Economic analysis of interport competition in container cargo: peripheral ports versus Tokyo Bay ports

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This paper deals with the problem of interport competition for container cargo in Japan. First, we analyse the effect of the containerization of peripheral ports on the extent of the hinterland of Tokyo Bay ports. Second, we analyse the different effects on each Tokyo Bay port. The ports selected as Tokyo Bay ports are Yokohama and Tokyo, and the ports selected as peripheral ports are Nagoya, Shimizu and Nigata.

By these analyses, it is first shown that there is an inverse relationship between the amount of container cargo handled and the distance carried inland. Second, it is shown that the port of Tokyo has been adversely affected, in the competition for container cargo from the distant prefectures, by the growth of the peripheral ports located near the hinterland of the Tokyo Bay ports.

Because of the characteristics of the port planning policy of the Ministry of Transport of Japan (The Ministry of Transport of Japan has strongly regulated the free competition between small ports and major ports), the effect of the peripheral ports upon the Tokyo Bay ports has not, as yet, been conspicuous. However, since the local government accounts are in the red in their port operations, they are likely to concentrate more on the sale of port services in future. Accordingly it is considered that interport competition in Japan may shortly become more severe.

1. Introduction

During the last two decades ocean transportation has experienced rapid changes. The tendency for ship size to increase, specialization of ships to grow stronger, and containerization to continue developing are particularly worthy of notice. Among them, containerization caused the system of cargo handling to be modified drastically, and exercised an important effect upon the hinterland of the ports concerned. Studies on the economics of containerization have been conducted by many researchers [1–3], but those concerning the influence of containerization upon changes in the extent of the hinterland are very few [4–6].

In this study, we first analyse the effect of containerization of the peripheral ports on the depth of the hinterland of Tokyo Bay ports. Second, we analyse the different effects on each Tokyo Bay port. The changing patterns in the competitive power of the port result mainly from the economic factors providing the inducement for shippers in the hinterland [7, 8] (see reference [8], explaining that shippers have decisive options to select the port). It is considered that containerization is one of the most powerful economic factors that strengthen the competitive power of the port.

To analyse the influence of containerization on the extent of the hinterland, data from surveys on Japanese container traffic for imports and exports are used. The ports selected as Tokyo Bay ports are Yokohama and Tokyo. They are located close to each other within Tokyo Bay and Tokyo Metropolitan Area. For this reason, it is

considered that the interport competition for import and export cargo may be more severe for these ports than for any other ports of Japan. The ports selected as peripheral ports are Nagoya, Shimizu and Nigata.

2. The range of the hinterland of the two ports

A hinterland can be described as organized and developed land which is connected with a port by means of transport links. The hinterland receives or ships goods through that port. In many cases, an inland area may be the hinterland of several ports [9]. According to the above definition, transport statistics serve to determine the extent of port hinterlands. We set the extent of the hinterland of Tokyo Bay ports, therefore, according to the origin and destination of 90% of the cargo moving through those ports, i.e. the ports of Yokohama, Tokyo and Kawasaki [10].

The 12 prefectures defined as the hinterland of the Tokyo Bay ports are depicted in the figure.
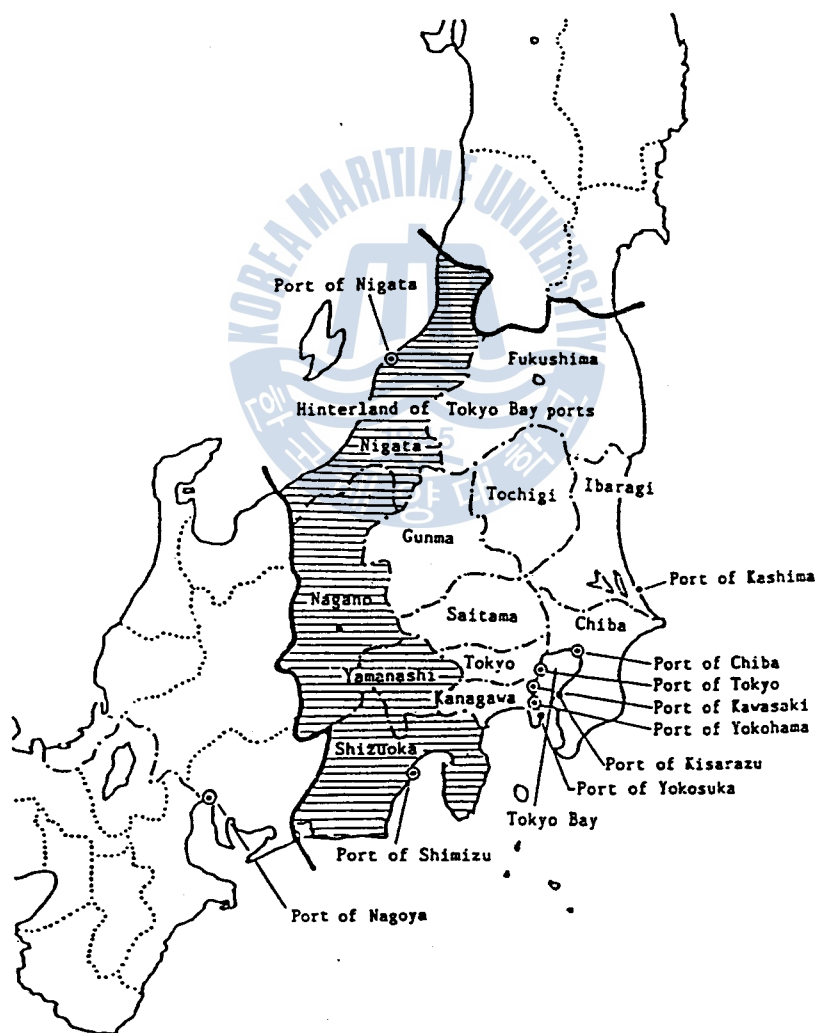
The range of the hinterland of the Tokyo Bay ports.

In this study, we analyse mainly the effect of the peripheral container handling ports upon Tokyo Bay ports with respect to competition for container cargo in the four shaded prefectures in the figure. As these prefectures are located near the relatively small container handling ports, they tend to be influenced by these small ports.

3. Progress of containerization

In recent years (from 1970 to 1986) the total merchant fleets of the world have increased by an annual average of 3·8%. During the same period those of fully cellular containers and lighter ships have increased by 16·6% per year. From 1983 the world fleet has decreased year by year, but the tonnage of container vessels has increased continuously. Table 1 shows the trend of those vessels owned in Japan which illustrates a similar phenomenon.

Table 1. Trend of merchant fleets of Japan.

Year	Total ships		Fully cellular container	
	G/T ('000 tons)	Growth rate	G/T ('000 tons)	Growth rate
1970	23715	—	233	—
1971	26647	12·4	354	51·9
1972	32020	20·2	712	101·1
1973	34948	9·1	951	33·6
1974	37120	6·2	1026	7·9
1975	38198	2·9	1086	5·8
1976	39496	3·4	1134	4·4
1977	38635	−2·2	1262	11·3
1978	37673	−2·5	1312	4·0
1979	37992	0·9	1392	6·1
1980	39015	2·7	1571	12·9
1981	39235	0·6	1602	2·0
1982	39853	1·6	1704	6·4
1983	39010	−2·1	1746	2·5
1984	38013	−2·6	1861	6·6
1985	38141	0·3	1867	6·9
1986	35619	−6·6	1831	−1·9

Source: *Handbook of Shipping Statistics* (published annually by the Japanese Shipowners' Association).

Japan's first container berth was completed at the port of Tokyo in 1967, followed by one at the port of Yokohama in 1969. The turnover of container cargo at the two ports has increased dramatically over the years both in amount and share (see table 2). It is considered that this trend will continue in the near future. Accordingly, the influence of containerization upon the extent of the hinterland will be maintained.

As the structure of the port system reaches maturity, however, challenge at the periphery by some of the smaller ports intensifies [11]. Some leading ports may lack space for expansion: growing traffic may cause increased congestion. In practice, a serious congestion problem occurred from 1961 to 1962 in the principal ports of Japan, causing an accelerated expansion of the port facilities of some of the smaller ports as well as those of the leading ports.

Table 2. Container cargo handled at Tokyo and Yokohama (in thousands of tons).

Year	Yokohama		Tokyo	
	Import	Export	Import	Export
1970	666 (1·6)	1335 (9·8)	472 (5·3)	406 (62·5)
1971	1235 (3·0)	2099 (12·6)	361 (4·5)	435 (65·2)
1972	1424 (3·4)	2678 (16·3)	1096 (12·9)	1272 (85·8)
1973	2103 (4·7)	2477 (15·3)	2315 (22·8)	2463 (88·5)
1974	1834 (4·2)	2815 (15·2)	2865 (28·9)	2924 (79·0)
1975	1633 (5·1)	2919 (16·8)	2119 (26·6)	2591 (73·3)
1976	2061 (6·5)	3561 (17·4)	2693 (29·2)	3760 (77·1)
1977	2237 (6·9)	3721 (17·0)	3237 (33·1)	4353 (78·8)
1978	2659 (8·7)	4196 (18·5)	4001 (37·7)	4752 (84·0)
1979	3072 (9·6)	4581 (19·7)	4411 (37·4)	4563 (81·4)
1980	3333 (11·2)	6223 (21·1)	4248 (39·5)	5316 (80·7)
1981	3486 (12·5)	7559 (25·1)	4269 (43·4)	5837 (79·9)
1982	3873 (14·7)	7908 (27·3)	4264 (41·6)	5332 (73·7)
1983	4137 (16·4)	8913 (30·8)	4510 (44·5)	5507 (80·9)
1984	4744 (18·0)	10901 (35·1)	5114 (50·2)	6675 (86·2)
1985	5649 (22·1)	11786 (35·6)	5380 (52·4)	6983 (85·2)
1986	6557 (25·0)	10750 (38·4)	6602 (56·2)	7197 (90·2)

Note: Figures in parentheses give the share of the container cargo compared to total import (export) cargo.

Just as the port has a close relationship with the region, so the import and export traffic has an interrelationship with distance. Accordingly, the growth of the other ports which have a common hinterland causes a change in the extent of the hinterland of all the ports concerned.

Table 3 shows the recent trend of the container cargo handled at the small peripheral ports that have a common hinterland with the Tokyo Bay ports. In particular, the growth of the port of Shimizu, is worthy of attention. The growth of the port of Nagoya, which is located near the hinterland of the Tokyo Bay ports, could be a future threat to the ports of Yokohama and Tokyo in the competition for container cargo.

Table 3. Container cargo handled at the peripheral ports (in thousands of tons).

Year	Nagoya		Shimizu		Nigata	
	Import	Export	Import	Export	Import	Export
1975	576	1267	59	267	0	0
1976	753	1738	57	258	0	0
1977	776	1757	88	406	0	0
1978	974	1679	96	432	0	0
1979	1234	1845	86	478	0	0
1980	1271	2219	129	515	0	0
1981	1208	2357	85	646	n.a.	n.a.
1982	1380	2454	155	881	n.a.	n.a.
1983	1659	3329	289	1060	n.a.	n.a.
1984	2134	3928	334	1176	n.a.	n.a.
1985	2557	4725	351	1374	3	27
1986	2984	5295	360	1326	2	27

Source: Statistical yearbooks for each port (published annually by each port authority).

4. Inland container traffic

When shippers make a decision about port selection, they are confronted by many factors that need to be considered. For example, Foster [12] presented ten items to distribution managers helping to explain why they chose the ports they use. These are: cost of transportation and port charges, proximity to plant, number of sailings, equipment and services, level of congestion, quality of customs handling, amount of free time, last port of call, security, and size and reputation. Also, Slack [13] presented eleven items adding the 'possibility of intermodal links' to the above ten.

The results of the two surveys have shown that 'proximity of port' scored highly. It was ranked as second criterion in the former survey, and third in the latter. But, as 'cost of transportation' includes the cost of inland transportation, the score for 'proximity of port' may be underestimated. In any case, it was shown that 'proximity of port' is one of the most important factors that shippers take into consideration when selecting the ports they use.

In Japan, since most of the inland container traffic is transported by truck, 'proximity of port' is more important than in America or Western Europe. Based on this fact, we examined the relationship between the amount of cargo handled at the port and the distance transported inland. The data used in this analysis are taken from the above-mentioned surveys. The surveys were conducted five times, viz. in 1970, 1972, 1974, 1978 and 1986. Each survey extended over one month. Because the first two surveys were not classified in detail according to prefecture in the hinterland of the Tokyo Bay ports, we used the last three surveys.

To examine the elasticity of the distance transported to and from the port, we conducted a log-linear regression analysis for import and export cargo, separately. The results are summarized in tables 4 and 5. Y relates to the amount of import or export container cargo handled at each port and X means the distance between each prefecture and the port.

The distance from each port to each prefecture, that is, the distance for import container cargo, was calculated by the method of weighted average. Here, the 'weight' is the population of each city located in each prefecture. The reason we chose the

Table 4. Relations between amount of container cargo handled and distance (import cargo).

Year	Yokohama	Tokyo
1974	$\ln Y = 14 \cdot 216 - 1 \cdot 267 \ln X$ $(-3 \cdot 164)$ $R^2 = 0 \cdot 500$	$\ln Y = 14 \cdot 454 - 1 \cdot 285 \ln X$ $(-4 \cdot 956)$ $R^2 = 0 \cdot 711$
1978	$\ln Y = 15 \cdot 690 - 1 \cdot 449 \ln X$ $(-4 \cdot 945)$ $R^2 = 0 \cdot 710$	$\ln Y = 14 \cdot 970 - 1 \cdot 226 \ln X$ $(-6 \cdot 269)$ $R^2 = 0 \cdot 797$
1986	$\ln Y = 15 \cdot 462 - 1 \cdot 201 \ln X$ $(-3 \cdot 318)$ $R^2 = 0 \cdot 524$	$\ln Y = 15 \cdot 915 - 1 \cdot 349 \ln X$ $(-5 \cdot 057)$ $R^2 = 0 \cdot 719$

Note: The numbers in parentheses under the coefficients are t values.
Source: The survey of container traffic for import and export cargo in Japan (published by the Department of Custom of the Ministry of Finance).

Table 5. Relations between amount of container cargo handled and distance (export cargo).

Year	Yokohama	Tokyo
1974	$\ln Y = 12 \cdot 272 - 0 \cdot 673 \ln X$ $(-1 \cdot 601)$ $R^2 = 0 \cdot 204$	$\ln Y = 10 \cdot 837 - 0 \cdot 372 \ln X$ $(-0 \cdot 952)$ $R^2 = 0 \cdot 083$
1978	$\ln Y = 12 \cdot 672 - 0 \cdot 636 \ln X$ $(-2 \cdot 027)$ $R^2 = 0 \cdot 291$	$\ln Y = 11 \cdot 846 - 0 \cdot 481 \ln X$ $(-1 \cdot 547)$ $R^2 = 0 \cdot 193$
1986	$\ln Y = 13 \cdot 017 - 0 \cdot 476 \ln X$ $(-1 \cdot 873)$ $R^2 = 0 \cdot 260$	$\ln Y = 13 \cdot 167 - 0 \cdot 579 \ln X$ $(-2 \cdot 997)$ $R^2 = 0 \cdot 473$

Note: The numbers in parentheses under the coefficients are t values.
Source: The survey of container traffic for import and export cargo in Japan (published by the Department of Custom of the Ministry of Finance).

population of each city as 'weight' is that the goods concerned with consumption comprised about 70% of the import container cargo handled at the two ports.

The distance from each prefecture to each port, that is, the distance for export cargo, was also calculated in a similar way. But the weight is different from that above: as the proportion of manufactured goods of the container cargo exported through the ports of Yokohama and Tokyo was about 90%, and 80% respectively during that period, we selected as weight the amount of exporting manufacturing industry located in each industrial area of each prefecture. Consequently, the distances for import and export cargoes are slightly different from each other. As a matter of fact, the two kinds of distance were calculated by reference to regulations about truck business distances according to guidelines from the Ministry of Transport of Japan. This is because most of the inland container cargoes are transported by truck, as mentioned above.

The equations summarized in table 4 indicate that for import container cargo of the port of Yokohama, from 50% to 71% of the variation in cargo handling turnover was

explained by the variable 'distance' and from 71% to 80% for the port of Tokyo. The coefficient of ln X indicates the elasticity of distance. As the coefficient is less than zero, it means that as the distance increases, the container cargo carried out decreases. This is in accordance with our postulate that the container cargo handled at the port has an inverse relation with the distance.

The equations summarized in table 5 also indicate that for export container cargo of the port of Yokohama, from 20% to 29% of the variation in container cargo handling turnover was explained by the variable 'distance', and from 8% to 47% for the port of Tokyo.

The t-test for import container cargo shows the results to be significant at the 0·01 level. By contrast, the t-test for export container cargo shows only one of the results to be significant at the 0·01 level, but we do not think that this fact is particularly important in the following analysis. The important thing, we think, is the changing trend of the coefficients as time goes on.

Tables 6 and 7 show the share of import and export container cargo handling turnover respectively which each container handling port located near the hinterland of the Tokyo Bay ports handled during one month in each year a survey was conducted. To examine the effect of the peripheral container handling ports upon the old ports, i.e. the ports of Yokohama and Tokyo, we selected the four prefectures shaded in the figure, located near the peripheral three ports, i.e. the ports of Nagoya, Shimizu and Nigata.

The general trend is that shares in import and export container cargo of the three peripheral ports have grown larger with time. But, for import cargo, that of the port of Tokyo grew larger in 1978, and smaller in 1986. By contrast, the share of the port of Yokohama decreased in 1978, but increased in 1986. For export cargo, the share of the port of Tokyo has decreased over time, while that of the port of Yokohama has, in general, increased.

Here, by comparing table 4 with table 6, we find that the changing trend of the share of cargo handled at the two ports is consistent with the changing trend of the elasticity

Table 6. The share of each port for import container cargo into the four prefectures (%).

Prefecture	Year	Yokohama	Tokyo	Nagoya	Shimizu	Nigata
Nigata	1974	19·5	80·3	0·1	0	—
	1978	21·7	76·0	2·3	0	—
	1986	38·9	52·3	7·9	0	0·9
Yamanashi	1974	40·0	60·0	0	0	—
	1978	31·8	68·2	0	0	—
	1986	45·4	48·5	0	6·1	0
Nagano	1974	37·7	53·9	8·4	0	—
	1978	25·4	59·8	14·3	0·6	—
	1986	52·2	28·4	8·9	10·5	0
Shizuoka	1974	36·7	42·5	1·4	19·5	—
	1978	25·5	47·9	6·6	19·9	—
	1986	28·0	23·2	10·7	38·1	0

— indicates a port with no container facilities at that time.
Source: The survey of container traffic for import and export cargo in Japan (published by the Department of Custom of the Ministry of Finance).

Table 7.   The share of each port for export container cargo from the four prefectures (%).

Prefecture	Year	Yokohama	Tokyo	Nagoya	Shimizu	Nigata
Nigata	1974	34·3	63·8	1·9	0	—
	1978	49·9	47·7	2·4	0	—
	1986	57·0	37·5	4·1	0	1·4
Yamanashi	1974	39·2	60·8	0	0	—
	1978	50·1	49·9	0	0	—
	1986	38·3	52·1	0·2	9·4	0
Nagano	1974	36·8	55·5	7·6	0·1	—
	1978	43·7	45·8	9·9	0·5	—
	1986	57·6	37·3	3·8	1·2	0·1
Shizuoka	1974	24·3	46·6	1·1	28·1	—
	1978	26·0	42·4	1·1	30·5	—
	1986	37·8	19·5	1·5	41·2	0

— indicates a port with no container facilities at that time.
Source: The survey of container traffic for import and export cargo in Japan (published by the Department of Custom of the Ministry of Finance).

of distance. Specifically, the coefficient of the distance of the port of Yokohama has changed from $-1·267$ (1974), to $-1·449$ (1978) and $-1·201$ (1986), reflecting the decline of share in 1978. Also, that of the port of Tokyo has changed from $-1·285$ (1974), to $-1·226$ (1978) and $-1·349$ (1986), reflecting a rise in its share of cargo handled in 1978. Each absolute value of the coefficient of the two ports is smallest when the port has the higher share. In other words, when the port handled relatively more container cargo from these four distant prefectures, its elasticity of distance was largest.

In a similar way, by comparing table 5 with table 7, we can establish the following facts. First, the absolute value of the elasticity of distance of the port of Yokohama has decreased with time. This means that the port of Yokohama has handled relatively more export container cargo from the distant prefectures with the passage of time. This is consistent with the trend of increasing share of export container cargo from the four prefectures. Second, the absolute value of the distance elasticity of the port of Tokyo has increased with time. This is also consistent with the trend of decreasing share of export cargo from the four prefectures.

Summing up, the following results are found. For import container cargo, the port of Tokyo has recently been deprived of the cargo from the four distant prefectures. It is thought that the immediate cause is the growth of the small peripheral ports near the four prefectures and the continuous growth of the port of Yokohama. For export container cargo, the port of Tokyo has gradually been deprived of cargo from the four distant prefectures, but, by contrast, the port of Yokohama has gradually increased its cargo from the four distant prefectures.

The fact that the port of Tokyo alone is influenced seriously, in spite of the geographical contiguity of the two ports, by the peripheral container handling ports is very interesting. This could be explained, apart from the distance, by the various other factors, for example, the ten factors previously listed. Another important factor is the policy on port planning by the central government of Japan. The central government of Japan has assigned the port's functions in order to prevent keen competition between small ports and major ports [14].

5. Conclusions

This study was undertaken to ascertain the effect of the geographically close but small container handling ports upon the older ports. By so doing, firstly, it was proved that there is an inverse relationship between the amount of container cargo handled and distance. Secondly, it was shown that the port of Tokyo has been affected by the competition for container cargo from the four distant prefectures by the growth of the peripheral ports which are located near the hinterland of the Tokyo Bay ports.

In spite of the geographical contiguity of the two ports, the port of Yokohama has maintained its competitive power for container cargo from those four distant prefectures. We think that this is because other factors, apart from distance, have strengthened its competitive power. More careful study is required in order to determine the cause. Because of the characteristics of the port planning policy of the Japanese central government, the effect of the peripheral ports upon the old ports has not, as yet, been conspicuous. But, as the local governments are in the red in their port operations, they are likely to concentrate more on the sale of port services from now on. Accordingly it is considered that interport competition in Japan may become more severe in the near future.

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