INFLUENCE OF PORT MANAGEMENT POLICY ON THE BEHAVIOR OF CONTAINER LINER SHIP COMPANY AND SHIPPERS

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Abstract: The present paper aims to analyze the container liner ship company's and the shipper's behavior under the variation of the port policy. First, we assume that the international container cargo flow is regarded as the result of the Stackelberg equilibrium between the liner ship company and the shipper. Second, we formulate the liner ship company's behavior and the shipper's behavior. The model is applied to the Asia-Pacific container transportation market. Then we discuss the port policy's influence on the liner ship company's service routes and the shipper's port choice.

1. INTRODUCTION

Recently, the situation of the international container transportation has been changed; the post-Panamax type ship is appeared in the international container transport market. And, from the viewpoint of the cost efficiency, the cargo carriers make a consortium in the long distance truck liner service such as the Asia-Pacific or the Asia-Europe liner. In the Asian line, many carriers who belong to the Asian countries except Japan have entered the market, which lead the market much more competitive.

Furthermore, the structure of Asian economy also has been changed. The NIES countries have the more sophisticated technology than the past, and the productivity at NIES countries greatly increases. Then, the NIES countries have much economic power and their mas production invites a large volume of container cargo flow. Especially, China who has remarkably developed by the economic policy change takes an important role in the current Asian economic structure; the China trade with U.S.A. has greatly increased and China becomes the greatest trading country with U.S.A. in Asia.

Moreover, corresponding to the growth of marine transportation market, the NIES countries rush to construct the container terminals with depth of minus fifteen meters and extend their ports' capacity. Each Asian country including Japan is making efforts to gather more service lines to her port.

In this way, the competition among ports becomes a very serious issue in Asian region and the behavior analysis of the carriers and shippers is very important for the port planning and port managing policies.

There have been some leading researches on the international container transport. Imai (1989) proposes a game theoretic approach to the behavior of ship companies where he formulates the competitions of container ship companies in the marine transportation market. However, he does not consider the strategic behavior of government and shippers. Then he fails to reflect the interactive behavior between carriers and shippers.

Ieda *et al* (1998) developed a simulation model of the behavior of the carriers and the shippers considering of the container liner ship companies' consortium. Then they apply the model to the Asian marine transportation market. In spite of the precise model, it also doesn't consider the equilibrium between the carriers and the shippers.

Kuroda *et al* (1997, 1997,1997) discuss the equilibrium between the carriers and the shippers as the Stackelberg Equilibrium. Then they formulate the market structure. In the stories of their research, most efforts have been made to explain the behavior of the carriers and the shippers in the real world. The analysis of the influence of port management policy on the market have been remained as the future issues. Therefore, the present paper discusses on the response of the market to the variety of port management policy.

2. MODEL FORMULATION

2.1 Outlines

The present paper follows the model developed by Kuroda *et al* (1997), thus the model of this paper is based on the thought that there is two type players in the international container transportation market; the carrier and the shippers.

The container liner ship company entering the international container transportation market (henceforth called as *carriers*) may compete each other to acquire the greater share of the market providing strategically their own transport service. However, in the real world, they make a consortium to avoid over-competition and keep almost same service level. On the other hand, there are some non-allied carriers who serve a little bit lower fees than the allied company. Therefore detail analysis should consider the competition among these carriers. In spite of existence of this competition, a loose alliance among all the carriers is still observed because they intend to coexist in the market. From this reason the present paper assumes one carrier in the market.

The carrier decides the liner route and the ship size and the ship number to be assigned at each route. This carrier's strategy depends upon the governmental strategy about container terminal construction and management. On the other hand, the carrier has complete information about the optimal behavior of shippers. From this reason the carrier can be regarded as the superior player to shippers but inferior to the government. It should be noticed that the forwarder has also important role in the cargo transportation market because they influences on the inland cargo transportation. However the present analysis assumes that the optimal inland route to and from the ports from and to every inland shipper is a priori given. Thus the forwarder is not taken into consideration in the present analysis.

Shippers may consider the total transportation cost including the inland transportation cost, the marine transportation cost and the total transportation time because time loss will reduce the value of cargo. Therefore, in order to reduce the time loss, the shippers prefer the port where the service of liner container ship is much more frequently scheduled. From the same reason, shippers dislike the port which is too much congested because queuing time may also decrease the value of cargo even if the frequency service is much more scheduled than the others. Taking these factors into consideration, the shippers choose the optimal port and carrier. Thus shippers' strategy can be considered as port choice and cargo volume allocation to the domestic ports.

In the present paper, the port managers are not regarded as the active subject in the market because it is difficult to formulate their behavior without the discussion of the economic analysis of the country. Then, in this paper, it is assumed that their strategies are given by scenarios.

2.2 Premises and Assumptions

In the present analysis, followings are premised and assumed. These assumptions are basically followed the latest study of Kuroda *et al*(1997).

1) Only world trade container cargo is considered.
2) O.D. zones of container cargo are appropriately divided corresponding to the purpose of analysis, and denoted by k or $k'(k, k' = 1, 2, ..., N)$.
3) Each of foreign country zones except Japan is assumed to have its own representative world trade port.
4) Each of foreign zones is considered as the hinterland of the representative port. Then, if the hinterland of a specific port covers more than two countries, the transshipped cargo is implicitly considered.
5) O.D. distribution of the container cargo between the zone k and k' is assumed to be a priori given, and ,if necessary, symbols I and E are superscribed for import and export.
6) World trade container port is denoted by i, l, $j(i, l, j = 1, 2, ..., M)$.
7) All container ships considered in the paper are liner and can route directly two ports or can call at one more port on each route.
8) Every berth of any port is available for any route if ships can move.
9) Total capacity of container berths of each country must be greater than equal to the necessary number to handle her total volume of the imported and the exported cargo. This is equivalent, in other words, to the constraint that the total number of container ships assigned to each country should be greater than the necessary number to carry her total imported and exported container cargo. This assumes that there is no infinite queue of cargo at ports.
10) Inter-governmental competition is not considered.
11) Competition among carriers is not taken into account. Then, only one carrier is assumed.
12) Carrier aims to maximize his net revenue considering cargo tariff and shipping expense.

13) Capacity of total container ships assigned to a specific route is at least greater than the total transportation demand for the route. This assumes all container cargo per unit period should be transported in the period.

14) Shipper allots his cargo to minimize the total cost including the inland and the marine transportation cost, the ship waiting loss and the marine transportation time loss of cargo. Inland transportation time loss of different route is assumed to be negligibly small.

15) Inland transportation is considered only for the domestic shippers. Thus the overseas shippers' behavior is neglected.

Under the above premises and assumptions, the foreign trade container transportation network considered in the analysis is shown as Figure 1.

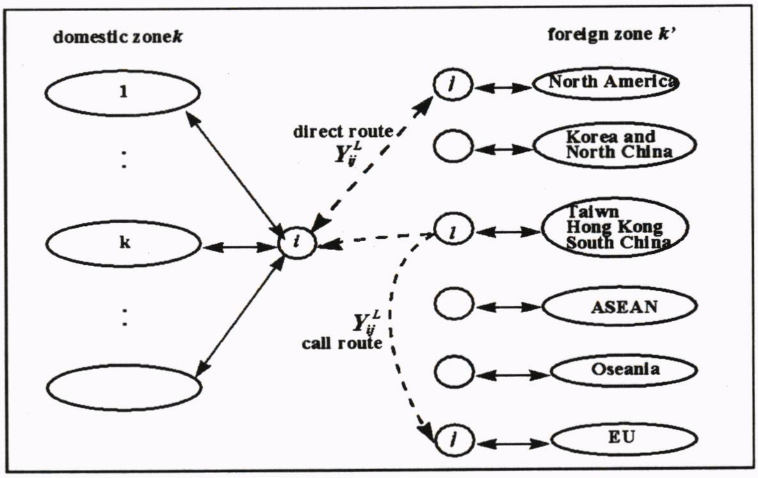

Figure 1 Network Concepts

2.3 Carrier's Behavior

Carrier aims to maximize his revenue by carrying larger volume of cargo as possible and minimize the ship expenses, the cargo handling cost and the port charges. Then, his objective function are formulated as Eq.(1). Eqs.(2) through (4) are the constraints. Eq.(3) means that the carrier can not assign the frequency of liner vessel more than the capacity of the port i.

$$\max_{Y_{ij}^L, Y_{ilj}^L} \quad Z_{carrier} = RF - (CT + CP + CM + CB + CL) - (CF + CC + CS) \tag{1}$$

Sub. to

$$Y_{ij}^L, \quad Y_{ilj}^L \geq 0 \tag{2}$$
$$z_i^L \leq Z_i^L \tag{3}$$

$$\sum_{i\in I_g}(\lambda_{ij}^{L}cp^{L}Y_{ij}^{L}+\sum_{l,j\neq i}(\lambda_{il}^{L}+\lambda_{lj}^{L})Y_{ilj}^{L}) \;\geq\; \sum_{k\in K_g}\sum_{k_2\neq k}(C_{kk_2}^{E}+C_{k_2k}^{I}) \tag{4}$$

(5)

and

$$Optimal \quad Behavior \quad of \quad Shippers \tag{6}$$

In Eq.(1), RF is the total revenue from the cargo tariff, CT is the tonnage tax for vessel size L which must be paid every time of entering the port, CP is the entrance charge for vessel size L, CM is the pilot charge, CB is the berth charge for mooring time and vessel size, and CL is the cargo handling charge. These costs are called as the port charge. CF, CC and CS is the fuel cost, the crew cost and the redemption cost of vessels, respectively. These costs are called as ship cost. Each term of Eq.(1) is given by Eq.(6) through Eq.(11).

$$\begin{aligned}
RF &= \sum_{i\in I_n}\sum_{j\notin I_n} f_{ij}(\sum_{k\in K_n}\sum_{k'\notin K_n}(X_{ialjk'}^{(1)}+X_{ialjk'}^{(2)})) && (7)\\
CT &= \sum_L\sum_i\sum_j GT^L(pt_i+pt_j)Y_{ij}^L+\sum_L\sum_i\sum_l\sum_j GT^L(pt_i+2pt_l+pt_j)Y_{ilj}^L && (8)\\
CP &= \sum_L\sum_i\sum_j GT^L(pf_i+pf_j)Y_{ij}^L+\sum_L\sum_i\sum_l\sum_j GT^L(pf_i+2pf_l+pf_j)Y_{ilj}^L && (9)\\
CM &= \sum_L\sum_i\sum_j GT^L(pc_i+pc_j)Y_{ij}^L+\sum_L\sum_i\sum_l\sum_j GT^L(pc_i+2pc_l+pc_j)Y_{ilj}^L && (10)\\
CB &= \sum_L\sum_i\sum_j GT^L(\nu_i^L(ht_i^{L(i,j)}+\tau_i^L)+\nu_j^L(ht_j^{L(i,j)}+ht_l^{L(i,j)}+\tau_i^L))Y_{ij}^L\\
&\quad +\sum_L\sum_i\sum_l\sum_j GT^L(\nu_i^L(ht_i^{L(i,j)}+\tau_i^L)+\nu_j^L(ht_l^{L(i,j)}+ht_l^{L(i,j)}+\tau_l^L)\\
&\quad +\nu_j^L(ht_j^{L(i,j)}+ht_l^{L(i,j)}+\tau_i^L))Y_{ilj}^L && (11)\\
CF &= \sum_L\sum_i\sum_j\{fc^{L(1)}2st_{ij}^L+fc^{L(2)}(ht_i^{L(i,j)}+ht_j^{L(i,j)}+\tau_j^L)\}Y_{ij}^L+\\
&\quad \sum_L\sum_i\sum_l\sum_j\{fc^{L(1)}(2st_{ilj}^L+2st_{lj}^L)+fc^{L(2)}(ht_i^{L(i,l)}+ht_l^{L(i,l)}+ht_l^{L(l,j)}\\
&\quad +ht_j^{L(l,j)}+\tau_i^L+2\tau_l^L+\tau_j^L)\}Y_{ilj}^L && (12)\\
CC &= \sum_L\sum_i\sum_j cc^L(ct_{ij}^LY_{ij}^L/365)+\sum_L\sum_i\sum_l\sum_j cc^L(ct_{ilj}^LY_{ilj}^L/365) && (13)\\
CS &= \sum_L\sum_i\sum_j cs^L(ct_{ij}^LY_{ij}^L/365)+\sum_L\sum_i\sum_l\sum_j cs^L(ct_{ilj}^LY_{ilj}^L/365) && (14)
\end{aligned}$$

(15)

where,

Y_{ab}^L:number of service frequency of liners directly connecting the port a with the port b (vessels/year).

Y_{acb}^L:number of service frequency of liners connecting the port a with the port b via the port c (vessels/year).

$ht_a^{L(a,b)}=(\lambda_{ab}^L+\lambda_{ba}^L)\frac{cp^L}{u_a^L}$:the cargo handling time at the port a (day/vessel).

cp^L:capacity of the liner vessel of size L (ton/vessel).

λ^L_{ab}:load factor of the liner of size L on the route connecting the ports a with b
u^L_a:cargo handling speed for the vessel of size L at the port i (ton/day).
τ_a:the staying time at the port a except of the cargo handling time (day/vessel).
f_{ab}:cargo tariff between the port a and b (yen/ton).
GT^L:gross tonnage of vessel size L.
pt_a:tonnage tax rate at the port a (yen/gross ton).
pf_a:entrance charge rate at the port a (yen/vessel).
pc_a: pilot charge rate at the port a (yen/vessel).
ν_a:cargo handling charge at the port a (yen/ton).
fc^L:fuel cost per day of vessel size L (yen/day/vessl).
cc^L:annual crew cost per vessel of size L (yen/vessel/year).
ct^L_{ij}:cycle time of the size L vessel directly routing the port i and j (day)/vessel).
ct^L_{ilj}:cycle time of size L vessel routing the port i and j via the port l (day/vessel).
cs^L:annual redemption cost of the size L vessel (yen/vessel/year).
Z^L_i:number of the container berth for ship size L of the port i.

2.4 Shipper's Behavior

Shippers aim to reduce the total transportation costs as possible. Then, they carefully choose the port and ships to minimize the total cost of the inland transportation cost and the marine transportation cost. Therefore, their objective function and constraints are formulated as Eq.(14) through Eq.(18).

$$\begin{aligned}\min_{X_{kijk'},X_{kiljk'}} Z_{shipper} &= \sum_k \sum_i \sum_{j\neq i} \sum_{k'\neq k} (p^*_{ki} + p^*_{jk'})\{X_{kijk'} + \sum_{l\neq i}((X_{kiljk'})^{(1)} + (X^{(2)}_{kiljk'}))\} \\ &+ \sum_{i\in I_n} \sum_{j\notin I_n} f_{ij}\{ \sum_{k\in K_n} \sum_{k'\notin K_n} (X^{(1)}_{kiljk'} + X^{(2)}_{kiljk'})\} \end{aligned} \tag{16}$$

Sub. to

$$X_{kiljk'},\quad X^{(1)}_{kiljk'},\quad X^{(2)}_{kiljk'} \geq 0 \tag{17}$$

$$\sum_i \sum_j (X^{(1)}_{kiljk'} + X^{(2)}_{kiljk'}) = C_{kk'} \tag{18}$$

$$\begin{aligned}\sum_k \sum_{k'} X_{kiljk'} + \sum_k \sum_{k'} \sum_l (X^{(1)}_{klijk'} + X^{(2)}_{klijk'} &+ X^{(1)}_{kijlk'} + X^{(2)}_{kijlk'}) \leq \\ \sum_L cp^L \lambda^L_{ij} Y^L_{ij} + \sum_L \sum_l cp^l \lambda^L_{ij} Y^L_{ijl} &+ \sum_L \sum_l cp^L \lambda^L_{ij} Y^L_{lij}\end{aligned} \tag{19}$$

$$\sum_k \sum_{k'} X^{(1)}_{kiljk'} \leq \sum_L \lambda^L_* cp^L Y^L_{ilj} \tag{20}$$

$$\tag{21}$$

where,
p^*_{ki}:freight rate of container cargo from the zone k to the port i by the cheapest transportation mode(yen/ton).
$X_{kijl'}$:volume of " direct cargo " from the zone k to the zone k' transported via ports i and j.
$X^{(1)}_{kiljk'}$:volume of " call cargo " from the zone k to the zone k' transported via ports i ,l and j.
$X^{(2)}_{kiljk'}$:volume of " transshipped cargo " from the zone k to the zone k' transported via ports

i ,l and j.

3. NUMERICAL COMPUTATION

Since the final purpose of this study is to analyze the effects of port management policies such as construction of new big scale container terminals, change of port charge and terminal charge etc, it is very important whether or not the model can explain the real container flow and the real behavior of carriers and shippers. Therefore, in this paper, the validity of the proposed model is examined by comparing with the observed data.

3.1 Numerical Conditions

Zoning and O.D. distribution of container cargo

In order to examine the validity of the proposed model, a numerical example is computed using the data of foreign trade container movement in 1994 surveyed by Ministry of Transport of Japan. It was done in one month from November 1st through 31st in order to survey the physical distribution of both of the domestic and the international cargo. To examine the zone share of Japanese port; the prefectural border is used as the unit domestic zones in Japan. The foreign zones are assumed such as North America (representative ports are Los Angels, San Francisco, Oakland and Seattle; these are called as the North America port), Europe (represented by Port of Rotterdam), Korea and North China (represented by Port of Busan), Taiwan and Hong Kong and South China (represented by Port of Kaoshung and Hong Kong), ASEAN(represented by Port of Singapore).
The O.D. distributions of the exported and the imported container cargo volume between Japan and overseas zones are a priori given. It is referred to the survey report by Ministry of Transport of Japan.

Transportation cost and average value of cargo

Inland transportation modes are considered as either truck or ferry in Japan. So the inland transportation cost is estimated based on Freight Rate Table and the distance from each domestic zone to each of port and the freight rate of both transportation modes. The loss of value of cargo due to ship waiting time and navigation time is estimated based on the data of total export and import container cargo of each domestic zone and total monetary value of the cargo. It is also referred to the report of Ministry of Transport.

Port and vessel data

Foreign trade container ports in Japan are considered as the four bay areas; Tokyo, Ise, Osaka and North Kyushu. Capable number to accept the container liner per month at each port is shown in Table 1. It also shows the berth charge, the port charge and the cargo handling charge. It should be notified that the acceptable number of container liner is calculated based on the number of cranes on each berth. Thus the handling capacity reflects the handling ability of cranes and work hours of labors. Those are referred to Statistics of Kobe Bureau of Port and Harbor and T. Abu *et al*(1995).

In order to examine the validity of the proposed model, Stackelberg equilibrium is computed using the data provided in the above. In Figure 2 is shown the computed and the observed results of total cargo volume of ports in Japan. From this figure, it is understood that the proposed model can well predict international cargo flow.

Table 1 Port Data

Port	Berth Charge (yen/GT*vessel)	Port Charge (yen/GT*vessel)	Handling Charge ton/yen	Cap. for The Large Ship (vessel/month)	Port Cap. (vessel/month)
Tokyo	13.4	45.1	1794	321	469
Ise	13.4	49.5	1794	91	135
Osaka	13.4	46.3	1794	474	652
North Kyushu	13.4	31.9	1794	61	165
Busan	4.1	26.3	525	551	693
Hong Kong	4.4	24.6	1239	697	839
Shingapore	6.9	15.6	838	955	1133

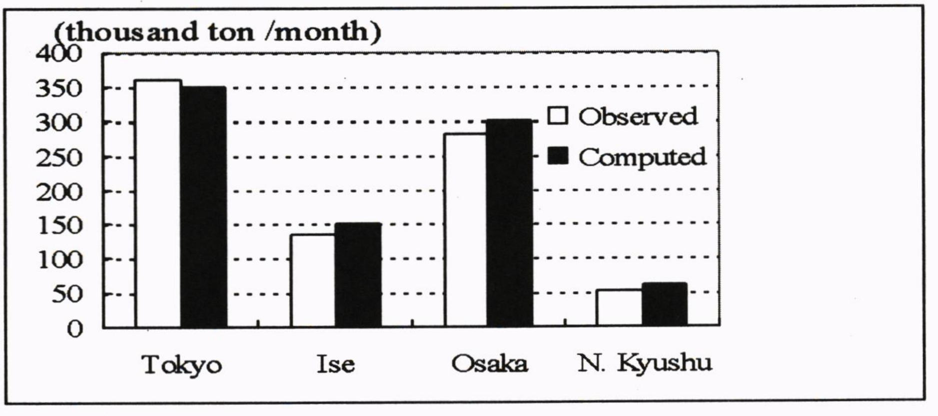

Figure 2 Comparison of the Computed and the Observed Cargo Volume

3.2 Impact of the Charge Policy

Taking account of the predictive capability of the proposed model, it is considered that the impact of the variety of the port management policies can be well predicted by the model. Thus, in this section, we examine the impact of some policy scenarios shown in Table 2.

In these policy scenarios, we deal with the variation of the port charge consisted of the summation of such charge as the berth charge and the pilot fee, the tonnage tax, the entrance tax and the handling charge. It is easily anticipated from their location that the port of Busan is mostly competitive to Japanese ports. Then, we discuss the impact of the variation of the port and the handling charge of the ports of Tokyo, Osaka and Busan. The computed results are presented in Figure 3 which shows the variation of the tranfer cargo volume from the present for each case.

In Figure 3, "the case 0" means the basic situation computed for the year of 1994. The computed results of Case 1 through Case 3 say that, if the port charge or the handling charge or both of the Osaka Bay is reduced to the same amount as the Busan port, the transshipped cargo at the Osaka Bay will increase while those of the Busan and the Tokyo Bay will be decreased. Particularly, the reduce of the handling charge gives much more impact than the port charge. However, these impacts will be mitigated if the charge of the Osaka and the Tokyo Bays is reduced at the same time. This is understood from the results of Case 4 through Case 6. These results are induced by the change of the carrier's behavior corresponding to the port charge policy. In fact, the detail can be understood by looking at Table 3 which lists the liner service frequency at each port.

Table 2 Policy Scenario of Charge

Case	Port Charge	Handling Charge
Case 1	Osaka = Busan	-
Case 2	-	Osaka=Busan
Case 3	Osaka = Busan	Osaka=Busan
Case 4	Osaka = Tokyo = Busan	-
Case 5	-	Osaka=Tokyo=Busan
Case 6	Osaka=Tokyo = Busan	Osaka=Tokyo=Busan

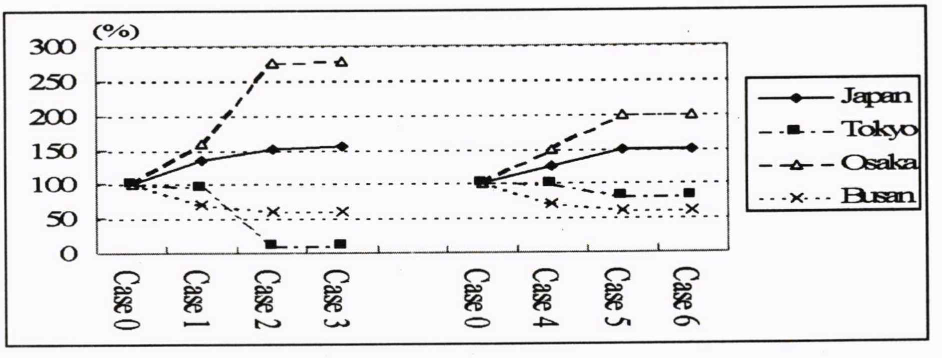

Figure 3 Impact of Charge Policy on Transshipped Cargo Volume

Comparing with Case 0 and Case 3, in the Europe line service at the Tokyo and the Busan ports, 17 frequency per month is reduced, respectively, and, in the North America line service, 23 frequency per month from the Tokyo Bay and 18 frequency per month from the Busan port are reduced. But, on the contrary, at the Osaka port, 15 frequency in the Europe line and 31 frequency in the North America line are increased, respectively. Of course, these are resultant from the carrier's behavior to maximize their net revenue. In fact, the net revenue of the carriers changes due to the port and the handling charge policy of the Japanese ports. The computed net revenue for each case is shown in Table 4. From this table, it is understood that the reduce of the port charge and the handling charge leads directly to the increase of the net revenue of the carrier, and that reducing of the handling charge is much more influencial.

Table 3 Service Frequency (vessel/month)

Port	Line	Case 0	Case1	Case2	Case3	Case4	Case5	Case6
Tokyo	Asia	162	155	145	145	162	184	182
	Europe	17	15	0	0	17	0	0
	N.A.	63	57	40	40	63	58	57
Ise	Asia	65	32	3	3	32	3	3
	Europe	0	0	0	0	0	0	0
	N.A.	40	27	21	21	27	10	10
Osaka	Asia	168	215	270	269	204	212	240
	Europe	0	0	15	15	0	14	15
	N.A.	46	65	75	75	58	80	87
North Kyushu	Asia	47	44	39	39	44	47	42
	Europe	5	5	0	0	5	4	2
	N.A.	1	1	5	5	1	2	4
Busan	Asia	78	75	60	63	78	67	47
	Europe	56	57	58	57	56	57	57
	N.A.	129	129	111	109	130	132	135
Hong Kong	Asia	226	227	209	206	227	226	227
	Europe	92	91	92	90	92	92	90
	N.A.	296	295	308	313	295	297	290
Singapore	Asia	242	242	228	228	242	246	252
	Europe	33	33	33	33	33	33	34
	N.A.	191	192	187	187	192	187	184

Table 4 Carrier's Net Revenue

Case	Total Net Revenue (bil. yen/month)	Increase Ratio(%)
Case 0	83.26	-
Case 1	83.40	+0.2
Case 2	91.26	+9.6
Case 3	91.39	+9.8
Case 4	83.69	+0.5
Case 5	95.31	+14.5
Case 6	95.99	+15.3

3.3 Impact of Extension of Port of Shanghai and Busan

In the 21st century, China may have a great influence on world trade as well as the marine transportation market. At the present, Hong Kong takes the role of the gate port of the trade of South China and Busan Port is the gate of North China, but, since the capacity of Port of Shanghai is too small to treat the trading cargo of its hinterland; the Central China, most of container cargo from Port of Shanghai is transshipped at Port of Osaka. Therefore, the development of Port of Shanghai or Port of Busan is expected to give some influence on Port of Osaka Bay. The present section discusses on this point.

Figure 4 shows the computed results of the transshipped container cargo volume and the frequency of the liner service at the Port of Osaka Bay area and its adjacent ports.
In this figure, Case 7 means the case that the capacity of Port of Shanghai is extended as the

same level of the present capacity of Ports of North Kyushu Bay, and Case 8 is the case that it is extended as the present level of Port of Ise Bay. The above case study assumes that the port charge and the handling charge of all ports are kept as the present level. As can be seen in this figure, the transshipped cargo of Port of Shanghai will be increased as its port capacity increased while the transshipped cargo at its adjacent port, particularly at the Japanese port will be decreased. Of course, corresponding to the increase of the cargo volume handled at Port of Shanghai, the service frequency of the liner to or from Europe and America will be increased.

In Figure 5 is shown the computed results about the influence of the extension of Port of Busan. Case 9, Case 10 and Case 11 means the case that the capacity of Port of Busan is increased 10 %, 30 % and 50 % than the present, respectively. In the case studies, it is also assumed that the port charge and the handling charge of all ports are kept as the present. It is remarkable in the Figure 5 that the transshipped cargo of Port of Busan and Ise Bay will be increased while that of the other ports will be decreased. This may come from that the great increase of the frequency service bound for and from Europe at the port of Busan will invite the cargo of Central China via Port of Shanghai, and the Japanese cargo through Port of Osaka and Tokyo Bay. The port of Ise Bay may invite the transshipped cargo from China bound for America in stead of Tokyo.

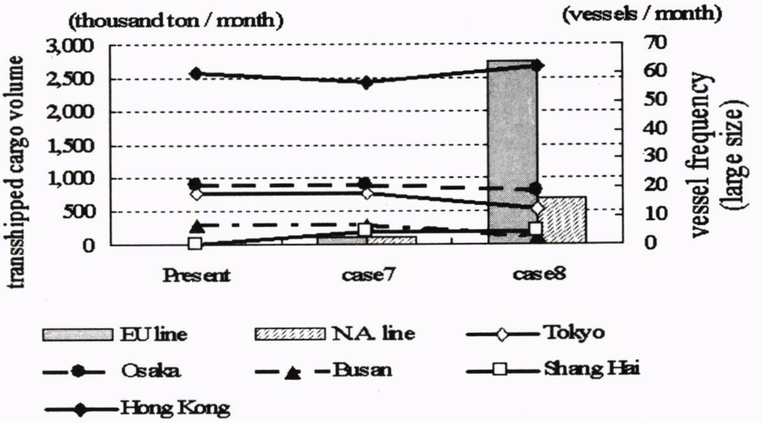

Figure 4 Comparison of the Transshipped Cargo Volume under the Variation of the Port Capacity at Shanghai

4. CONCLUDING REMARKS

The present paper discusses on the influence of the port management policy on the marine transportation market focussing on the East Asian region. The analysis is carried out based on the model developed by Kuroda *et al* (1997). In the port management policy analysis, mainly tow scenarios are discussed; firstly, the port charge and the cargo handling charge policy of Port of Osaka Bay, and, secondly, the port capacity extension policy of Port of Shanghai and Busan. The computed results say that the reduce of the port charge and the cargo handling charge of Port of Osaka will invite much more transshipped cargo to the port of Osaka but that of Port of Busan will be decreased as well as the port of Tokyo Bay. The extension of the capacity of Shanghai or Busan will directly influenced on the Japanese ports.

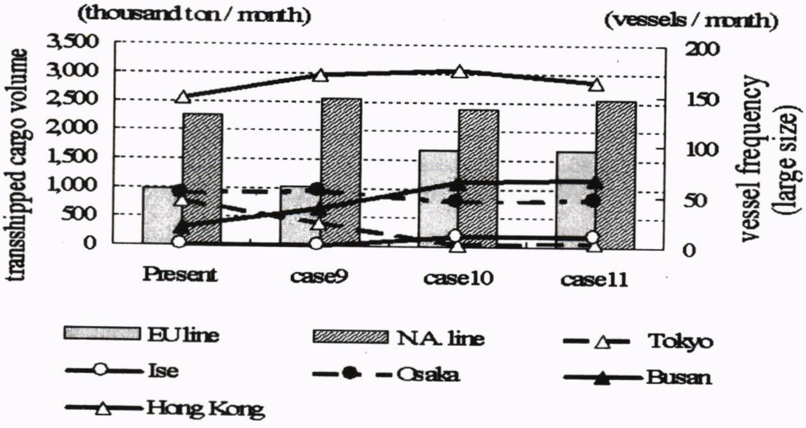

Figure 5 Comparison of the Transshipped Cargo Volume under the Variation of the Port Capacity of Busan Port

These scenario analysis of port management policies suggest the liner ship companies in the marine transportation market are very much sensitive not only to the O.D. cargo volume but also to the port management policy. Then it is necessary, in the port planning, to consider the world wide behavior of ship company and shippers.

However the model employed in this scenario analysis does not consider the equilibrium of cargo tariff at the marine transportation market. Thus, if considered this equilibrium price, the results may be changed from the present paper. This is remained as the future problem.

REFERENCES

a) Books and Books Chapters

Imai, A.(1989), Research on Optimal Planning for Container Transportation Systems, **Doctoral Theses, Kyoto University**, No. 652.

b) Journal Papers

Ieda,H., Shibasaki, R., (1998) A Simulation Model of International Container Shipping in Eastern Asia and Comparative Analysis of Network Assignment Rules, **Infrastructure Planning Review**, No.15,JSCE, 469-480 (in Japanese).

Kuroda, K. and Yang, Z., (1997) Port Management Policy and the Influence on Behavior of Liner Shipping Company and Shippers, **Journal of the Eastern Asia Society for Transportation Studies**, Vol.2, No.1, 73-86.

Kuroda, K. and Shao, Y. (1997) Impact of Costruction of an International Container Terminal at Shanghai on the Container Cargo Flow in Asian Pacific Region, **Journal of the Eastern Asia Society for Transportation Studies**, Vol.2, No.1, 115-126.

Kuroda, K. Yang, Z.,Takebayashi, M.,(1997) Analysis on Domestic Physical Distribution of Container Cargo with Feeder Service, **Infrastructure Planning Review**, No.14,JSCE, 551-558 (in Japanese).