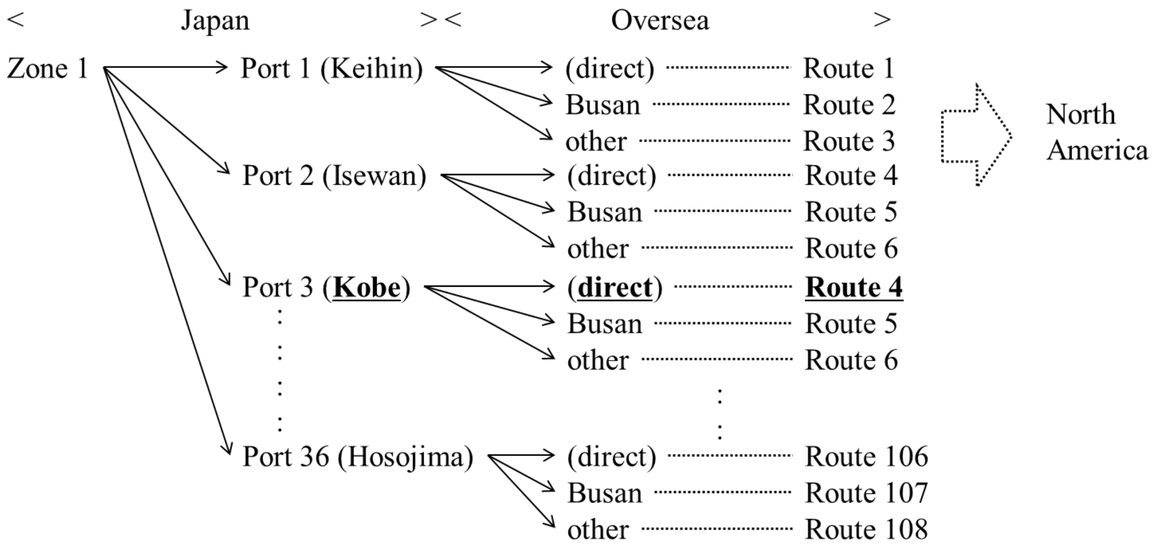

Figure 2. Choice tree of transport route choice

For the parameter estimation, we choose 206 zones and 36 ports as representative origin zones and ports in Japan. As a result, we have 108 routes for each origin zone. Based on the random utility theory, the choice probability can be formulated as:

$$P_{ni} = \frac{\exp(U_{ni})}{\sum_j \exp(U_{nj})}, \tag{1}$$

where,

n : origin zone,

i : shipping route,

U_{ni} : utility function of the route i of zone n.

The utility function of the shipper is defined as

$$U_{ni} = a \times C_{ni} + b \times T_{ni} + c \times 1/F_i + d \times TS_i, \tag{2}$$

where,

[1] Since MLIT data shows the majority of US bound shipping is occupied by the pattern in which cargos are off-loaded at the major ports in West Coast, and then we simply define that the destination zone is the US.

$C_{ni} = CD_{ni} + CF_{ni}$: total cost of route *i* from zone *n* (JPY/TEU),

$CD_{ni} = CDL_{ni} + CDM_{ni} + CDMTS_i + CP_i$: domestic cost of route *i* (JPY/TEU),

CDL_{ni} : domestic land transport cost of route *i* (JPY/TEU),

CDM_{ni} : domestic ship transport cost of route *i* (JPY/TEU),

$CDMTS_i$: transshipment cost of route *i* (JPY/TEU),

CP_i : port cost of route *i* to mothership (JPY/TEU),

$CF_{ni} = CFM_{ni} + CFMTS_i$: total cost of route *i* using oversea transshipment (JPY/TEU),

CFM_{ni} : feeder charge of route *i* (JPY/TEU),

$CFMTS_i$: oversea transshipment cost of route *i* (JPY/TEU),

$T_{ni} = TD_{ni} + TF_{ni}$: total shipping time of route *i* from zone *n* (hour),

$TD_{ni} = TDL_{ni} + TDM_{ni} + TDMTS_i + TP_i$: domestic time of route *i* (hour),

TDL_{ni} : domestic land transport time of route *i* (hour),

TDM_{ni} : domestic ship transport time of route *i* (hour),

$TDMTS_i$: additional time of route *i* for transshipment (hour),

TP_i : total dwelling time of route *i* (hour),

$TF_{ni} = TFM_{ni} + TFMTS_i$: shipping time of route *i* using feeder service (hour),

TFM_{ni} : sailing time of route *i* using feeder service (hour),

$TFMTS_i$: additional time of route *i* using oversea transshipment (hour),

F_i : service frequency of route *i* (sailing/month),

TS_i :dummy of overseas transshipment of route *i* which takes one if route i includes oversea transshipment service; otherwise takes zero.

3.2 Parameter Estimation

As mentioned in the former subsection, we use the OD survey data provide by MLIT (2008). As for the oversea transshipment, we mainly focus on the transshipment at Port of Busan and Port of Hong Kong as the second. Removing some extra outliers in the samples, we obtain the values listed in Table 5.

Table 5. Parameter estimation results

Independent Variables		Parameter		t score
C_{ni}	: Total transport cost	-1.327E-05	[1/(JPY/TEU)]	-9.039
T_{ni}	: Total transport time	-8.148E-03	[1/hour]	-1.596
$1/F_i$	: Duration given by the service frequency	-2.357E+01	[1/(month/sailing)]	-7.222
TS_i	: Dummy of overseas transshipment	-2.954E+00		-6.584
R-squared		0.706		

Specific sample 20% rejection

Table 5 shows all statistical values are significant and stable. Regarding the cargo throughput at ports, Figure 3 expresses the comparison of the estimated flows with the observed. As for the total cargos, the flow at Port of Kobe is overestimated, while that of North Kyushu is underestimated; at other ports, the model fits well. But in detail, some points should be noted. First, the flow via Busan from North Kyushu is quite underestimated, while the flow via Busan from other local ports is quite overestimated. This suggests that the service including direct shipping from North Kyushu is underestimated because of its low service frequency: on the other hand, the service of Busan transshipment is overestimated because of its good connectivity with Busan based trunk line services, while the direct shipping service is underestimated because of its low service frequency.

All in all, the model can estimate the cargo flow well. Henceforth, we use this parameter combination.

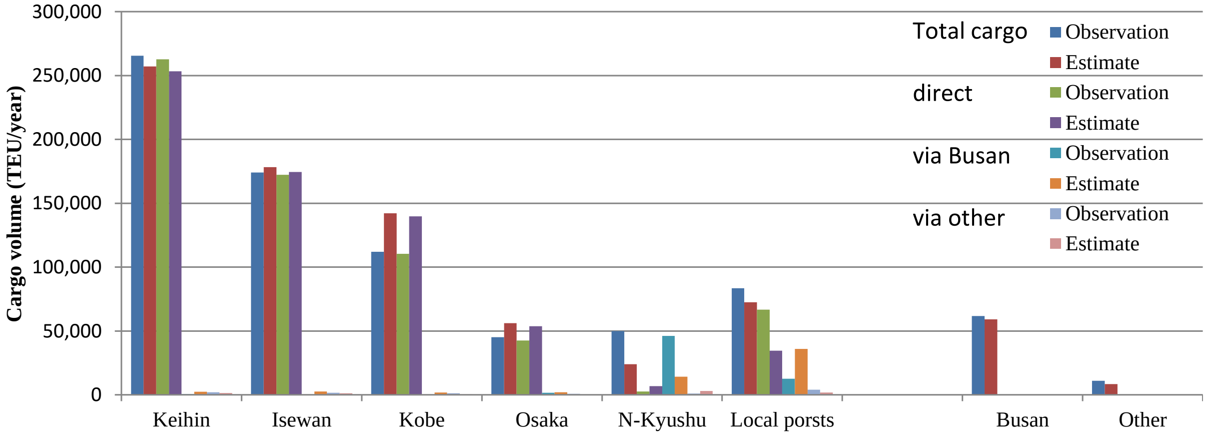

Figure 3. Reproducibility of model by each port (2008)

4. ECONOMIC ANALYSIS OF OVERSEAS TRANSSHIPMENT

For the econometric approach, we need to measure the value of each element in the shipper's behavior as monetary value. Table 7 lists the monetary values of parameter. It means

1) Reducing transportation cost by one JPY/TEU increases the utility by one JPY/TEU.
2) Shortening transportation time by 1 hour increases the utility by 614 JPY/TEU.
3) Increasing mothership frequency from one sailing/month to two sailing/month increases the utility by 888,261 JPY/TEU (increasing from 46 sailing/month to 47 sailing/month increases the utility by 822 JPY/TEU).
4) Avoidance of overseas transshipment increases the utility by 222,615 JPY/TEU.

Table 7. Normalizing of the parameters by total transport cost

Independent Variables		Parameter	
C_{ni}	: Total transport cost	-1	
T_{ni}	: Total transport time	-614	[JPY/hour·TEU]
F_i	: Duration given by the service frequency	-1,776,522	[JPY·(sailing/month)/TEU]
TS_i	: Dummy of overseas transshipment	-222,615	[JPY/TEU]

Let us see the actual status of services for trunk lines. Table 8 lists the comparison of frequency between 2008 and 2013. The service frequency from Port No. 5 (North Kyushu), No. 8 (Hitachi) and No. 10 (Naha) increases: but other ports, especially major ports like Port of Kobe, decrease the number of frequency in trunk lines. It suggests the shipper's utility can decrease. Indeed, we can confirm our concern.

Table 8. Service frequency in trunk lines in 2008 and 2013 (sailing/month)

	Japan port													Foreign	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2008	121.5	54	46	16.5	6	6	6	4	12	2	4	2	2	126	162
2013	91	39	34	12	8	4	4	5	8	4	0	0	2	116	118

- 1. Keihin, 2. Isewan, 3. Kobe, 4. Osaka, 5. N-Kyushu, 6. Tomakomai, 7. Sendai, 8. Hitachi, 9. Shimizu, 10. Naha, 11. Hachinohe, 12. Onahama, 13. Nagasaki, 14. Busan, 15. Hong Kong

In the following part, we compare the shippers' benefits of 2008 with that of 2013 by adopting the observed service frequencies. Table 9 lists the change in total of shippers' benefit between 2008 and 2013. The total cost of shippers increases 7,479 million JPY. One of the causes of this cost increase is the reduction of direct service mentioned above; the existence of oversea transshipment may be one cause.

Table 9. Shippers' benefit

	2008	2013
Total utility (measured as total cost)	-140,724 million JPY	-148,195 million JPY
Change (2013-2008)	-7,470 million JPY	

Then, the following question arises: how to improve the level of service in service frequency at the major ports in Japan, e.g. Port of Kobe? Our result shows the additional cost for overseas transshipment is estimated as 222,615 JPY/TEU, which corresponds to

1) Reducing transportation costs by 222,615 JPY/TEU
2) Reducing transportation time by 362 hours
3) Increasing service frequency: at least 1.14 sailing/month

Of course, reducing transportation time by 362 hours (about 15 days) is unrealistic. As for the service frequency at Kobe, Kobe has 46 sailing/month at 2008, which is much less than Busan; less than one third. Then, increasing the service frequency as the comparable service to Busan cannot be adopted as the workable alternative.

Therefore, reducing the charges is the only alternative for increasing the direct service at Kobe.

5. SENSITIVITY ANALYSIS OF KOBE PORT'S MEASURES EFFECT

In this section, we carry out the sensitivity analysis on the port charge at Port of Kobe. Since we like to evaluate the situation close to the current condition, we carry out the sensitivity analysis on the sailing route. For this aim, we adopt the data of 2013. The current port charge is 15,000 JPY/TEU and the charge almost remains the same as in 2013.

Table 10 shows the cargo volume by route when port charge of Kobe is reduced by subsidy amount. Seeing this table, we find that the subsidy to Kobe route does not affect the cargo flow from Region No .1 (Hokkaido), No. 2 (Tohoku-Pacific Ocean-side), No. 3 (Tohoku-Japan Sea-side), No. 8 (Kinki-Japan Sea-side), No. 9 (Chugoku-Japan Sea-Side), and No. 15 (Okinawa). Since Region No. 1, No. 2, No. 3, and No. 15 locate far from Kobe and they need much more subsidy if they have a motivation of using Kobe. Region No. 8 and 9 are close to Kobe, but these regions can enjoy the better connectivity to Busan under the current situation. Then, we look at another regions' situation.

The cargo flows from Region No. 4 (Kanto), No. 5 (Koshin-etsu), and No. 6 (Tokai) increase with the increase of the subsidy; however, the oversea transshipment cargo volume at Port of Busan does not decrease so much. This result suggests that the subsidy to Kobe routes arises the local port competition; the subsidy does not affect the international port competition.

The rest regions, i.e. Region No. 7 (Kinki), No. 10 (Chugoku-Setouchi), No. 11 (Shikoku-Setouchi), No. 12 (Shikoku-Pacific Ocean-side), No. 13 (Kyushu-North), and No. 14 (Kyushu-South) increase the cargo flows via Kobe with the increase of the subsidy and reduce the flow via Busan: it means that the subsidy to Kobe route is workable for gathering cargos from these regions.

Table 10. Sensitivity analysis of port charge (data 2013)

(unit : TEU/year)

	region	route	Base	Subsidy for port charge (JPY/TEU)					
				+5000	+10000	+15000	+20000	+25000	+30000
1	Hokkaido	Kobe direct	0	0	0	0	0	0	0
		Via Busan	3,750	3,750	3,750	3,750	3,750	3,750	3,750
2	Tohoku	Kobe direct	0	0	0	0	0	0	0
	-Pacific	Via Busan	9,070	9,070	9,070	9,070	9,070	9,070	9,070
3	Tohoku	Kobe direct	0	0	0	0	0	0	0
	-Japan Sea	Via Busan	20	20	20	20	20	20	20
4	Kanto	Kobe direct	1,414	1,507	1,605	1,710	1,821	1,939	2,063
		Via Busan	2,375	2,373	2,372	2,370	2,368	2,366	2,364
5	Koshinetsu	Kobe direct	416	435	454	473	492	512	532
		Via Busan	584	583	582	580	579	578	577
6	Tokai	Kobe direct	33,878	35,732	37,661	39,665	41,744	43,898	46,125
		Via Busan	3,374	3,339	3,304	3,266	3,228	3,188	3,147
7	Kinki	Kobe direct	72,764	74,899	77,020	79,123	81,205	83,262	85,291
		Via Busan	3,922	3,777	3,635	3,494	3,355	3,219	3,085
8	Kinki	Kobe direct	258	258	258	258	258	258	258
	-Japan Sea	Via Busan	0	0	0	0	0	0	0
9	Chugoku	Kobe direct	290	291	291	292	292	293	293
	-Japan Sea	Via Busan	0	0	0	0	0	0	0
10	Chugoku	Kobe direct	6,414	6,637	6,862	7,090	7,319	7,550	7,782
	-Setouchi	Via Busan	11,500	11,405	11,307	11,207	11,106	11,003	10,898
11	Sikoku	Kobe direct	3,729	3,805	3,880	3,952	4,024	4,093	4,161
	-Setouchi	Via Busan	726	700	675	649	624	599	575
12	Sikoku	Kobe direct	439	442	444	447	449	452	454
	-Pacific	Via Busan	50	48	45	42	40	38	36
13	Kyushu	Kobe direct	12,120	12,479	12,836	13,190	13,540	13,887	14,229
	-North	Via Busan	6,198	6,034	5,871	5,710	5,551	5,394	5,239
14	Kyushu	Kobe direct	8,048	8,428	8,818	9,219	9,630	10,050	10,479
	-South	Via Busan	17,587	17,318	17,039	16,753	16,459	16,157	15,848
15	Okinawa	Kobe direct	0	0	0	0	0	0	0
		Via Busan	18	18	18	18	18	18	18
	All Japan	Kobe direct	198,937	203,338	207,808	212,341	216,935	221,585	226,285
			(27.2%)	(27.8%)	(28.5%)	(29.1%)	(29.7%)	(30.3%)	(31.0%)
		Via Busan	59,177	58,438	57,690	56,934	56,172	55,403	54,629
			(8.1%)	(8.0%)	(7.9%)	(7.8%)	(7.7%)	(7.6%)	(7.5%)

Figure 4 shows the relationship between cargo volume and subsidy to Kobe routes. Obviously, cargo volume increases with the increase the subsidy. The relation between subsidy and the increase of cargo volume seems to be linear but the increase ratio decrease with the increase of subsidy. This suggests that the effect by subsidy will be saturated.

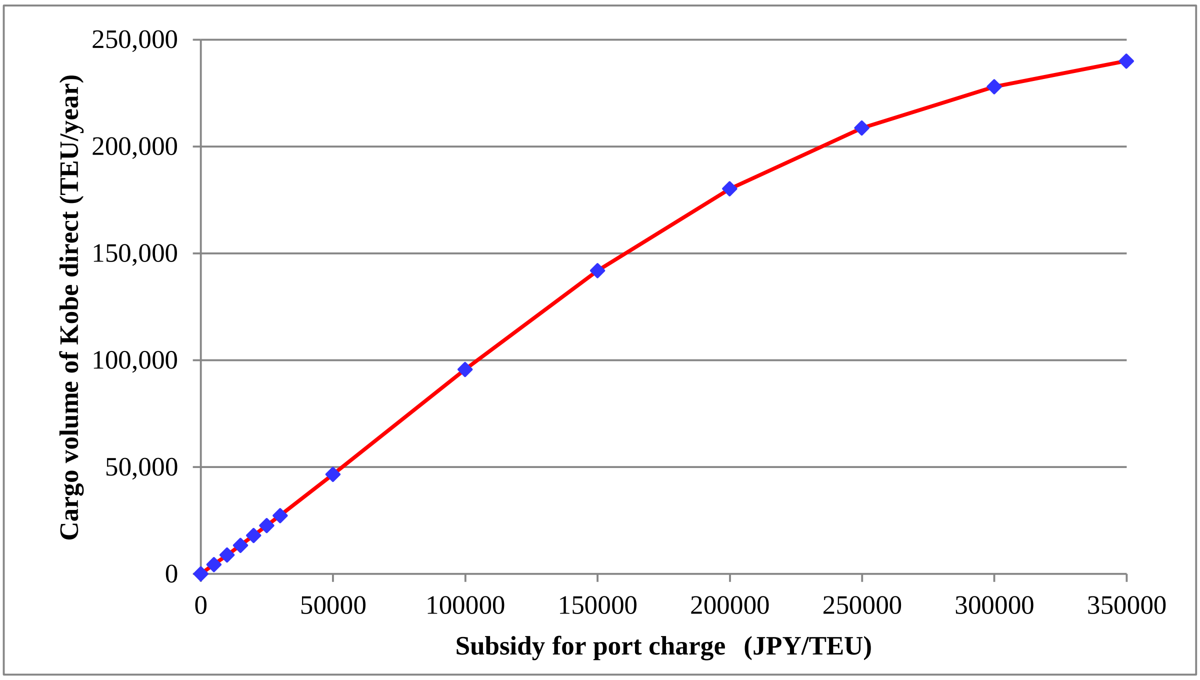

Figure 4. Relation between subsidy and cargo volume

Table 11 shows the result of cost-benefit analysis. Shippers' benefit (B) is defined as the difference in monetary value of shippers' utility between each case and base case. Policy cost (C) is defined as Kobe direct cargo volume multiplied by subsidy unit price. We find that B/C is less than 1 in all cases. B'/C does not exceed 1 even in the case of a modified benefit (B') that includes terminal revenue multiplied by handling charge to the increment of Kobe direct cargo volume. Namely, this subsidy policy has not been able to recover the effect (even if add terminal revenue to shippers' benefit) that matches the investment.

Table 11. Summary of sensitivity analysis on port charge

		Base	Subsidy for port charge (JPY/TEU)					
			+5000	+10000	+15000	+20000	+25000	+30000
Utility	million JPY	-140,724	-139,840	-138,911	-137,937	-136,916	-135,849	-134,736
Benefit	million JPY	-	884	1,813	2,788	3,808	4,875	5,989
Cost	million JPY	-	1,017	2,078	3,185	4,339	5,540	6,789
B/C		-	0.870	0.872	0.875	0.878	0.880	0.882
Terminal revenue	million JPY	-	66	133	201	270	340	410
B'	million JPY	-	950	1,946	2,989	4,078	5,215	6,399
B'/C		-	0.934	0.937	0.938	0.940	0.941	0.943

		Subsidy for port charge (JPY/TEU)						
		+50000	+100000	+150000	+200000	+250000	+300000	+350000
Utility	million JPY	-129,811	-114,252	-94,582	-72,105	-48,310	-24,274	-569
Benefit	million JPY	10,913	26,472	46,142	68,619	92,414	116,450	140,155
Cost	million JPY	12,275	29,468	51,127	75,832	101,903	128,065	153,623
B/C		0.889	0.898	0.903	0.905	0.907	0.909	0.912
Terminal revenue	million JPY	699	1,436	2,129	2,703	3,130	3,419	3,600
B'	million JPY	11,611	27,908	48,271	71,322	95,545	119,869	143,755
B'/C		0.946	0.947	0.944	0.941	0.938	0.936	0.936

Figure 5 shows the response of B/C (or B'/C) to government's subsidy for port charge. From this figure, we find that the value of B/C is monotonically increasing; but after the subsidy exceeds 100,000 yen/TEU, the value moderately decreases. On other hand, the transition of B'/C decreases after the subsidy to shipper surpasses 100,000JPY/TEU and then converges to 0.94 around; the efficiency of the subsidy to shipper can saturate without any other supports. That also means that subsidy strategy has a limited effect for increasing the number of handled cargos; we need to consider another support strategy[2].

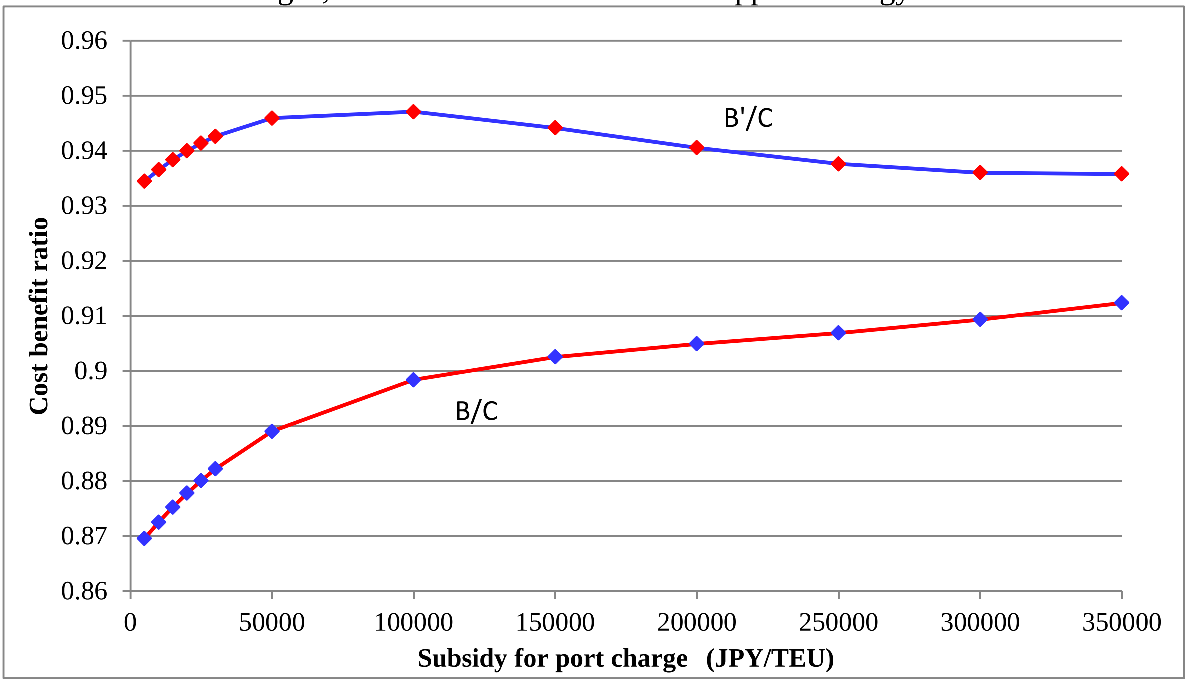

Figure 5. Relation between cost per benefit and subsidy

6. CONCLUDING REMARKS

In this paper, we overview of the current situation of Japan-based container cargo transport bound for the US and analyze the shippers' route choice behavior. The summary of our research is as follows:

1) We develop the multinomial logit type shippers' route choice behavior model and estimate its parameters.
2) We apply the developed model to the market export to the US from Japan. The shipper's disutility due to the oversea transshipment is up to 222,615 JPY/TEU.
3) Through the sensitivity analysis on the subsidy for cargo collection at Port of Kobe, this subsidy can be effective to increase the direct shipping via Port of Kobe; however, this subsidy cannot reduce the shippers' demand of transshipment at Busan.
4) The subsidy strategy alone seems not to be cost efficient.

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[2] Please remind that this analysis is carried out under the condition of fixed frequency; in reality, if Kobe direct cargo increases, the direct service of Kobe may increase. When we can invite more frequency of direct service of Kobe, the shipper's utility of using Port of Kobe may increase. However, due to the limitation of our methodology, we cannot have further analysis. Then, we will try this issue in the next research.

Summary 2) shows that our research reveals the potential loss by the oversea transshipment, and this potential loss should be reduce for improving the local economy. Summary 2) also suggests that the direction of "International Container Strategy Port" of MLIT can be justified in terms of improving the local economy by improving the service level for shipping. On the other hand, from summary 3) and 4), we can say that the subsidy strategy has a limited effect and if we like to have more efficiency on inviting more direct shipping services from Port of Kobe, we need to have supporting policy for the subsidy strategy. We should also consider division with other ports in Japan, but this time we considered only measures at Kobe. Of course, our results show the subsidy strategy itself is workable for inviting more direct shipping services from Kobe; but, we need to strengthen the port competitiveness with better productivity, i.e. cost-efficiency. Thus, we will try to find the better supporting policy in the next research.

Furthermore, as mentioned in footnote 2, this study is carried out under the condition of fixed frequency. However, the impact of the increase in cargo volume on the behavior of careers should be great. In the next research, we will try to join analysis of careers' behavior to this study, using an equilibrium simulation.

ACKNOWLEDGEMENTS

This research is partially supported by the Research Grant by the Ports & Harbours Association of Japan (PHAJ). Waterfront Vitalization and Environment Research Foundation (WAVE) also supports this research.

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