Container Liner Shipping Alliances, Excess Investment, and
Antitrust Immunity

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Abstract
Introducing the unique characteristics of the international marine transport industry, this paper examines whether load capacity is excessive or insufficient in the presence of uncertainty on the future economic situation in terms of both welfare of one country and global welfare. We also consider the effect of alliances and the application of antitrust immunity on capacity building of shipping liners. We find that the transportation charge may be lower than the marginal operation cost and, accordingly, the profits of liners/firms may be negative in a recession. We also find that global alliances increase the supply of transportation services. Moreover, we demonstrate that the supply of transportation service and the investment for decreasing the marginal operating cost by each liner is insufficient in terms of global welfare when there are neither governmental supports nor global alliances. On the other hand, global alliances mitigate the degree of insufficiency of the supply and investment, and make the problem of excessiveness more serious.

Key Words: Alliances, antitrust immunity, container liners, international marine transportation.

JEL Classification: F12, K21, R48.

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1. Introduction

Marine transportation has been constantly and drastically increasing for the past several decades. According to UNCTD (2014), the total amount of seaborne trade was tripled for the past five decades.\(^2\) It is well known that the economic growth across world and increases in inter-process division of labor have been key motives for this increase in seaborne trade. Accordingly, vessels/bottoms that are used for international marine transportation have been increasing constantly. For example, the number of vessels for world container liners in 2012 is twice as large as that in 2000. (see Figure 1).

The market of international marine transportation is competitive for trampers, such as bulk carriers and tankers. On the other hand, the market for container shipping liners is oligopolistic, and operation of container transportation needs a large amount of investment.\(^3\)

\[\text{Figure 1. The total number of container vessels.} \]

\textbf{Source: Japanese Shipowners’ Association}

In particular, excess capacity problems often become apparent under recessions because

\(^{2}\) See Table 1.3 (p. 5) of UNCTAD (2014).

\(^{3}\) The average number of liner companies has been decreasing and the average container capacity per company per country has been increasing. See Figure 2.6 (p.42) of UNCTAD (2014).
capacity cannot be flexibly changed once vessels are constructed. If price competition becomes serious, liners cannot make profits and have to scrap container vessels. Actually, as compared with the number of newly constructed vessels, the number of dismantled vessels is unstable across years because it is directly influenced by economic situations. This fact implies that when firms face uncertainty about future economic situations, they may hesitate to invest in vessels, which may lead to insufficiency of load capacity in good and normal economic situations.

Thus, antitrust immunity was applied to the container shipping industry across the world until the late 1990s. The purpose of the application of this policy was to realize a stable supply of capacities. Historically, under antitrust immunity, shipping liners determined shipping charges and load capacity cooperatively in the same line: the cooperative group is called shipping conference. However, the negative effect of this scheme, which is hindrance of competition, was considered to become greater, antitrust immunity has been removed in many countries such as the US, EU, and Japan for the past two decades, although some countries has been keeping types of conditional antitrust immunity. After pro-competitive policy reforms prevailed, it was difficult for shipping liners to keep shipping conferences. Instead, they have been forming global alliances. Like alliances in the airline industry, we can observe several alliances in the shipping liner industry. For example, Hapag-Loyd, OOCL, APL, NYK Line, Mitsui O.S.K Lines, and Hyundai are members of G6 Alliance. Also, COSCO, Yang Ming, Hanjin, Evergreen, and Kawasaki Kisen are members of CKYH/Evergreen Alliance. Similar to airline alliances, shipping liner alliances are being converged to three major alliances.5

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4 Even recently, the governments and this industry have been discussing this issue. For example, see Boney (2012) and King (2012).
5 Based on the data of the Land, Infrastructure, Transport, and Tourism Japan (the data is published in Japanese). See the website of the ministry (http://www.mlit.go.jp/statistics/details/kaiun_list.html)
Introducing these characteristics of the international marine transport industry, we examine (i) whether load capacity is excessive or insufficient in the presence of uncertainty on the future economic situation in terms of both welfare of one country and global welfare, and (ii) the effects of alliances on load capacity and shipping charges. We also consider the effect of alliances on capacity building of liners.

We extend the analysis in the following two directions. First, we investigate the welfare effect of investment by shipping liners for decreasing operating costs. Similar to the analysis on load capacity, we examine whether the investment amounts are excessive or insufficient. Second, we consider the effect of removing antitrust immunity on investment and load capacity and, accordingly, governments’ decision makings on antitrust immunity.

Theoretically, the literature mainly focused on alliances of the airline industry (Bruckner, 2001, Bilotkach, 2007, Flores-Fillol and Moner-Colonques, 2007, Czerny, 2009, and Bruckner and Proost, 2010). A few studies analyzed the market of ocean liner shipping (see Fox, 1994, Abe et al., 2014). Both industries have common features such as huge investment costs, alliances, and the application of antitrust immunity. However, the literature mainly focused on the oligopolistic industrial structure and the effect of policy changes on the prices and supplies. We extend the study of this field in two ways. First, we introduce uncertainty on future economic situations into the model and examine whether excess/insufficient capacity and investment arises. This type of uncertainty is one of important key factors for justifying the application of antitrust immunity to this industry. Second, introducing a four-stage game structure, we explicitly focus on the capacity building and investment for decreasing operating costs. Capacity building and investment are determined before economic situations become clear. This order of decision making is also

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6 There are many empirical studies. For example, see Fusillo (2003, 2004, 2009), Wu (2012), and Wang (2013) among others. Moreover, some articles analyzed the policy issue of antitrust immunity and leniency using a laboratory experimental approach. For example, see Hampton and Sherstyuk (2010).
an important factor for implementing policies to realize an efficient situation in this industry.

Main results are as follows. First, the transportation charge may be lower than the marginal operation cost and, accordingly, the profits of liners/firms may be negative in a recession. Second, global alliances increase the supply of transportation services, and decrease shipping charges. Third, the supply of transportation service and the investment for decreasing the marginal operating cost by each liner is insufficient in terms of global welfare when there are neither governmental supports nor global alliances. Fourth, global alliances mitigate the degree of insufficiency of the supply and investment, and make the problem of excessiveness more serious.

The structure of the paper is as follows. Section 2 describes the basic model. Section 3 examines the equilibrium capacities and shipping charges. Section 4 investigates insufficiency/excessiveness of load capacity and investment. Section 5 considers the effect of alliances on capacities and investment. The issue on antitrust immunity is also investigated. Section 6 provides concluding remarks.

2. The Model

We consider a simple three-country two-shipping-line model (Figure 1). There are three countries, \( H \), \( M \), and \( F \), one shipping line between \( H \) and \( M \) (the \( HM \) line), and one shipping line between countries \( M \) and \( F \) (the \( MF \) line). In each line, there are two shipping liners: firms 1 and 2 operate in the \( HM \) line, and firms 3 and 4 operate in the \( MF \) line. Countries \( H \), \( M \), and \( F \) produce goods \( H \), \( M \), and \( F \) and export them to other countries, respectively. The markets of these goods are competitive, and both fixed and variable costs of producing those goods are zero.
Producers have to purchase transportation service to export their products to other countries, which are supplied by shipping liners. There are two possible economic situations: a boom and a recession. Let $T_H$ and $t_H$ denote the charges for transporting a unit of any good (the price of a unit of transportation service) between countries H and M in a boom and in a recession, respectively. Also, let $T_F$ and $t_F$ denote the charges for transporting a unit of any good between countries M and F in a boom and in a recession, respectively.

The demand for good $i$ by consumers of country $j$ in a boom ($X_{ij}$, $i,j = H,M,F$) is given by

\[ X_{HI} = X_{MM} = X_{FM} = A, \quad X_{HM} = X_{MH} = A - \frac{T_H}{6}, \]
\[ X_{MF} = X_{FM} = A - \frac{T_F}{6}, \quad X_{HF} = X_{FH} = A - \frac{T_H + T_F}{6}. \]  

Then, total transportation demand between countries $H$ and $M$ in a boom is

\[ Q_{HM} = X_{MH} + X_{HM} + X_{FH} + X_{HF} = 2 \left( A - \frac{T_H + T_F}{6} + A - \frac{T_H}{6} \right), \]  

And the corresponding demand between countries $M$ and $F$ is

\[ Q_{MF} = X_{FM} + X_{MF} + X_{FH} + X_{HF} = 2 \left( A - \frac{T_H + T_F}{6} + A - \frac{T_F}{6} \right). \]  

On the other hand, demand for goods shrinks in a recession. Assuming that $A > a$, the demand for good $i$ by consumers of country $j$ in a recession ($x_{ij}$, $i,j = H,M,F$) is given by
\[ x_{HI} = x_{MM} = x_{FF} = a, \quad x_{HM} = x_{MI} = a - \frac{t_H}{6}, \]
\[ x_{MF} = x_{FM} = a - \frac{t_F}{6}, \quad x_{HF} = x_{FH} = a - \frac{t_H + t_F}{6}. \]  

Then, total transportation demand between countries \( H \) and \( M \) in a recession is

\[ q_{HM} = x_{MH} + x_{HM} + x_{FH} + x_{HF} = 2\left(a - \frac{t_H + t_F}{6} + a - \frac{t_H}{6}\right), \]  

And the corresponding demand between countries \( M \) and \( F \) is

\[ q_{MF} = x_{FM} + x_{MF} + x_{FH} + x_{HF} = 2\left(a - \frac{t_H + t_F}{6} + a - \frac{t_F}{6}\right). \]  

From (3) and (4), we obtain the inverse demand functions for transportation services in a boom in both lines:

\[ T_H = 4A - 2Q_{HM} + Q_{MF}, \quad T_F = 4A - 2Q_{MF} + Q_{HM}, \]  

and from (7) and (8), we obtain the inverse demand functions in a recession:

\[ t_H = 4a - 2q_{HM} + q_{MF}, \quad t_F = 4a - 2q_{MF} + q_{HM}. \]  

Let \( Q_k \) and \( q_k \) \((k = 1, 2, 3, 4)\) denote supply quantities of transportation by firm \( k \) in a boom and a recession, respectively. We assume that the marginal cost of transporting one unit of good for firm \( k \) is \( c_k \) \((k = 1, 2, 3, 4)\), which we also refer to as the marginal operation cost. The conditions that demand is equal to supply in equilibrium are given by

\[ Q_1 + Q_2 = Q_{HM}, \quad Q_3 + Q_4 = Q_{MF}, \quad q_1 + q_2 = q_{HM}, \quad q_3 + q_4 = q_{MF}. \]  

The structure of the game is described as follows. In the first stage, each firm/liner \( k \) determines its investment, which decreases its marginal operating cost of transportation. In the second stage, each firm \( k \) builds/determines its capacity, which we refer to as the maximum capacity for operation. In the third stage, nature determines the economic condition: boom or recession. The probability of a boom (a recession) is \( \gamma \) \((1 - \gamma)\). In the fourth stage, each liner determines the amounts of capacity for operation, which we refer to as the operating capacity. When the capacity for operation of firm \( k \) is smaller than the capacity it built in the second stage, it has to pay mooring costs for capacities that are not
operated. The unit mooring cost is $c_m$, which is assumed to be common to all liners.

We consider two cases for the objectives of liners. In the first case, each firm maximizes its own profit. On the other hand, in the second case, firms 1 and 3 maximize the sum of their profits, while firms 2 and 4 maximize the sum of their profits. In the latter case, it is considered that firms 1 and 3 are alliance partners, and firms 2 and 4 are also alliance partners.

3. Equilibrium Capacities

3.1 Equilibrium situation without any alliances

First, we consider the case in which each liner/firm chooses the maximum and operating capacities to maximize its profits. In the fourth stage, each firm determines its operating capacity after the economic situation becomes clear: a recession or a boom. Since the demand for transportation service in a boom is greater than that in a recession, capacities for operation in a boom ($Q^*_k$) are the same as those determined in the second stage ($\hat{Q}_k$): $Q^*_k = \hat{Q}$.

Thus, firms do not pay any mooring costs. On the other hand, in a recession, firms determine their operating capacities to maximize their own profits given the capacities built in the second stage. The objective functions are given by

$$\pi_1 = \{4a - 2(q_1 + q_2) + (q_3 + q_4) - c_1\} \cdot q_1 - (\hat{Q}_1 - q_1) \cdot c_m,$$  \hspace{1cm} (12)

$$\pi_2 = \{4a - 2(q_1 + q_2) + (q_3 + q_4) - c_2\} \cdot q_2 - (\hat{Q}_2 - q_2) \cdot c_m,$$  \hspace{1cm} (13)

$$\pi_3 = \{4a + (q_1 + q_2) - 2(q_3 + q_4) - c_3\} \cdot q_3 - (\hat{Q}_3 - q_3) \cdot c_m,$$  \hspace{1cm} (14)

$$\pi_4 = \{4a + (q_1 + q_2) - 2(q_3 + q_4) - c_4\} \cdot q_4 - (\hat{Q}_4 - q_4) \cdot c_m.$$  \hspace{1cm} (15)

The first-order condition (FOC) is given by

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7 We formally examine this fact later in this subsection.
The second-order conditions (SOC) are satisfied in this case. Consequently, we obtain the equilibrium supply of transportation services in the fourth stage when a recession takes place:

\[ q_1^* = \frac{32a - 11c_1 + 5c_2 - c_3 - c_4 + 8c_m}{32}, \quad q_2^* = \frac{32a + 5c_1 - 11c_2 - c_3 - c_4 + 8c_m}{32} \], \quad (16)

\[ q_3^* = \frac{32a - c_1 - c_2 - 11c_3 + 5c_4 + 8c_m}{32}, \quad q_4^* = \frac{32a - c_1 - c_2 + 5c_3 - 11c_4 + 8c_m}{32} \], \quad (17)

\[ q_{HM}^* = \frac{32a - 3(c_1 + c_2) - (c_3 + c_4) + 8c_m}{16}, \quad q_{MF}^* = \frac{32a - (c_1 + c_2) - 3(c_3 + c_4) + 8c_m}{16} \]. \quad (18)

For simplicity, we set up the following assumption.\(^8\)

**Assumption 1.** \( q_k^* < \hat{Q}_k \) (\( k = 1, 2, 3, 4 \)).

The equilibrium shipping charges are

\[ t_{HM}^* = \frac{32a + 5(c_1 + c_2) - (c_3 + c_4) - 8c_m}{16}, \quad t_F^* = \frac{32a - (c_1 + c_2) + 5(c_3 + c_4) - 8c_m}{16} \]. \quad (19)

From (14), we obtain that:

\[ t_{HM}^* - c_1 = \frac{32a - 11c_1 + 5c_2 - c_3 - c_4 - 8c_m}{32} \] \quad (20)

Comparison of (16) and (20) reveals that even if (20) is negative, the supply quantity of transportation service by firm 1 may be positive. The same situation may take place for other firms. Thus, we obtain the following result.

**Proposition 1.** \textit{In a recession, the transportation charge may be lower than the marginal operation cost. Accordingly, the profits of liners/firms may be negative in a recession.}

\(^8\) We describe the intuition later in this subsection.
The intuition is as follows. As noted above, a liner has to pay mooring costs when it anchors its container vessels. Thus, the cost for operating a unit of vessel is not the marginal operating cost but the marginal operating cost minus the mooring cost. Thus, if the mooring cost is relatively large, the charges may be lower than the marginal operation cost.

In the second stage, each firm determines its capacity before the economic situation becomes clear. Let $\Pi_k$ denote the profit of firm $k$ in a boom. Then, the objective function (the expected profits) for each firm in the second stage is given by

$$\hat{\pi}_k = \gamma \cdot \Pi_k^* + (1 - \gamma) \cdot \pi_k^*, \quad k = 1, 2, 3, 4.$$ (21)

Superscript * denotes the equilibrium variable in the fourth stage. Because capacity for operation in a recession is not influenced by the capacity building in the second stage, the objective function can be rewritten as follows:

$$\hat{\pi}_1 = \gamma \cdot \{4A - 2(Q_1 + Q_2) + (Q_3 + Q_4) - c_1\} \cdot Q_1 - (1 - \gamma) \cdot \left(\hat{Q}_1 - q_1^*\right) \cdot c_m,$$ (22)

$$\hat{\pi}_2 = \gamma \cdot \{4A - 2(Q_1 + Q_2) + (Q_3 + Q_4) - c_2\} \cdot Q_2 - (1 - \gamma) \cdot \left(\hat{Q}_2 - q_2^*\right) \cdot c_m,$$ (23)

$$\hat{\pi}_3 = \gamma \cdot \{4A + (Q_1 + Q_2) - 2(Q_3 + Q_4) - c_3\} \cdot Q_3 - (1 - \gamma) \cdot \left(\hat{Q}_3 - q_3^*\right) \cdot c_m,$$ (24)

$$\hat{\pi}_4 = \gamma \cdot \{4A + (Q_1 + Q_2) - 2(Q_3 + Q_4) - c_4\} \cdot Q_4 - (1 - \gamma) \cdot \left(\hat{Q}_4 - q_4^*\right) \cdot c_m.$$ (25)

The FOC is given by

$$\frac{\partial \hat{\pi}_k}{\partial Q_k} = 0.$$ (26)

The SOCs are also satisfied in this stage. Equations (21) through (24) reveal that $Q_k^* = \hat{Q}$ holds. To verify this point, consider the profit function of firm 1 in a boom in the fourth stage which is given by:

$$\pi_1 = \{4A - 2(Q_1 + Q_2) + (Q_3 + Q_4) - c_1\} \cdot Q_1 - \left(\hat{Q}_1 - Q_1\right) \cdot c_m.$$ (27)

The comparison of (20) and (24) suggests that, when considering the effect of the mooring cost, the marginal cost of supplying an additional unit of transportation service in (25) is
smaller than that in (21). The same relationship is obtained for any other firms. Thus, we obtain the equilibrium capacity building in the second stage that is equal to the equilibrium supply of transportation services in the fourth stage when a boom takes place:

\[
\hat{Q}_1 = Q_1^* = \frac{32A - 11c_1 + 5c_2 - c_3 - c_4 - 8(1 - \gamma)c_m/\gamma}{32},
\]

(26)

\[
\hat{Q}_2 = Q_2^* = \frac{32A + 5c_1 - 11c_2 - c_3 - c_4 - 8(1 - \gamma)c_m/\gamma}{32},
\]

(27)

\[
\hat{Q}_3 = Q_3^* = \frac{32A - c_1 - c_2 - 11c_3 + 5c_4 - 8(1 - \gamma)c_m/\gamma}{32},
\]

(28)

\[
\hat{Q}_4 = Q_4^* = \frac{32A - c_1 - c_2 + 5c_3 - 11c_4 - 8(1 - \gamma)c_m/\gamma}{32},
\]

(29)

\[
\hat{Q}_{HM} = Q_{HM}^* = \frac{32A - 3(c_1 + c_2) - (c_3 + c_4) - 8(1 - \gamma)c_m/\gamma}{16},
\]

(30)

\[
\hat{Q}_{MF} = Q_{MF}^* = \frac{32A - (c_1 + c_2) - 3(c_3 + c_4) - 8(1 - \gamma)c_m/\gamma}{16}.
\]

(31)

The equilibrium shipping charges in a boom in the fourth stage are

\[
T_{HM}^* = \frac{32A + 5(c_1 + c_2) - (c_3 + c_4) + 8(1 - \gamma)c_m/\gamma}{16},
\]

(32)

\[
T_{MF}^* = \frac{32A - (c_1 + c_2) + 5(c_3 + c_4) + 8(1 - \gamma)c_m/\gamma}{16}.
\]

(33)

We should also confirm the situation in which Assumption 1 holds. Because \( A > a \), it is clear that \( \hat{Q}_k > q_k^* \) holds if \( \gamma \geq 0.5 \). Even if \( \gamma < 0.5 \), \( \hat{Q}_k > q_k^* \) may hold depending on the difference between \( A \) and \( a \). Thus, (i) the possibility of a recession is not very large, or/and (ii) the relative size of the demand in a boom is sufficiently large as compared with that in a recession, Assumption 1 holds.

In the first stage, each firm determines the investment amount, which is denoted by \( B_k \) \((k = 1,2,3,4)\). This investment decreases the marginal operating cost. For example, the size of container vessels has been becoming larger for the past several decades. A shipping liner may have to invest in the port facilities. It may also have to invest in management skills for operating large-sized vessels. Human capital, such as the skill for navigation and know-how
are also needed. Liners have to pay the costs for these types of investment before they introduce large-sized vessels. However, once introduced, the marginal operating cost becomes lower as compared with when small-sized vessels are used. The cost of one unit of investment is equal to one, which means that the total investment cost is equal to $B_k$. The investment by each firm decreases its own marginal cost:

$$c_k(B_k), \quad c'_k < 0, \quad c''_k > 0.$$ 

The objective function of each firm is given by

$$\hat{\Pi}_k = \hat{\alpha}_k^{**}(c_k(B_k),c_{-k}) - B_k.$$ 

Superscript $**$ denotes the equilibrium variable in the second stage. In addition, subscript $-k$ denotes firms other than firm $k$. The FOC is given by

$$\frac{\partial \hat{\Pi}_k}{\partial B_k} = 0.$$

### 3.2 Existence of Alliances

Let us now consider a type of global alliances: firms/liners in different lines cooperate with each other. In our model, firms 1 and 3 are alliance partners of the alliance group 1, and firms 2 and 4 are also alliance partners of the alliance group 2. The objective of these firms is to choose capacities or/and investments to maximize the sum of the (expected) profits of both firms in the same alliance group.

In the fourth stage, the objective functions for both alliance groups in a recession are given by:

$$\pi_{G1} = \pi_1 + \pi_3, \quad \pi_{G2} = \pi_2 + \pi_4,$$

where subscripts $G1$ and $G2$ denote the alliance group 1 and 2, respectively. Similar to the case without alliances, we assume that the operating capacity in a recession is necessarily smaller than the maximum capacity built in the second stage (see Assumption 1). The FOCs
are:
\[
\frac{\partial \pi_{G_1}}{\partial q_1} = 0, \quad \frac{\partial \pi_{G_1}}{\partial q_3} = 0, \quad \frac{\partial \pi_{G_2}}{\partial q_2} = 0, \quad \frac{\partial \pi_{G_2}}{\partial q_4} = 0. \tag{35}
\]

The second-order conditions (SOC) are satisfied in this case. Consequently, we obtain the equilibrium supply of transportation services in the fourth stage when a recession takes place:
\[
q_{1,G}^* = \frac{12a - 4c_1 + 2c_2 - 2c_3 + c_4 + 3c_m}{9}, \quad q_{2,G}^* = \frac{12a + 2c_1 - 4c_2 + c_3 - 2c_4 + 3c_m}{9}, \tag{36}
\]
\[
q_{3,G}^* = \frac{12a - 2c_1 + c_2 - 4c_3 + 2c_4 + 3c_m}{9}, \quad q_{4,G}^* = \frac{12a + c_1 - 2c_2 + 2c_3 - 4c_4 + 3c_m}{9}, \tag{37}
\]
\[
q_{HM,G}^* = \frac{24a - 2(c_1 + c_2) - 2c_m + 6c_m}{9}, \quad q_{MF,G}^* = \frac{24a - (c_1 + c_2) - 2c_m + 6c_m}{9}, \tag{38}
\]

where subscript \( G \) denotes the case in the presence of global alliances.

The equilibrium shipping charges are
\[
I_{H,G}^* = \frac{12a + 3(c_1 + c_2) - 6c_m}{9}, \quad I_{F,G}^* = \frac{12a + 3(c_3 + c_4) - 6c_m}{9}. \tag{39}
\]

Two points should be noted. First, interestingly, the shipping charge for the \( HM \) line is not influenced by changes in the marginal operation costs of the \( MF \) line. Similarly, the shipping charge for the \( MF \) line is not influenced by changes in the marginal operation costs of the \( HM \) line. Second, similar to the case without alliances, even if the shipping charges are lower than the marginal operating costs, liners may supply positive amounts of transportation services.

Similarly, we obtain the equilibrium capacity building in the second stage that is equal to the equilibrium supply of transportation services in the fourth stage when a boom takes place:
\[
\hat{Q}_{1,G} = Q_{1,G}^* = \frac{12A - 4c_1 + 2c_2 - 2c_3 + c_4 - 3(1 - \gamma)c_m}{9}/\gamma, \tag{40}
\]
\[
\hat{Q}_{2,G} = Q_{2,G}^* = \frac{12A + 2c_1 - 4c_2 + c_3 - 2c_4 - 3(1 - \gamma)c_m}{9}/\gamma, \tag{41}
\]
\[
\hat{Q}_{3,G} = Q_{3,G}^* = \frac{12A - 2c_1 + c_2 - 4c_3 + 2c_4 - 3(1 - \gamma)c_m}{9}/\gamma. \tag{42}
\]
\[
\hat{Q}_{A,G} = \mathcal{Q}_{A,G}^* = \frac{12A + c_1 - 2c_2 + 2c_3 - 4c_4 - 3(1 - \gamma)c_m}{9},
\]

\[
\hat{Q}_{HM,G} = \mathcal{Q}_{HM,G}^* = \frac{24A - 2(c_1 + c_2) - (c_3 + c_4) - 6(1 - \gamma)c_m}{9},
\]

\[
\hat{Q}_{MF,G} = \mathcal{Q}_{MF,G}^* = \frac{24A - (c_1 + c_2) - 2(c_3 + c_4) - 6(1 - \gamma)c_m}{9}.
\]

The equilibrium shipping charges in a boom in the fourth stage are

\[
T_{H,G}^* = \frac{12A + 3(c_1 + c_2) + 6(1 - \gamma)c_m}{9}, \quad T_{F,G}^* = \frac{12A + 3(c_3 + c_4) + 6(1 - \gamma)c_m}{9}.
\]

Comparing the quantities and shipping charges in the presence of global alliances with those in the absence of alliances, we obtain the following results.

**Proposition 2.** Global alliances (i) increase the supply of transportation services, and (ii) decrease shipping charges. Moreover, a shipping charge in a certain line is not influenced by changes in the marginal operation costs of the other line, although the supply of transportation quantities in a certain line are influenced by changes in the marginal operation costs of the other line.

Intuition for the first result is as follows. An increase in a transportation service in the \( HM \) line directly lower the shipping charge of the line. This price decrease increases not only the demand of consumers in country \( M \) for transportation services between countries \( H \) and \( M \), but also increases the demand of consumers in country \( F \) for transportation services between countries \( M \) and \( F \). This demand increase benefits the liners that are operating in the \( MF \) line, and gives those liners incentives to increase the supply of transportation services. In other words, transportation services in different lines are complements.

If an alliance agreement includes a clause on investment, liners may also determine the investment amounts to maximize the sum of the profits of alliance members. Then, the objective function of each firm is given by
\[ \hat{\Pi}_{G1} = \hat{\Pi}_1 + \hat{\Pi}_3, \quad \Pi_{G2} = \hat{\Pi}_2 + \hat{\Pi}_4. \]

4. Capacities and Investment

In this section, we investigate the important issue for this industry: first, we consider whether excess capacity takes place and, then, we examine whether excess investment can be realized. Although several cases are possible depending on the nationality of liners, it is redundant to enumerate all cases. Thus, focusing on the capacity and investment of firms 1, we examine the following two cases: first, firm 1 is the firm of country \( H \) (home firm), which implies that the profit of firm 1 is taken into consideration when examining the welfare of country \( H \); second, by contrast, firms 2 is the home firm. Moreover, when we consider the welfare of one country, we focus on that of country \( H \) (home welfare).

4.1 Capacities without Alliances

Given the investment amounts in the first stage, we examine whether each firm’s maximum capacity is excessive or insufficient in terms of the welfare of one country or global welfare. We define that welfare is the sum of consumer surplus and the profits of firms.

First, we focus on the case of recession. From equations (5) and (6), we obtain the equilibrium consumer surplus of each country in a recession (\( cs_i \)):

\[ cs^*_H = 3x_{HH}^2 + 3x_{MH}^2 + 3x_{FH}^2, \quad cs^*_M = 3x_{MM}^2 + 3x_{HM}^2 + 3x_{FM}^2, \quad cs^*_F = 3x_{FF}^2 + 3x_{HF}^2 + 3x_{MF}^2. \] (47)

Changes in the international transportation sector does not affect the consumption of domestic goods (\( x_{ii}, \ i = H, M, F \)). Thus, we exclude the consumer surplus generated by the consumption of domestic goods in the following analysis.

Consider the equilibrium situation in the fourth stage. A marginal increase in the transportation service of firm 1 does not change the profit of firm 1. On the other hand, this marginal increase affects consumer surplus and the profits of other firms. From (5), (6), (10),
and (44), we obtain that
\[ \frac{\partial cs_{MH}}{\partial q_1} = 2x_{MH}^* + x_{FH}^*, \quad \frac{\partial cs_{MH}}{\partial q_1} = 2x_{MH}^* - x_{FM}^*, \quad \frac{\partial cs_{F}}{\partial q_1} = x_{HF}^* - x_{MF}^*. \]
(48)

It is interesting that an increase in the supply of transportation services in a certain line may
decrease the consumer surplus of countries that are directly connected to the other line. The
fact that transportation services in different lines are complements is the key to understand
this result. An increase in the supply in the \( HM \) line result in an increase in the shipping
charge in the \( MF \) line, which leads to a decrease in the trading amounts of goods \( M \) and
\( F \) between countries \( M \) and \( F \). Moreover, from (13) through (15), we obtain that
\[ \frac{\partial \pi_2^*}{\partial q_1} = -2q_2^*, \quad \frac{\partial \pi_1^*}{\partial q_1} = q_3^*, \quad \frac{\partial \pi_1^*}{\partial q_1} = q_4^*. \]
(49)
The sign of the effects are intuitive when taking into consideration the complementarity.

Consider the case in which firm 1 is the home firm. In this case, a marginal increase in
the supply of firm 1 at equilibrium necessarily increases the consumer surplus of country \( H \).
This fact implies that the supply of transportation services by firm 1 is insufficient in terms
of the home welfare. Moreover, from (7), (8), and (11), it holds that
\[ x_{MH}^* + x_{HM}^* + x_{HF}^* > q_2^*, \quad x_{MF}^* + x_{FM}^* + x_{HF}^* + x_{FH}^* = q_3^* + q_4^*. \]
Then, from (48) and (49), we obtain that
\[ \frac{\partial cs_{MH}}{\partial q_1} + \frac{\partial cs_{MH}}{\partial q_1} + \frac{\partial cs_{F}}{\partial q_1} + \frac{\partial \pi_2^*}{\partial q_1} + \frac{\partial \pi_3^*}{\partial q_1} + \frac{\partial \pi_4^*}{\partial q_1} > 0. \]
(50)
This inequality implies that the supply of transportation services by firm 1 is insufficient in
terms of global welfare.

Consider the case in which firm 2 is the home firm. It may hold that \( 2q_2^* > 2x_{HM}^* + x_{FH}^* \).
This inequality implies a possibility that a marginal increase in the supply of firm 1 at
equilibrium may decrease the home welfare. Thus, the supply of transportation services by
firm 1 may be excessive in terms of the home welfare. The lower is the marginal operating
cost of firm 2 as compared with that of firm 1, the more likely it is that the supply of firm 1
is excessive. On the other hand, (50) also holds in this case. Thus, the insufficiency of the
supply of firm 1 in terms of global welfare holds.

Comparison of the objective functions in a recession ((12) through (15)) and those in the
second stage ((21) through (24)) reveals that the same results are obtained for the
insufficiency/excessiveness of the supply of transportation services (and the capacity) in a
boom.

Then, is there no possibility that the supply of transportation services is excessive in
terms of global welfare? Consider a case in which the home government supports the home
firm/liner, which is firm 1, for building its capacity or supplying transportation services to
maximize its welfare. Evaluating the effect of a marginal increase in the supply of firm 1 on
global welfare \( w^*_h \) in a recession when the home welfare is maximized, we obtain that

\[
\left. \frac{\partial w^*_h}{\partial q_1} \right|_{\frac{\partial w^*_h}{\partial q_1}=0} = \frac{\partial cs^*_M}{\partial q_1} + \frac{\partial cs^*_F}{\partial q_1} + \frac{\partial \pi^*_2}{\partial q_1} + \frac{\partial \pi^*_3}{\partial q_1} + \frac{\partial \pi^*_4}{\partial q_1}
\]

where \( hw^*_h \) denotes the home welfare in equilibrium in a recession. From (49), it can be
said that (51) may be either positive or negative, which implies that the supply of firm 1 may
be excessive in terms of global welfare.

**Proposition 3.** (i) Suppose that firm 1 is the home firm. When there is no governmental
support for the supply of transportation services, the supply of firm 1 is insufficient in terms
of both the home welfare and global welfare. However, when the home government supports
the home firm for supplying the transportation services, the supply of firm 1 may be
excessive in terms of global welfare. (ii) Suppose that firm 2 is the home firm. Then, the
supply of firm 1 is insufficient in terms of global welfare, while it may be excessive in terms
of the home welfare.
4.2 Investment without Alliances

Now let us turn to the first stage: the investment amounts by liners for decreasing the operating cost. We examine whether each firm's investment is excessive or insufficient in terms of the home welfare and global welfare.

From (5), (6), and (19), the equilibrium consumption amounts in a recession are given by

\[
x_{HM}^* = x_{MF}^* = \frac{64a - 5(c_1 + c_2) + (c_3 + c_4) + 8c_m}{96},
\]

(52)

\[
x_{MF}^* = x_{FM}^* = \frac{64a + (c_1 + c_2) - 5(c_3 + c_4) + 8c_m}{96},
\]

(53)

\[
x_{HF}^* = x_{FH}^* = \frac{32a - 4(c_1 + c_2 + c_3 + c_4) + 16c_m}{96},
\]

(54)

and, from (1), (2), (32), and (33), those in a boom are given by

\[
X_{HM}^* = X_{MF}^* = \frac{64A - 5(c_1 + c_2) + (c_3 + c_4) - 8(1 - \gamma)c_m}{96},
\]

(55)

\[
X_{MF}^* = X_{FM}^* = \frac{64A + (c_1 + c_2) - 5(c_3 + c_4) + 8(1 - \gamma)c_m}{96},
\]

(56)

\[
X_{HF}^* = X_{FH}^* = \frac{32A - 4(c_1 + c_2 + c_3 + c_4) + 16(1 - \gamma)c_m}{96}.
\]

(57)

Consider the equilibrium situation in the first stage. A marginal increase in the investment by firm does not change the profit of firm 1. On the other hand, this marginal increase affects consumer surplus and the profits of other firms. Let $CS_i$ denote the equilibrium consumer surplus in the first stage of country $i$ ($i = H, M, F$). From (48), and (52) through (57), we obtain the effects of a change in $c_1$ on the expected consumer surplus, which are given by

\[
\frac{\partial CS_H}{\partial c_1} = -\gamma \left( \frac{5X_{HM}^* + X_{FH}^*}{16} \right) - (1 - \gamma) \left( \frac{5X_{HM}^* + X_{FH}^*}{16} \right),
\]

(58)

\[
\frac{\partial CS_M}{\partial c_1} = -\gamma \left( \frac{5X_{HM}^* - X_{FM}^*}{16} \right) - (1 - \gamma) \left( \frac{5X_{HM}^* - X_{FM}^*}{16} \right),
\]

(59)
\[
\frac{\partial \bar{C} \bar{S}_F}{\partial c_1} = -\gamma \left( \frac{X_{HF}^*}{4} - \frac{X_{MF}^*}{16} \right) - (1 - \gamma) \left( \frac{x_{HF}^*}{4} - \frac{x_{MF}^*}{16} \right). \tag{60}
\]

Because an additional unit of investment decreases the marginal operating cost, it is clear that a small increase in investment by firm 1 at equilibrium (i) increases expected consumer surplus of country \( H \); (ii) increases expected consumer surplus arising from consumption of goods \( H \) in countries \( M \) and \( F \); (iii) decreases expected consumer surplus arising from consumption of goods \( M \) (\( F \)) in country \( F \) (\( M \)).

From (12) through (17), (21) through (24), and (26) through (29), we obtain the effects of a change in \( c_1 \) on the expected profits of other firms (\( \bar{\Pi}_k \)), which are given by

\[
\begin{align*}
\frac{\partial \bar{\Pi}_2}{\partial c_1} &= \gamma \cdot \frac{5Q_2^*}{8} + (1 - \gamma) \cdot \frac{5q_2^*}{8}, \\
\frac{\partial \bar{\Pi}_3}{\partial c_1} &= -\gamma \cdot \frac{Q_3^*}{8} - (1 - \gamma) \cdot \frac{q_3^*}{8}, \\
\frac{\partial \bar{\Pi}_4}{\partial c_1} &= -\gamma \cdot \frac{Q_4^*}{8} - (1 - \gamma) \cdot \frac{q_4^*}{8}. \tag{61}
\end{align*}
\]

It is clear that a small increase in investment by firm 1 at equilibrium (i) increases the expected profits of firms 3 and 4; (ii) decreases the expected profit of firm 2.

Similar to the analysis on capacities, we consider the case in which firm 1 is the home firm. In this case, as noted above, because a marginal increase in the investment by firm 1 necessarily increases the consumer surplus of country \( H \). This fact implies that the investment amount by firm 1 is insufficient in terms of the home welfare. On the other hand, the sum of the effects on consumer surplus of three countries and the profits of firms 2, 3, and 4 may be either positive or negative. In particular, if

\[
Q_2^* > \frac{X_{HM}^* + 6X_{HF}^*/5 + X_{MF}^*/5}{5}
\]

holds and, accordingly, if \( q_2^* > \frac{x_{HM}^* + 6x_{HF}^*/5 + x_{MF}^*/5}{5} \) holds, the sum of the effects is positive, which implies that the investment amount by firm 1 is excessive in terms of global welfare. When \( c_1 = c_2 \) holds, the condition (\((60)\)) cannot be satisfied because \( Q_2^* = X_{HM}^* + X_{HF}^* \). Thus, define that the larger is the marginal effect of a unit of investment on the decrease in the marginal operating cost, the more efficient is the investment. Then, the
more efficient is the investment of firm 2 and, accordingly, the lower the marginal operating cost of firm 2 as compared with that of firm 1, the more likely it is that the investment by firm 1 is excessive in terms of global welfare.

Next, consider the case in which firm 2 is the home firm. It may hold that

$$\frac{5Q_2^*}{8} > \frac{5X_{MH}^*}{16} + \frac{X_{FH}^*}{4}.$$ 

This can be hold even if firm 1 is more competitive than firm 2. This inequality implies a possibility that a marginal increase in the investment by firm 1 at equilibrium may decrease the home welfare. Thus, the investment amount of firm 1 may be excessive in terms of the home welfare. The result for global welfare is the same as the case in which firm 1 is the home firm.

Analogous to the case of excessiveness of capacities, the possibility that the investment amount by firm 1 is excessive in terms of global welfare becomes stronger, when firm 1 is the home firm and the home government supports the home firm for investing in decreasing the marginal operating cost. This fact can be verified by observing the sign of (58), which is negative. This negative sign implies that a small increase in the investment by firm 1 increases the home consumer surplus. Thus, the home government has an incentive to support the home firm (firm 1) for investing in decreasing the marginal operating cost.

**Proposition 4.** (i) Suppose that firm 1 is the home firm. When there is no governmental support for the investment in decreasing the marginal operating cost, the investment amount of firm 1 is insufficient in terms of both the home welfare and global welfare. On the other hand, it may be excessive in terms of global welfare. The support by the home government increases the possibility of excessiveness, (ii) Suppose that firm 2 is the home firm. Then, the investment amount of firm 1 may be excessive in terms of both home welfare and global welfare.
5. Alliance Effects and Antitrust Immunity

In this section, we focus on two important features of international container transportation industry: alliances and the application of antitrust immunity, and consider the effects of those factors on capacities and investment.

First, consider the alliance effects. Proposition 2 states that global alliances increases the supply of transportation services given the investment amounts by liners in the first stage. Therefore, intuitively, it seems that the global alliances mitigate the degree of insufficiency although they make the problem of excessiveness more serious.

To verify this point, recall the objective functions and FOCs in the presence of alliances ((34) and (35)). Firm 1 determines the supply to maximize the sum of the profits of firms 1 and 3. Other firms do the similar decision makings on the supplies of their transportation services. When comparing the equilibrium supply and the optimal supply in terms of global welfare, we do not need to take into consideration $\frac{\partial \pi^*_{3,G}}{\partial q_3}$. This means that the fourth term in the right hand side of (49) is dropped from this comparison.9

Applying (47) for the case with alliances, it is obvious that $\frac{\partial \pi^*_{3,G}}{\partial q_3}$ is positive, which implies that global alliances mitigate the degree of insufficiency and make the problem of excessiveness more serious. Moreover, it is possible that the supply of firm $k$ may be excessive in terms of global welfare. For example,

$$\left. \frac{\partial w^*_{R,G}}{\partial q_1} \right|_{\frac{\partial w^*_{R,G}}{\partial q_1} = 0} = \frac{\partial c s^*_{M,G}}{\partial q_1} + \frac{\partial c s^*_{F,G}}{\partial q_1} + \frac{\partial \pi^*_{2,G}}{\partial q_1} + \frac{\partial \pi^*_{4,G}}{\partial q_1}$$

may be negative. In particular, the greater is the supply of firm 2 as compared with that of firm 1, and the greater is the supply of firm 3 as compared with that of firm 4, the more

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9 Precisely, equation (49) represents the partial derivative at equilibrium in the absence of global alliances. However, the partial derivative at equilibrium in the presence of alliances can be written in a similar way.
likely it is that the supply of firm 1 is excessive in terms of global welfare. Similar to the case in the absence of global alliances, the same result is obtained in a boom.

Now let us turn to the investment amount in the first stage. Similar to the supply of transportation services, applying (61) to the case in the presence of alliances, it is obtained that \( \frac{\partial \widetilde{\Pi}_{3,G}}{\partial c_1} \) is dropped when comparing the equilibrium investment amounts and the optimal ones in terms of global welfare ((61)). Because the sign of the second equation in (61) is clearly negative, it can also be said that global alliances encourage the investment of each firm for decreasing its marginal operating cost. Thus, global alliances mitigate the degree of insufficiency of the investment and make the problem of excessiveness more serious.

Now let us turn to the effect of antitrust immunity. There are various types of the application of antitrust immunity, because there are various types of possible cartels and capacity coordination. It is obvious that any types of cartels between liners that operate in the same line decrease the supply of transportation service, because cartels basically maximize the sum of the profits of the firms in the same line. Because antitrust immunity allows firms to form a cartel, it can be said that the application of antitrust immunity makes the degree of insufficiency of the supply of transportation services more serious, and mitigates the excessiveness.

On the other hand, cartels do not necessarily discourage the investment by firms for decreasing the marginal operating cost. For example, consider a cartel that includes a clause on capacity coordination: the share of a liner is determined based on the maximum capacity it has. Then, the more investment a liner does, the greater share it expects to have when a cartel is formed. In this case, a small increase in the investment by a liner increases its market share in the presence of a cartel. Thus, the marginal benefit of an increase in the investment may be greater in the presence of a cartel than that in the absence of a cartel. In
such a case, the application of antitrust immunity may encourage the investment by firms, which implies that antitrust immunity may mitigate the degree of insufficiency of the investment and make the problem of excessiveness more serious. In contrast with the supply of transportation services, whether antitrust immunity discourages the investment depends on which types of cartels are allowed under the enforcement of the antitrust law.

6. Conclusion

In this paper, introducing the unique characteristics of the international marine transport industry, such as alliances, uncertainty, and the application of antitrust immunity, we examined (i) whether load capacity is excessive or insufficient in the presence of uncertainty on the future economic situation in terms of both welfare of one country and global welfare, and (ii) the effects of alliances on load capacity and shipping charges. We also investigated the welfare effect of investment by shipping liners for decreasing marginal operating costs. Similar to the analysis on load capacity, we examined whether the investment amounts are excessive or insufficient in terms of global welfare. Moreover, we considered the effect of removing antitrust immunity on investment and load capacity and, accordingly, governments’ decision makings on antitrust immunity.

We obtained several interesting results. First, the transportation charge may be lower than the marginal operation cost and, accordingly, the profits of liners/firms may be negative in a recession. This result suggests that the profits of liners can be unstable and, accordingly, it is possible that shipping liners may hesitate to construct new vessels even if the construction is justified in terms of profit maximization.

Second, global alliances increase the supply of transportation services, and decrease shipping charges. Complementarity of transportation services in different lines play a key role for this result. When one liner take into consideration the profit of the other alliance
member that is operating in the other line, a small increase in its transportation service/capacity increases the profits of the other member.

Third, the supply of transportation service and the investment for decreasing the marginal operating cost by each liner is insufficient in terms of global welfare when there are neither governmental supports nor global alliances. The reason for this insufficiency is the distortion caused by imperfect competition and the uncertainty on future economic situations when building capacities.

Fourth, global alliances mitigate the degree of insufficiency of the supply and investment, and make the problem of excessiveness more serious. This result is intuitive after obtaining the third result. The key for the result is also complementarity of transportation services in different lines. Moreover, the supply of transportation service and the investment for decreasing the marginal operating cost by each liner may be excessive in terms of global welfare even if there are no governmental supports.

Finally, whether antitrust immunity is applied influences the insufficiency/excessiveness of the supply of transportation services and the investment for decreasing the marginal operating costs through changing the marginal effect of an increase in the supply or the investment on the profits.

In this paper, we have not considered a few factors that are specific to this industry. First, there are other types of the structure of international lines in the real world, such as triangles with three countries. Second, governments seem to use antitrust immunity strategically. Moreover, each line connects two countries. Therefore, in terms of international law, it is important to determine which country’s law application is effective: the way of application may influence the market structure and capacities. It is also interesting to investigate this industry by including these aspects.
References


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