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A Study of Subsidy Policy in the Ship Financing Market

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ABSTRACT

This study considers the case in which governments decide whether to support private commercial banks with a subsidy policy in order to encourage participation in the international ship financing market. We examine two cases: (i) identical efficiency between domestic and foreign commercial banks; and (ii) different efficiencies between these banks. In the first case, the domestic government has the incentive to provide a subsidy strategy for domestic commercial banks to maximize social welfare, while the foreign government does not use the subsidy support. Furthermore, in the second case, foreign governments and commercial banks always prefer the subsidy strategy in order to maximize both social welfare and profits. However, the domestic government uses the subsidy strategy depending on the efficiency gap between the two banks. Our model suggests that governments need to support commercial banks with an appropriate subsidy strategy (direct or indirect) to promote participation in the market.

1. Introduction

The theory of the banking industry has remarkably progressed in terms of the game theoretical approach (e.g., Tirole, 2006; Xavier and Rochet, 1997). Banks are defined as financial intermediaries that buy securities of a certain type (loans) and sell securities of another type (deposits). Indeed, granting a loan is similar to buying a security issued by borrowers. Likewise, collecting deposits is similar to issuing securities. This discussion confirms the traditional view of banking, which emphasizes buying funds from depositors and selling them to borrowers. Therefore, these activities form the demand for loans by borrowers and the supply of deposits by householders.

Recently, there has been an increase in the literature regarding both the banking industry (e.g., privatization of state-owned banks in a mixed oligopoly market) and the incentive strategy of private commercial banks in the context of industrial organization. Specifically, Monti (1972) and Klein (1971) applied a model to the case of risky loan borrowing using the industrial organization approach.

Moreover, Purroy and Salas (1999) discovered that in oligopolistic markets, an expense preference behavior bank outperforms a profit maximizing bank with respect to market share and profits, even if both banks have identical costs and demand functions. Furthermore, Saha and Sensarma (2010) showed that state-owned banks, which are purely a welfare maximizing institution, and private commercial banks, which do not offer managerial incentives, face risks in loan markets due to downsizing. Fries et al. (2006) noted that during the post-communist transition, foreign bank entry and privatization resulted in lower marginal costs of individual banks and attracted greater demand for banking services. Chen et al. (2009) found that if the efficiency gap between state-owned banks and private banks is not large enough in a mixed oligopoly market, a partial release of shares is the best strategy for governments. Thus, the theoretical and empirical literatures have focused on the optimal privatization of state-owned banks, the managerial incentive strategy of private commercial banks, as well as the changes in social welfare caused by foreign equity participation in the banking industry.

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The existing literature, however, has paid little attention to aspects of industrial organizations with competition between domestic and foreign banks featuring subsidies offered by each government. To fill this gap, we combine the models of Purroy and Salas (1999) and Saha and Sensarma (2010) to discuss the endogenous choice of a government's subsidy for commercial banks in the international banking industry. Due to addressing this issue in the industrial organization context, the potential impact of government subsidy was not incorporated theoretically.

In fact, financing policy is necessary for trade policies dependent on financial support promoting growth for industry or for project financing. However, this type of financing commonly features high risk and conditions such as long-term horizons and low interest rates. Therefore, while state-owned banks are the main participants, limited private commercial banks participate in loan markets. However, financing, which is mainly organized by state-owned banks, may lead to the violation of regulations within the WTO agreements which prohibits the use of subsidies. Therefore, indirect ways for government support of banks are necessary. Thus, government incentives (explicit or implicit subsidies) to private commercial banks to supply loans to specific industries could be one alternative to attract private commercial banks into the loan market.

From our theoretical model, we can provide necessary implications for the ship financing market, which consists of domestic and foreign private commercial banks. For example, there have been considerable studies concerning Asian countries, such as China and Korea, regarding the trend analysis of the present ship financing market and political proposals. However, the game theoretical analysis has been limited in examining bank efficiency in the ship financing market, or the relationship between social welfare and bank profits.

Recently, the ship financing market has been adversely affected by the global financial crisis. Most European banks have reduced participation in the international ship financing market. Furthermore, in compliance with the Basel III guidelines, these banks have strengthened their loan conditions in the ship financing market. Therefore, the necessity for alternative sources of financing has increased. The decline of ship financing has caused a recession in the shipbuilding and shipping industries, which may have extensive negative effects on not only export strategies, but also other industries. Thus, it is necessary to reform and expand the existing Asian ship financing system.

In this study, we focus on the effects on bank profits and social welfare in which the government provides incentives to banks in order to encourage participation in the loan market. Following the basic model of Chen et al. (2009), this study suggests a duopoly ship financing loan market in which domestic and foreign commercial banks compete. First, we focus on the case in which both banks have identical efficiency. Subsequently, we consider a second case that features different efficiencies of these banks.

This paper is organized as follows: Section 2 sets out the basic model. Section 3 analyzes and compares the results when the efficiency levels in both banks are identical. Likewise, Section 4 demonstrates and compares the results when both banks have different levels of efficiency. Finally, Section 5 closes the paper with concluding remarks.

2. The model

We consider an extension of Chen et al. (2009)'s model of mixed oligopoly in which state-owned banks compete with foreign and domestic commercial banks. Hence, we consider that under a pure duopoly situation, a domestic commercial bank competes with a foreign commercial bank. Both banks compete in the ship financing loan market with the supply function using a homogeneous product. l_1 and l_2 represent the production capacity of each bank. We consider the market's inverse demand for ship financing loans to be linear, given by:

$$R = A - L, \text{ where } L = l_1 + l_2,$$

where R denotes loan interest rates, A is the reserve interest rate of each bank for loans, and L represents the total supply of ship financing loans in the market. Moreover, D is the total deposit in the market:

$$D = d_1 + d_2.$$

Let us denote θ ($0 < \theta < 1$) as the deposit reserve ratio; hence, $L = (1 - \theta)D$. This formula can be stated as $D = L/(1 - \theta) = \alpha L$, $\alpha = 1/(1 - \theta) > 1$ as the ratio between loans and deposits. In addition, $d_1 = \alpha l_1$, $d_2 = \alpha l_2$. For convenience, we assume that the fixed costs are zero. (Furthermore, governments have mostly supported the commercial banks participating in the international ship financing market by guaranteeing bank loans. This could be considered as fixed costs of the bank's profit. In this study, we assumed that fixed costs are zero, and we focused more on the explicit supports, such as tax benefits or monetary support for training of professionals in the field of ship financing.) Furthermore, we suppose that the costs in both banks are equal in terms of production condition. In the main body of analysis, we focus on the cost function for each bank, which is given by:

$$c_i(d_i, l_i) = \frac{1}{2} \hat{k}_i d_i^2 + \frac{1}{2} \hat{k}_i l_i^2 = \frac{1}{2} \hat{k}_i \alpha l_i^2 + \frac{1}{2} \hat{k}_i l_i^2 = \frac{1}{2} (1 + \alpha) \hat{k}_i l_i^2 = \frac{1}{2} k_i l_i^2,$$

where $\hat{k}_i > 0$, $i = 1, 2$ denotes the cost parameter of the domestic or foreign commercial bank and $k_i = (1 + \alpha)^2 \hat{k}_i$.

With this consideration in mind, the profit function of each bank can be written as:

$$\pi_1 = Rl_1 - rd_1 - c_1(d_1, l_1) + s_1 l_1, \quad \pi_2 = Rl_2 - rd_2 - c_2(d_2, l_2) + s_2 l_2,$$

where r denotes the interest rates paid to depositors in the market. Note that s_i is the unit subsidy rate and it represents a subsidy for the domestic commercial bank offered by the domestic government. Using the definition $r/(1 - \theta) = \alpha r = \hat{r}$, we can rewrite as follows:

$$\pi_1 = (A - \hat{r} - l_1 - l_2)l_1 - \frac{1}{2}k_1 l_1^2 + s_1 l_1, \quad \pi_2 = (A - \hat{r} - l_1 - l_2)l_2 - \frac{1}{2}k_2 l_2^2.$$

As stated above, both domestic and foreign commercial banks maximize their profits, while the goal of both the domestic and foreign governments is to maximize social welfare. (We follow the concept of domestic government's social welfare from Chen et al. (2009), which was derived from the profit of banks and consumer surplus of borrowers and depositors.) Furthermore, in this basic model, social welfare also considers the profit of the domestic and foreign commercial banks. Given that there are no subsidies, the foreign government's payoff is the same as that of the foreign commercial bank, and the social welfare of both governments is given by:

$$W_1^{sn} = \pi_1^{sn} + \frac{L^2}{2} - s_1 l_2^{sn}, \quad W_2^{sn} = \pi_2^{sn},$$

where W_2^{sn} represents the social welfare for the foreign government. Furthermore, $L^2/2$ denotes consumer surplus based on the assumption of linear demand. (The main borrowers, such as a shipping company or a shipbuilding company, receive benefits. Furthermore, depositors also have benefits because the loans are mainly composed of their deposits.)

Specifically, a two-stage game model is used. In the first stage, the domestic government decides to provide a subsidy explicit or implicit subsidy to the domestic commercial bank which competes in the ship financing loan market. (The literature on ship financing in Asian countries pointed out the following: First, government provides specific incentives (e.g., tax benefits) to private commercial banks that offer financial products in the ship financing market. Second, the government supports educational programs to foster competence in specialists who engage in ship financing. Third, the government invests in establishing specialized institutions with private commercial banks for ship financing. Fourth, the government has committed to support the domestic shipping and shipbuilding industries (Maritime Korea, 2011-13).) In the second stage, given a subsidy by the domestic government, the domestic and the foreign commercial banks choose their loan levels simultaneously in order to maximize their own profits.

3. The case of identical cost between two banks

In this section, we assume that the efficiency in both domestic and foreign banks is identical. (Even though we assumed that the efficiency in both banks is identical, this does not imply that both are identically efficient. Rather, it implies that both banks simply have the same cost function.) Specifically, we consider four main scenarios: (i) The subsidy is only provided by the domestic government on the profit function of the domestic commercial bank; (ii) both banks receive subsidies from their respective governments; (iii) both banks compete in the ship financing loan market without any government subsidies; and (iv) only the foreign commercial bank receives government subsidies. Before we analyze these four cases to identify the point of equilibrium under identical cost conditions between the two banks, our game is solved by backward induction. Thus, the solution concept used is the subgame perfect Nash equilibrium (SPNE).

3.1 The case of subsidy only from the domestic government

To simplify the calculations, let us denote a constant of $A - \hat{r} = \rho$ in the respective profit functions of banks, and assume that $k_1 = k_2 = k_3$.

During stage two, for each bank's profit function, the first-order conditions for each commercial bank are given as follows:

$$l_1^{sn} = \frac{\rho(k+1) + s_1(k+2)}{G}, \quad l_2^{sn} = \frac{\rho(k+1) - s_1}{G},$$

where $G = (k^2 + 4k + 3) > 0$. Solving the equation of best response functions, we obtain each bank's profit as follows:

$$\pi_1^{sn} = \frac{(k+2)[\rho(k+1) + s_1(k+2)]^2}{2G^2}, \quad \pi_2^{sn} = \frac{(k+2)[\rho(k+1) - s_1]^2}{2G^2}.$$

Using each bank's profit and the level of loan, the domestic social welfare can be obtained as follows:

$$\max_{s_1} W_1^{sn} = \frac{(k+2)[\rho(k+1) + s_1(k+2)]^2 + [(k+1)(2\rho + s_1)]^2 - 2Gs_1[\rho(k+1) + s_1(k+2)]}{2G^2},$$

where the consumer surplus is $[(k+1)(2\rho + s_1)]^2 / 2G^2$. Thus, the first-order condition with respect to s_1 for the domestic government is given by:

$$\frac{\partial W_1^{sn}}{\partial s_1} = 0 \Leftrightarrow s_1^{sn} = \frac{\rho(k+1)(2k+3)}{(k+1)(k+3) + k(k+2)^2}.$$

Thus, we can summarize as follows:

Lemma 1. Suppose that the cost in each bank is identical, and that only the domestic commercial bank receives a subsidy from the domestic government. Then, the equilibrium values of loan interest rates, loan level, the profit of each bank, and social welfare of each government are given by

$$\begin{aligned} R^{sn} &= \frac{Ak(k+1)(k+2) + \hat{r}(2k^2 + 6k + 3)}{(k+1)(k+3) + k(k+2)^2}, \\ l_1^{sn} &= \frac{\rho(k+1)(k+3)}{(k+1)(k+3) + k(k+2)^2}, \quad l_2^{sn} = \frac{\rho(k+2)}{(k+1)(k+3) + k(k+2)^2}, \\ \pi_1^{sn} &= \frac{k+2}{2} \left[\frac{\rho(k+1)(k+3)}{(k+1)(k+3) + k(k+2)^2} \right]^2, \quad \pi_2^{sn} = \frac{\rho^2 k^2 (k+2)^2}{2[(k+1)(k+3) + k(k+2)^2]^2}, \\ W_1^{sn} &= \frac{\rho^2 [k(k+3)(k+1)^2 + (2k^2 + 6k + 3)^2]}{2[(k+1)(k+3) + k(k+2)^2]^2}, \quad W_2^{sn} = \pi_2^{sn} = \frac{\rho^2 k^2 (k+2)^2}{2[(k+1)(k+3) + k(k+2)^2]^2}. \end{aligned}$$

Note that in Lemma 1, there is no subsidy for the foreign commercial bank, and social welfare of the foreign government is equal to the profit of the foreign commercial bank.

3.2 The case of subsidy provided by both governments

In the previous subsection, we considered the scenario involving a subsidy provided only from the domestic government. However, in this subsection we assume that both domestic and foreign commercial banks receive subsidies from their respective governments. Therefore, the profit function of the foreign bank is as follows:

$$\pi_2^{ss} = (\rho - l_1 - l_2)l_2 - \frac{1}{2}kl_2^2 + s_2l_2.$$

Differentiating each bank's profit with respect to l_i yields the best response function as follows:

$$l_1^{ss} = \frac{\rho(k+1) + s_1(k+2) - s_2}{G}, \quad l_2^{ss} = \frac{\rho(k+1) + s_2(k+2) - s_1}{G}.$$

Solving the equation of response function, we obtain the profit of each commercial bank as follows:

$$\pi_1^{ss} = \frac{(k+2)[\rho(k+1) - s_2 + s_1(k+2)]^2}{2G^2}, \quad \pi_2^{ss} = \frac{(k+2)[\rho(k+1) - s_1 + s_2(k+2)]^2}{2G^2}.$$

Using the same process as in the previous subsection, the objective function of the domestic government, which consists of both consumer surplus and the profit function of the domestic bank, is given by:

$$\max_{s_1} W_1^{ss} = \frac{(k+2)[\rho(k+1) - s_2 + s_1(k+2)]^2 + [(k+1)(2\rho + s_1 + s_2)]^2 - 2Gs_1[\rho(k+1) + s_1(k+2) - s_2]}{2G^2},$$

which derives the optimal subsidy of the domestic government, s_1 , as follows:

$$\frac{\partial W_1^{ss}}{\partial s_1} = 0 \Leftrightarrow s_1^{ss} = \frac{\rho(k+1)(2k+3) + s_2k(k+2)}{k^3 + 5k^2 + 8k + 3}.$$

On the other hand, the foreign government which also supports the subsidy s_2 for the foreign commercial bank has the following social welfare function: $W_2^{ss} = \pi_2^{ss} - s_2l_2$. Since we have already derived the best response function for the foreign commercial bank, we can obtain the social welfare of the foreign government as follows:

$$\max_{s_2} W_2^{ss} = \frac{(k+2)[\rho(k+1) + s_2(k+2) - s_1]^2 - 2Gs_2[\rho(k+1) + s_2(k+2) - s_1]}{2G^2}.$$

The first-order condition for the foreign government is given by:

$$\frac{\partial W_2^{ss}}{\partial s_2} = 0 \Leftrightarrow s_2^{ss} = \frac{\rho(k+1) - s_1}{(k+2)(k^2 + 4k + 2)},$$

hence, using the optimal subsidies from each government, we obtain Lemma 2 as follows:

Lemma 2. Suppose that both banks have identical costs, and that each government provides subsidies to the respective banks. Then, the equilibrium values of loan interest rates, loan level, profit of each bank, and social welfare of each government are given by:

$$\begin{aligned} R^{ss} &= \frac{Ak + 2\hat{r}}{k+2}, \\ l_1^{ss} &= \frac{\rho(k^2 + 4k + 2)}{(k+2)(k^2 + 3k + 1)}, \quad l_2^{ss} = \frac{\rho k}{k^2 + 3k + 1}, \\ \pi_1^{ss} &= \frac{1}{2(k+2)} \left[\frac{\rho(k^2 + 4k + 2)}{k^2 + 3k + 1} \right]^2, \quad \pi_2^{ss} = \frac{\rho^2 k^2 (k+2)}{2(k^2 + 3k + 1)^2}, \\ W_1^{ss} &= \frac{\rho^2 [k^2(k+2)(k^2 + 4k + 2) + 4(k^2 + 3k + 1)^2]}{2[(k+1)(k^2 + 3k + 1)]^2}, \quad W_2^{ss} = \frac{\rho^2 k^2 (k^2 + 4k + 2)}{2(k+2)(k^2 + 3k + 1)^2}. \end{aligned}$$

3.3 The case of no subsidy

In this subsection, we assume that both commercial banks do not receive any subsidy from their respective governments, and their costs are identical. Consistent with the previous profit functions of both banks in previous sections of this study, each bank simultaneously maximizes its profit function.

Using the same process as before, we can obtain each equilibrium value as the following Lemma 3:

Lemma 3. Suppose that the costs in both banks are identical, and that both governments do not provide any subsidy to their respective banks. Then, the equilibrium values of loan interest rates, loan level, profit of each bank, and social welfare of each government are given by:

$$\begin{aligned}
R^{nn} &= \frac{A(k+1) + 2\hat{r}}{k+3}, \\
l_1^{nn} &= \frac{\rho}{k+3}, \quad l_2^{nn} = \frac{\rho}{k+3}, \\
\pi_1^{nn} &= \frac{\rho^2(k+2)}{2(k+3)^2}, \quad \pi_2^{nn} = \frac{\rho^2(k+2)}{2(k+3)^2}, \\
W_1^{nn} &= \frac{\rho^2(k+6)}{2(k+3)^2}, \quad W_2^{nn} = \frac{\rho^2(k+2)}{2(k+3)^2}.
\end{aligned}$$

The social welfare of the domestic government includes the consumer surplus and the profit of the domestic bank. On the other hand, the social welfare of the foreign government only includes the profit of the foreign commercial bank.

3.4 The case of subsidy only from the foreign government

We assume that only the foreign commercial bank which participates in the market receives foreign government subsidy s_2 . Although the cost of the domestic bank is equal to that of the foreign bank, the former does not receive any support from the domestic government. Thus, using the first-order condition for each bank's profit yields the optimal level of loan as follows:

$$\pi_1^{ns} = \frac{(k+2)[\rho(k+1) - s_2]^2}{2G^2}, \quad \pi_2^{ns} = \frac{(k+2)[\rho(k+1) + s_2(k+2)]^2}{2G^2}.$$

Because only the foreign commercial bank receives subsidy from its government, the optimal subsidy s_2 can be derived as follows:

$$\frac{\partial W_2^{ns}}{\partial s_2} = 0 \Leftrightarrow s_2^{ns} = \frac{\rho(k+1)}{(k+2)(k^2 + 4k + 2)}.$$

Hence, we summarize these results as Lemma 4.

Lemma 4. Suppose that the costs in both banks are identical, and that only the foreign commercial bank receives a government subsidy. Then, the equilibrium values of loan interest rates, loan level, profit of each bank, and social welfare of each government are given by:

$$\begin{aligned}
R^{ns} &= \frac{A(k+1)(k^2 + 3k + 1) + \hat{r}(2k^2 + 6k + 3)}{(k+2)(k^2 + 4k + 2)}, \\
l_1^{ns} &= \frac{\rho(k^2 + 3k + 1)}{(k+2)(k^2 + 4k + 2)}, \quad l_2^{ns} = \frac{\rho(k+1)}{k^2 + 4k + 2}, \\
\pi_1^{ns} &= \frac{1}{2(k+2)} \left[\frac{\rho(k^2 + 3k + 1)}{k^2 + 4k + 2} \right]^2, \quad \pi_2^{ns} = \frac{k+2}{2} \left[\frac{\rho(k+1)}{k^2 + 4k + 2} \right]^2, \\
W_1^{ns} &= \frac{\rho^2[(k+2)(k^2 + 3k + 1) + (2k^2 + 6k + 3)^2]}{2[(k+1)(k^2 + 4k + 2)]^2}, \quad W_2^{ns} = \frac{\rho^2(k+1)^2}{2(k+2)(k^2 + 4k + 2)}.
\end{aligned}$$

3.5 A comparative analysis of the four scenarios

Having obtained the results in subsections 3.1-3.4, we can compare the respective social welfare levels from Lemma 1 to Lemma 4 in which the costs between both banks are identical.

Table 1. Social welfare under identical cost conditions

$I \mid 2$	s_2	n_2
s_1	W_1^{ss}, W_2^{ss}	W_1^{sn}, W_2^{sn}
n_1	W_1^{ns}, W_2^{ns}	W_1^{nn}, W_2^{nn}

Table 2. Banks' profits under identical cost conditions

$I \mid 2$	s_2	n_2
s_1	π_1^{ss}, π_2^{ss}	π_1^{sn}, π_2^{sn}
n_1	π_1^{ns}, π_2^{ns}	π_1^{nn}, π_2^{nn}

To employ the two-stage game, let s_i and n_i represent receipt and non-receipt of subsidy from each government, respectively, in the case that costs are identical for both banks. Then, the social welfare matrix between both the governments can be represented by the following Table 1.

To find the Nash equilibrium, we compare the social welfare of each government as follows:

$$\begin{aligned}
 W_1^{ss} - W_1^{ns} &= \frac{\rho^2[k^2(k+2)(k^2+4k+2)+4(k^2+3k+1)^2]}{2[(k+2)(k^2+3k+1)]^2} - \frac{\rho^2[(k+2)(k^2+3k+1)+(2k^2+6k+3)^2]}{2[(k+2)(k^2+4k+2)]^2} > 0, \\
 W_1^{sn} - W_1^{nn} &= \frac{\rho^2[k(k+3)(k+1)^3+(2k^2+6k+3)^2]}{2[(k+1)(k+3)+k(k+2)^2]^2} - \frac{\rho^2(k+6)}{2(k+3)^2} > 0, \\
 W_2^{ss} - W_2^{sn} &= \frac{\rho^2 k^2(k^2+4k+2)}{2(k+2)(k^2+4k+2)} - \frac{\rho^2(k+2)}{2(k+3)^2} < 0, \\
 W_2^{ns} - W_2^{nn} &= \frac{\rho^2(k+1)^2}{2(k+2)(k^2+4k+2)} - \frac{\rho^2(k+2)}{2(k+3)^2} > 0.
 \end{aligned}$$

Hence, choosing s_1 is the best option for the domestic government, whereas, n_2 is the best option for the foreign government. Thus, the following proposition is derived:

Proposition 1. Under identical cost conditions for both domestic and foreign banks, a unique SPNE can be sustained with (s_1, n_2) .

Proposition 1 suggests that the subsidy strategy is desirable only for the domestic government, while the non-subsidy strategy is desirable for the foreign government in equilibrium.

Performing simple calculations with $l_1^{ss} > l_1^{ns}$ and $l_1^{sn} > l_1^{nn}$, choosing the subsidy strategy (s_1) for the domestic government is dominant strategy regardless of what strategy the foreign government chooses. Furthermore, the loan level from the foreign commercial bank is larger ($l_2^{ss} > l_2^{sn}$) when the foreign government chooses the subsidy strategy than when the foreign government does not opt to provide subsidies. That is, if both governments choose subsidy strategies, then the total loan interest rate R decreases. Thus, the interest rate R reduces further if the foreign government also provides subsidy to the foreign commercial bank. Since the objective function of the foreign government does not include consumer surplus, the foreign government decides to choose the non-subsidy strategy. This is due to the main expenditure of foreign social welfare is the given subsidy from the foreign commercial bank.

Proposition 1 suggests that when the costs for domestic and foreign banks are identical, the domestic government has incentive to promote project financing by offering subsidies to domestic commercial bank. Doing so is desirable for the social welfare of the domestic government to foster strategic industries (e.g., ship financing) through project financing. This implication suggests that if the efficiency of domestic banks is the same as that of foreign banks, it is possible for foreign governments to restrain subsidy strategies.

Next, we are ready to assess the comparisons of profit for the domestic and foreign commercial banks. Similar to the choice of subsidy strategy between governments, we can determine the banks' preference orderings over profit. Thus, the profit matrix for both banks is displayed in Table 2.

Again, to find Nash equilibrium comparing each bank's profit shows that:

$$\begin{aligned}\pi_1^{ss} - \pi_1^{ns} &= \frac{1}{2(k+2)} \left[\frac{\rho(k^2 + 4k + 2)}{k^2 + 3k + 1} \right]^2 - \frac{1}{2(k+2)} \left[\frac{\rho(k^2 + 3k + 1)}{k^2 + 4k + 2} \right]^2 > 0, \\ \pi_1^{sn} - \pi_1^{nm} &= \frac{k+2}{2} \left[\frac{\rho(k+1)(k+3)}{(k+1)(k+3) + k(k+2)^2} \right]^2 - \frac{\rho^2(k+2)}{2(k+3)^2} > 0, \\ \pi_2^{ss} - \pi_2^{sn} &= \frac{\rho^2 k^2 (k+2)}{2(k+3k+1)^2} - \frac{\rho^2 k^2 (k+2)^3}{2[(k+1)(k+3) + k(k+2)^2]^2} > 0, \\ \pi_2^{ns} - \pi_2^{nm} &= \frac{k+2}{2} \left[\frac{\rho(k+1)}{k+4k+2} \right] - \frac{\rho^2(k+2)}{2(k+3)^2} > 0.\end{aligned}$$

We summarize these results in proposition 2.

Proposition 2. Under identical cost conditions for both domestic and foreign banks, a unique SPNE can be sustained with (s_1, s_2) .

In contrast to Proposition 1, Proposition 2 suggests that the subsidy strategies of both the foreign and domestic governments are the solution of Nash equilibrium. The profitability of both banks always increases along with the subsidy strategy of the respective governments in the ship financing market. Therefore, both banks prefer subsidy from their respective governments for maximizing their profits under identical cost conditions.

As mentioned prior, the Chinese and Korean banking industries have demonstrated inefficiency in terms of both the immature banking industry itself and passive strategic investment featuring high risk. (For more specific explanations, see Park and Lee (2011) and Choi and Ham (2012).) Thus, the banking industry has demonstrated inefficiency in the ship financing loan market, which competes with foreign commercial banks. This will be discussed further in subsection 4 with the case of different efficiency levels between two banks.

4. The case involving different costs between two banks

In this section, we assume different costs for both banks. Specifically, the efficiency in the foreign commercial bank is higher than the domestic commercial bank (i.e., $0 < k_2 < k_1$). (For example, the only Korean domestic bank that participates in the international ship financing market is KDB. However, it is lower ranked in the top 40. Indeed, the share of other domestic banks in the international ship financing market is only 4% (ABN AMRO Bank, 2011), which also implies the inefficiency of the domestic commercial banks.)

To simplify our analysis, instead of measuring the difference between the efficiency levels of both banks, we consider the difference in cost functions between the domestic and foreign commercial banks. In order to determine the difference in efficiency between both banks, we assume that the difference in cost is explained by the exclusion of the cost parameter of the foreign commercial bank $k_2 = 0$. Furthermore, the domestic commercial bank, which has less operating efficiency than the foreign commercial bank, only has the cost function $k_1 > 0$. According to this assumption, both banks' profits are given by:

$$\pi_1 = (\rho - \hat{l}_1 - \hat{l}_2)\hat{l}_1 - k_1\hat{l}_1, \quad \pi_2 = (\rho - \hat{l}_1 - \hat{l}_2)\hat{l}_2.$$

Next, we discuss the same four scenarios from the previous case, as shown in Section 3.

4.1 The case of subsidy offered by the domestic government

Consider that only the domestic bank receives government subsidy. We can derive the optimal loan level at the second stage as follows:

$$\hat{l}_1^{sn} = \frac{\rho - 2k + 2s_1}{3}, \quad \hat{l}_2^{sn} = \frac{\rho + k - s_1}{3},$$

which yields the following profit function for each bank:

$$\hat{\pi}_1^{sn} = \frac{(\rho - 2k + 2s_1)^2}{9}, \quad \hat{\pi}_2^{sn} = \frac{(\rho + k - s_1)^2}{9}.$$

A straightforward computation yields the social welfare of the domestic government as follows:

$$\max_{s_1} \hat{W}_1^{sn} = \frac{2(\rho - 2k + 2s_1)^2 + (2\rho - k + s_1)^2 - 6s_1(\rho - 2k + 2s_1)}{18},$$

which yields the optimal subsidy s_1 :

$$\frac{\partial \hat{W}_1^{sn}}{\partial s_1} = 0 \Leftrightarrow s_1^{sn} = \rho - k.$$

The following lemma can then be stated. For simplified analysis, we assume that $\rho > 3kg$. (We consider only this assumption because if $\rho < 3k$, the domestic government subsidy s_1 is converted to tax. Therefore, we excluded the case of $\rho < 3k$.)

Lemma 5. Suppose that the efficiency of the domestic commercial bank is less than that of the foreign bank, and that only the domestic commercial bank receives government subsidy. Then, the equilibrium values of loan interest rates, loan level, profit of each bank, and social welfare of each government are given by:

$$\begin{aligned} \hat{R}^{sn} &= \frac{3\hat{r} + 2k}{3}, \\ \hat{l}_1^{sn} &= \frac{3\rho - 4k}{3}, \quad \hat{l}_2^{sn} = \frac{2k}{3}, \\ \hat{\pi}_1^{sn} &= \frac{(3\rho - 4k)^2}{9}, \quad \hat{\pi}_2^{sn} = \frac{4k^2}{9}, \\ \hat{W}_1^{sn} &= \frac{3\rho^2 + 4k^2 - 6\rho k}{6}, \quad \hat{W}_2^{sn} = \hat{\pi}_2^{sn} = \frac{4k^2}{9}. \end{aligned}$$

4.2 The case of subsidy from both governments

We now consider the scenario in which both banks receive subsidy from their respective governments. Therefore, the profit function of the foreign commercial bank is modified as follows:

$$\hat{\pi}_2^{ss} = (\rho - \hat{l}_1^{ss} - \hat{l}_2^{ss})\hat{l}_2^{ss} + s_2\hat{l}_2^{ss}$$

Given the optimal loan level and each bank's profit at stage two, the two levels of social welfare of the domestic and foreign government are derived by:

$$\begin{aligned} \max_{s_1} \hat{W}_1^{ss} &= \frac{2(\rho - 2k + 2s_1 - s_2)^2 + (2\rho - k + s_1 + s_2)^2 - 6s_1(\rho - 2k + 2s_1 - s_2)}{18}, \\ \max_{s_2} \hat{W}_2^{ss} &= \frac{(\rho + k - s_1 + 2s_2)^2 - 3s_2(\rho + k - s_1 + 2s_2)}{9}. \end{aligned}$$

Therefore, differentiating each social welfare with respect to s_1 and s_2 , and solving yields:

$$\frac{\partial \hat{W}_1^{ss}}{\partial s_1} = 0 \Leftrightarrow s_1^{ss} = \rho - k, \quad \frac{\partial \hat{W}_2^{ss}}{\partial s_2} = 0 \Leftrightarrow s_2^{ss} = \frac{\rho + k - s_1}{4}.$$

Lemma 6. Suppose that the efficiency of the domestic commercial bank is less than that of the foreign bank, and that banks receive subsidy from their respective governments. Then, the equilibrium values of loan interest rates, loan level, profit of each bank, and social welfare of each government are given by:

profit of each bank, and social welfare of each government are given by:

$$\begin{aligned}\hat{R}^{ss} &= \frac{2\hat{r} + k}{2}, \\ \hat{l}_1^{ss} &= \frac{2\rho - 3k}{2}, \quad \hat{l}_2^{ss} = k, \\ \hat{\pi}_1^{ss} &= \frac{(2\rho - 3k)^2}{4}, \quad \hat{\pi}_2^{ss} = k^2, \\ \hat{W}_1^{ss} &= \frac{4\rho^2 - 8\rho k + 7k^2}{8}, \quad \hat{W}_2^{ss} = \frac{k^2}{2}.\end{aligned}$$

4.3 The case involving no government subsidy

We consider the scenario in which the efficiency of both banks are different and there are no government subsidies provided. Using the same process as before, we obtain each equilibrium value as stated in Lemma 7:

Lemma 7. Suppose that the efficiency of the domestic commercial bank is less than that of the foreign bank, and that both banks do not receive subsidy from their respective governments. Then, the equilibrium values of loan interest rates, loan level, profit of each bank, and social welfare of each government are given by:

$$\begin{aligned}\hat{R}^{nn} &= \frac{A + 2\hat{r} + k}{3}, \\ \hat{l}_1^{nn} &= \frac{\rho - 2k}{3}, \quad \hat{l}_2^{nn} = \frac{\rho + k}{3}, \\ \hat{\pi}_1^{nn} &= \frac{(\rho - 2k)^2}{9}, \quad \hat{\pi}_2^{nn} = \frac{(\rho + k)^2}{9}, \\ \hat{W}_1^{nn} &= \frac{2\rho^2 - 4\rho k + 3k^2}{6}, \quad \hat{W}_2^{nn} = \hat{\pi}_2^{nn} = \frac{(\rho + k)^2}{9}.\end{aligned}$$

4.4 The case of subsidy only from the foreign government

In this subsection, we assume that the foreign commercial bank receives the subsidy s_2 from the foreign government, and that the domestic government does not provide any support to the domestic commercial bank in the ship financing loan market. Using the same process as before, we obtain each equilibrium value as detailed in Lemma 8.

Lemma 8. Suppose that the efficiency of the domestic commercial bank is less than that of the foreign bank, and that only the foreign bank receives government subsidy. Then, the equilibrium values of loan interest rates, loan level, profit of each bank, and social welfare of each government are given by:

$$\begin{aligned}\hat{R}^{ns} &= \frac{A + 3\hat{r} + k}{4}, \\ \hat{l}_1^{ns} &= \frac{\rho - 3k}{4}, \quad \hat{l}_2^{ns} = \frac{\rho + k}{2}, \\ \hat{\pi}_1^{ns} &= \frac{(\rho - 3k)^2}{16}, \quad \hat{\pi}_2^{ns} = \frac{(\rho + k)^2}{4}, \\ \hat{W}_1^{ns} &= \frac{11\rho^2 - 18\rho k + 19k^2}{32}, \quad \hat{W}_2^{ns} = \frac{(\rho + k)^2}{8}.\end{aligned}$$

4.5 A comparative analysis of the four scenarios

To employ the two-stage game, let s_i and n_i represent, respectively, the receipt and non-receipt of subsidy from the governments under different efficiency conditions. Thus, the social welfare matrix between the governments is presented in Table 3.

Based on Table 3, we can compare each solution of social welfare for the Nash equilibrium. When the foreign

government chooses the subsidy strategy (s_2), the social welfare of the domestic government is:

$$\hat{W}_1^{ss} - \hat{W}_1^{ns} = \frac{7k^2 - 8\rho k + 4\rho^2}{8} - \frac{19k^2 - 18\rho k + 11\rho^2}{32} = \frac{9k^2 - 14\rho k + 5\rho^2}{32}.$$

Table 3. Social welfare under different cost conditions

$I \mid 2$	s_2	n_2
s_1	$\hat{W}_1^{ss}, \hat{W}_2^{ss}$	$\hat{W}_1^{sn}, \hat{W}_2^{sn}$
n_1	$\hat{W}_1^{ns}, \hat{W}_2^{ns}$	$\hat{W}_1^{nn}, \hat{W}_2^{nn}$

By directly applying the above equation to a discriminant, we obtain the roots, k for ρ . The minimum value is attained because $9k^2 > 0$. Two positive roots, $k = \rho$ and $k = 5\rho/9$, emerge when comparing each social welfare function. Hence, $\hat{W}_1^{ss} > \hat{W}_1^{nn}$, if $k \in (0, 5\rho/9)$ or $k > \rho$. Otherwise, if $k \in (0, 5\rho/9)$, then $\hat{W}_1^{ss} < \hat{W}_1^{ns}$.

On the other hand, when the foreign government does not choose the subsidy strategy (n_2), comparing $\hat{W}_1^{sn}$ with $\hat{W}_1^{nn}$ yields

$$\hat{W}_1^{sn} - \hat{W}_1^{nn} = (4k^2 - 6\rho k + 3\rho^2) - (3k^2 - 4\rho k + 2\rho^2) = (k - \rho)^2.$$

Thus, if $\rho > k$ ($\rho < k$), then $\hat{W}_1^{sn} > (<) \hat{W}_1^{nn}$. Furthermore, comparing $\hat{W}_2^{ss}$ and $\hat{W}_2^{ns}$ with $\hat{W}_2^{sn}$ and $\hat{W}_2^{nn}$ yields:

$$\begin{aligned} \hat{W}_2^{ns} - \hat{W}_2^{sn} &= \frac{k^2}{2} - \frac{4k^2}{9} > 0, \\ \hat{W}_2^{ns} - \hat{W}_2^{nn} &= \frac{(\rho + k)^2}{8} - \frac{(\rho + k)^2}{9} > 0. \end{aligned}$$

We summarize these findings in Proposition 3.

Proposition 3. Suppose that either the foreign or domestic government decides whether or not to offer the subsidy. Then, (i) if $k \in (0, 5\rho/9)$, choosing the subsidy strategy is the dominant strategy for both governments: (s_1, s_2), (ii) if $k \in (0, 5\rho/9)$, the domestic government chooses not to provide subsidies, while the foreign government chooses to do so: (n_1, s_2),

Proposition 3 suggests that the foreign government chooses the subsidy strategy irrespective of whether the domestic government employs the subsidy strategy. (We can understand this intuitively, because they can strengthen their competitive advantage in the ship financing market by receiving government subsidies and support, even though they have had efficiency in competition with other commercial banks.) Conversely, the domestic government has an incentive to choose the subsidy strategy depending on the efficiency of the domestic commercial bank. Thus, if the efficiency gap between the domestic commercial bank and the foreign bank is sufficiently large or not large enough, the domestic government will follow the subsidy strategy.

Since, the loan level under the subsidy strategy is larger than the non-subsidy strategy ($\hat{l}_2^{ss} > \hat{l}_2^{sn}$ and $\hat{l}_2^{ns} > \hat{l}_2^{nn}$), it is always desirable for the foreign government to choose the subsidy strategy. Regarding the domestic government, the loan level depends on the level of efficiency in the domestic commercial bank. That is, if the efficiency of the domestic commercial bank is sufficiently high ($\hat{l}_2^{ss} > \hat{l}_2^{ns} \Leftrightarrow \rho > k$), the loan level by the bank gradually increases following the receipt of the subsidy. This results in increased bank profits under the subsidy strategy. Thus, the increased profit of the bank increases domestic social welfare: (s_1, s_2).

On the other hand, if the degree of efficiency falls in the intermediate range (if $k \in (0, 5\rho/9)$), then the loan interest rate R begins to increase, which implies that the loan level of the domestic commercial bank will begin to decrease gradually. Moreover, the decreased loan level results in an increase in the loan's interest rate ($R = A - L$). Thus, the domestic government has the incentive to not subsidize the domestic commercial bank: (n_1, s_2).

Consequently, Proposition 3 suggests that the domestic government determines subsidy policy in order to maximize social welfare and bank profits when the efficiency gap between the foreign and domestic banks is either too small or too large.

We now consider the implications of Proposition 3. When Korea was enjoying rapid economic growth, the Korean government provided support for ship financing. (The Korean government established a state-owned bank, (the Korea

Development Bank, which has been referred to as KDB Saneobeunhaeng since 2009 with privatization) which supported domestic ship financing during Korea's rapid economic growth.) Recently, the Chinese government has also strongly supported ship financing. These cases indicate that the government uses implicit or explicit subsidy policies when the efficiency gap among banks is sufficiently large. On the other hand, several European governments have utilized subsidy and support

Table 4. Banks' profit under different cost conditions

$I \mid 2$	s_2	n_2
s_1	$\hat{\pi}_1^{ss}, \hat{\pi}_2^{ss}$	$\hat{\pi}_1^{sn}, \hat{\pi}_2^{sn}$
n_1	$\hat{\pi}_1^{ns}, \hat{\pi}_2^{ns}$	$\hat{\pi}_1^{nn}, \hat{\pi}_2^{nn}$

policies to help European banks, which are efficient in ship financing. (Hwang (2012) indicated that, for many of these banks, the main ship financing operations in the foreign financial market are organized by their government with a large amount of share.) This fact is consistent with our theoretical result in Proposition 3 (i).

Nevertheless, note that the non-subsidy strategy by the domestic government is beneficial to domestic social welfare when the degree of efficiency in domestic banks falls in the intermediate range. Thus, Proposition 3 provides important implications when the foreign commercial banks receiving the subsidy compete with domestic commercial banks. According to Cho (2012), the German government offers aggressive guarantees for bank loans, which amounted to 15 billion Euro. Funding has been made through KfW, the German government-owned financial institution, which can be considered as implicit subsidies. (Other practical evidences are as follows: (i) The Danish government, through the establishment of the Export Lending System in 2009, has supported banks by providing 460 million dollars in ship financing; and (ii) The U.S. government has organized the Maritime Security Program in order to support banking industries by executing a 200 million dollar budget until 2015. Furthermore, (iii) The U.S. government had already provided support of 500 million dollars for loan guarantee through the Loan Guarantee Program.)

Next, we compare the profit between the domestic and foreign commercial banks. Similar to the choice of subsidy strategy between governments, we now consider the preferred strategy for each bank in maximizing its profit function under different efficiency conditions. Thus, the bank's profit matrix is represented in Table 4.

As in comparing social welfare, comparing profit $\hat{\pi}_1^{ss}$ with $\hat{\pi}_1^{ns}$ when the foreign government chooses the subsidy strategy (s_2) yields:

$$\hat{\pi}_1^{ss} - \hat{\pi}_1^{ns} = \frac{(2\rho - 3k)^2}{4} - \frac{(\rho - 3k)^2}{16} = \frac{9k^2 - 14\rho k + 5\rho^2}{16}.$$

We can apply this equation to a discriminant. Subsequently, we obtain the roots, k for ρ and the minimum value is attained because $9k^2 > 0$. Two positive roots are $\rho = k$ and $k = 5\rho/9$. Furthermore, if the foreign government does not choose the subsidy strategy, then the domestic bank is:

$$\hat{\pi}_1^{sn} - \hat{\pi}_1^{nn} = (3\rho - 4k)^2 - (\rho - 2k)^2 = 3k^2 - 6\rho k + 2\rho^2,$$

using the same process as before, since the minimum value is attained because $3k^2 > 0$. Two positive roots have either positive root, $\rho < k$ or $k < 2\rho/3$.

Moreover, comparing the profits $\hat{\pi}_2^{ss}$ and $\hat{\pi}_2^{ns}$ with $\hat{\pi}_2^{sn}$ and $\hat{\pi}_2^{nn}$ yields:

$$\begin{aligned} \hat{\pi}_2^{ss} - \hat{\pi}_2^{sn} &= k^2 - \frac{4k^2}{9} > 0, \\ \hat{\pi}_2^{sn} - \hat{\pi}_2^{nn} &= \frac{(\rho + k)^2}{4} - \frac{(\rho + k)^2}{9} > 0. \end{aligned}$$

We summarize these findings in Proposition 4.

Proposition 4. Suppose that either the foreign or domestic government decides whether or not to offer subsidies. Then, (i) if $k \in (0, 5\rho/9)$, both banks have an incentive to receive subsidies from their governments: (s_1, s_2); (ii) if $k \in (5\rho/9, 6\rho/9)$, the domestic bank does not have an incentive to receive subsidies, while the foreign bank has incentive, (n_1, s_2), (iii) if $k \in (6\rho/9, \rho)$, then the domestic bank does not prefer subsidies from the government, while the foreign bank has an incentive to receive subsidies: (n_1, s_2).

Proposition 4 implies that the domestic government chooses the subsidy strategy depending on the efficiency level of the domestic commercial bank. If the efficiency of the domestic commercial bank is low compared to that of the foreign commercial bank, or the efficiency gap between the foreign and domestic commercial banks becomes smaller, then the domestic government chooses the subsidy strategy. On the other hand, the foreign government always prefers the subsidy strategy in order to maximize its own social welfare. Similar to Proposition 3 regarding the efficiency parameter, the preference for the subsidy policy is shared between the government and the bank. In practice, if the domestic commercial bank is comparatively less efficient than the foreign bank, then the domestic government has an incentive to choose the subsidy strategy to make the domestic commercial banks attain higher efficiency levels (or a certain efficiency level). Finally, Proposition 4 implies that the domestic government needs to continue the subsidy policy even after the domestic commercial bank has increased efficiency in the ship financing loan market. (Recently, several Korean commercial banks have made contracts with the public institutions of Korea to support ship financing. In 2014, Korean public institutions (KoFC and KSURE) made agreements with the domestic commercial banks to supply indirect loans for ship financing. Examples include the agreements of Busan Bank and Suhyup Bank with KoFC (Korea Finance Corporation) and those of KB Kookmin Bank, Woori Bank, and Nonghyup Bank, KEB with KSURE (Korea Trade Insurance Corporation), respectively.)

5. Concluding remarks

This study investigated the optimal subsidy strategy for a government which promotes private commercial banks to participate in the ship financing loan market. We employ the framework of a duopoly market involving a domestic commercial bank and a foreign commercial bank.

The first model considers the costs of both banks as identical, and the domestic government chooses the subsidy strategy in order to maximize its own social welfare. The foreign government chooses the non-subsidy strategy. Furthermore, both banks prefer the subsidy strategy offered by each government.

Regarding the second model, when the foreign commercial bank has a higher efficiency in the ship financing loan market, the bank prefers the subsidy strategy regardless of whether the domestic government chooses the subsidy strategy. Therefore, the subsidy strategy is adopted by the foreign government in order to maximize social welfare. On the other hand, the domestic government has the incentive to choose the subsidy strategy after considering the level of efficiency in the domestic commercial bank. When the efficiency in the domestic commercial bank falls in the intermediate range, the domestic government does not choose a subsidy policy. We believe that the Chinese and Korean governments chose a passive subsidy policy during the 2000s. This is due to the Chinese and Korean commercial banks demonstrated inefficiency in the ship financing loan market.

Furthermore, if the domestic commercial bank is significantly inefficient or has comparable efficiency with the foreign commercial bank, then the domestic government's subsidy strategy can improve the profit of the domestic commercial bank and social welfare. Therefore, the Chinese and Korean governments should choose strategic subsidy policies for domestic commercial banks in order to promote higher efficiency in the ship financing loan market, and sustainable participation. Such subsidy policies have positive effects on the domestic social welfare and bank profits.

However, in this study, we only used the simplifying assumptions on the loan market composed of the domestic commercial bank and the foreign commercial bank with perfect substitution rather than on the deposit market. Moreover, we have not modeled private banks' competition with state-owned banks in the ship financing loan market. In this regard, our model could be extended in further studies. (For example, the Chinese government has developed aggressive support and subsidy policies in order to promote its own shipbuilding industry and ship financing.) Finally, we did not consider the non-linear demand structures. The extension of our model in these directions is left for future research.

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