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Revista de Cercetare si Interventie Sociala

ISSN: 1583-3410 (print), ISSN: 1584-5397 (electronic)

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Revista de cercetare și intervenție socială, 2019, vol. 64, pp. 352-365

https://doi.org/10.33788/rcis.64.26

Published by:
Expert Projects Publishing House

On behalf of:
„Alexandru Ioan Cuza" University,
Department of Sociology and Social Work
and
HoltIS Association

REVISTA DE CERCETARE SI INTERVENTIE SOCIALA
is indexed by Clarivate Analytics (Web of Science) -
Social Sciences Citation Index
(Sociology and Social Work Domains)

Duopoly, Optimal Proportion of State-Owned Shares and International Cross-Ownership

Junlong CHEN[1], Hao TANG[2], Jiali LIU[3]

Abstract

This paper constructs a duopoly model to study the optimal international cross-ownership and state-owned shares proportion when domestic state-owned enterprise competes with foreign-funded enterprise in home market or against local enterprise in foreign market under Cournot competition. The results indicate that whether to implement international cross-ownership or not and the proportion of state-owned depend on the implementing subject of cross-ownership, competitive environment, the efficiencies of state-owned and private capitals, and so on. The proportion of state-owned shares may influence the action of international cross-ownership in some cases. Complete nationalization is optimal choice under specified condition. These conclusions have certain significance for the formulation of privatization policies in various countries and the merger and reorganization of enterprises in the international scope.

Keywords: Duopoly, Cross-ownership, optimal proportion of state-owned shares, social welfare, competition, cooperation.

Introduction

The cross-ownership is that an enterprise holds the share of its rival's stock in the same or similar market which is composed of multi-market entities. While the cross shareholding means that both enterprise hold shares with each other. The cross-ownership can be understood as a special equity investment on enterprise in the same or similar industry. With the development of market-oriented economy, cross-ownership is very common in many industries such as motor industry, and many leading companies adopt it as competitive strategy in terms of spreading

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business risk, adding new profit growth point, inhibiting vicious competition and strengthening monopoly power. With the deepening of economic globalization, the cross-ownership has broken through the national boundaries and become one of the means of helping enterprise blending and competing in host market, avoiding trade barriers and enhancing international competitiveness. Moreover, the mixed ownership is a common form of enterprises in the market-oriented economy and the proportion of state-owned shares is the focus of investigation on mixed ownership enterprises. If the proportion of state-owned shares is too low, it may go against the stability of key industries and weaken the state's grip on economy. However, it's not easy to break the "the highly concentrated ownership structure", "insider control" and other traditional drawbacks if the proportion is too high. Therefore, it is necessary to explore the most scientific proportion of state-owned shares to make full use of comparative advantage of state-owned and private capital so as to achieve efficient allocation of resources. The existing literature has provided significant insight into the proportion of state-owned shares and cross-ownership, which provide useful inspiration for this paper.

Researches on the proportion of state-owned shares: The past few decades have witnessed a global wave of privatization of state-owned enterprises and the major reform measures are issuing shares and mergers and acquisitions (Florio, 2014). A large number of state-owned enterprises achieve partial or full privatization on the basis of overcoming the drawbacks of state-owned enterprise system and promoting enterprise efficiency, which attracts much attention of scholars. However, there are two distinct viewpoints about the optimal proportion of state-owned shares or the optimal level of privatization under the oligopoly model. Some scholars believe that state-owned property rights will lead to inefficient governance and corruption in government, and the private enterprise are more efficient than other state-owned enterprise so the state-owned enterprise should be fully privatized (Shleiefr & Vishny, 1994; Megginson & Netter, 2001). However, opponents argue that the state-owned enterprise would be more conducive to maximize social welfare because of its different operation target from private enterprise for its state-owned nature. The social welfare generated by pure oligopoly consisting of private enterprises is lower than that of mixed oligopoly. The proportion of state-owned shares is optimally affected by various factors such as the type of market competition, enterprise efficiency, product differentiation, principal-agent, partial privatizations and even complete nationalization is optimal under certain circumstances (Saha & Sensarma, 2011; Gelves & Heywood, 2013; Gelves & Heywood, 2016).

Researches on the cross-ownership: A larger number of studies show that cross-ownership is widespread in some industries especially in enterprises that have specific investment relationship (Alley, 1997; Barcena-Ruiz & Olaizola, 2007). The causes mainly include: avoiding deviations caused by management deviations and promoting cooperation and mutual supervision among group enterprise; preventing hostile takeover to maintain the survival of enterprises; obtaining

special knowledge to achieve synergies and diversified investment by equity holding; strengthening the cooperation of upstream and downstream enterprise to promote production efficiency (Manasakis, & Vlassis, 2014). Among them, there are studies using the oligopoly model to study the cross-ownership under the pure oligopoly and mixed oligopoly and analyze its effect on social welfare (Ghosh & Morita, 2012; Ghosh *et al.*, 2014; Florackis, Kanas, & Kostaki, 2015), economic performance (Chen, Hu, & Song, 2017) and the level of privatization (Jain & Pal, 2012), product differentiation and profitability (Fanti, 2013), the setting of cooperative and non-cooperative environmental taxes (Barcena-Ruiz & Campo, 2012). For the whole market, the cross-ownership can reduce the efficiency loss caused by information asymmetry and vicious competition but also lead to collusion between enterprises to affect fair competition in the market and then lower market performance. There are two contrasting views on the impact of cross-ownership on social welfare at present. Conventional wisdom holds that the cross-ownership would easily cause collusion to strengthen monopoly power and then reduce social welfare (Gilo & Spiegel, 2003), so the severe anti-monopoly regulation should be taken. For example, the western governments' control over the large media groups' cross-ownership. While opponents argue that the cross-ownership is the choice of market competition, and it will not necessarily cause damage to social welfare if the effective competition is guaranteed (Fanti, 2014). On the contrary, excessive government regulation will lead to government failure. Thus, many countries begin to relax severe regulation over some industries for the purpose of enhancing the vitality of market competition.

A few authors combine the state-owned shares proportion with cross-ownership. Jain & Pal (2012) explore the optimal proportion of state-owned shares by combined research of them, which is limited to domestic research rather than international competition. Cai & Karasawa-Ohtashiro (2015) study the cross-ownership between state-owned enterprise and foreign enterprise and then introduce privatization issues to study privatization policies within a country but they ignore the cross-ownership of domestic enterprise in the overseas investments. Based on limitations above, this paper attempts to study how the domestic state-owned enterprise confront with foreign enterprise's cross-ownership and its implementation of cross-ownership. Meanwhile, how to implement cross-ownership to the enterprise in host country in overseas investments and the optimal proportion of state-owned shares is the research emphasis.

The model construction

We consider a duopoly competition model based on the analysis and research objectives above. The basic assumptions are as follows:

Assumption 1: We consider that there are two enterprise, firm 1 and firm 2, in an duopoly market. Enterprise are engaged in Cournot competition. Firm 1 is a state-owned enterprise, and firm 2 is a foreign enterprise. They produce homogeneous goods and the market demand function is given by $P = a - q_1 - q_2$

Assumption 2: Firm 1 is a partially privatized state-owned enterprise, β denotes the weight associated with state-owned share which is socially optimal, where $0 \le \beta \le 1$. The cost function of firm 1 is given by $C_1 = \beta m + (1-\beta)n$, where m denotes the production cost of public shares, i.e. efficiency of state-owned capital, and n denotes the production cost of private shares, i.e. efficiency of private capital. The cost function of firm 2 is given by $C_2 = n$ ($m > 0$ and $n > 0$). One of the enterprises acquires proportion of shares of the other firm which is given by δ, with $0 \le \delta \le 1$.

Assumption 3: The two firms perform three-stage dynamic sequential game.

Stage 1: The government decides on the optimal level of nationalization β of firm 1 to maximize social welfare.

Stage 2: The optimal cross-ownership δ depends on the utility maximization of the firm which implements the cross-ownership.

Stage 3: Two enterprise compete with each other under Cournot competition, where q_1 and q_2 denote the optimal outputs of firm 1 and firm 2, respectively.

Under above assumptions, this paper analyzes decision-making mechanism about international cross-ownership and the optimal proportion of state-owned shares in different situations.

Model analysis

Firm 2 implements cross-ownership to firm 1.

If firm2 cross owns (δ) firm 1, $\delta \le 1-\beta$. The utility function of firm1 is denoted as $U_1 = \beta W + (1-\beta)\pi_1$, and the utility function of firm 2 is denoted as $U_2 = \pi_2 + \delta\pi_1$. It's no need to consider the utility of firm 2 for domestic firm 1. Social welfare is given by $W_2 = (1-\delta)\pi_1 + CS$, and consumer surplus is given by $CS = \dfrac{q_1^2 + q_2^2 + 2q_1q_2}{2}$.

Let us first consider the stage 3 of the game that two enterprise compete with each other under Cournot competition to achieve utility maximization. Solve the derivative of U_1 with respect to q_1 and the derivative of U_2 with respect to q_2 and

then let $\frac{\partial U_1}{\partial q_1} = 0$, $\frac{\partial U_2}{\partial q_2} = 0$

$$\frac{\partial U_1}{\partial q_1} = (\beta + 2\beta\delta - 2)q_1 + (\beta + \beta\delta - 1)q_2 + a(1 - \beta\delta) = 0 \quad (1)$$

$$\frac{\partial U_2}{\partial q_2} = -2q_2 + a - (1 + \delta)q_1 = 0 \quad (2)$$

q_1, q_2 are obtained as

$$q_1 = \frac{a(\beta\delta - \beta - 1)}{\beta + 2\beta\delta - \beta\delta^2 + \delta - 3} \quad (3)$$

$$q_2 = \frac{a(\beta + \beta\delta - \beta\delta^2 + \delta - 1)}{\beta + 2\beta\delta - \beta\delta^2 + \delta - 3} \quad (4)$$

By substituting Equation (3) and (4) into U_2, W, we deduce

$$U_2 = -\delta q_1^2 - q_2^2 - (1 + \delta)q_1 q_2 + a\delta q_1 + aq_2 - \delta\beta m - \delta(1 - \beta)n - n \quad (5)$$

$$W = (\delta - \frac{1}{2})q_1^2 + \frac{1}{2}q_2^2 + \delta q_1 q_2 + a(1 - \delta)q_1 - (1 - \delta)\beta m - (1 - \delta)(1 - \beta)n \quad (6)$$

Then in the stage 2 we study the optimal cross-ownership of firm 2. MATLAB R2016a is used to simulate the relation between U_2 and δ according to (5). We assume that $m = n = 0$ to simplify the analysis and exclude the effect of m and n. Meanwhile, the correlation between U_2 and δ is not affected by a and we assume that $a = 1$, as depicted in *Figure 1*.

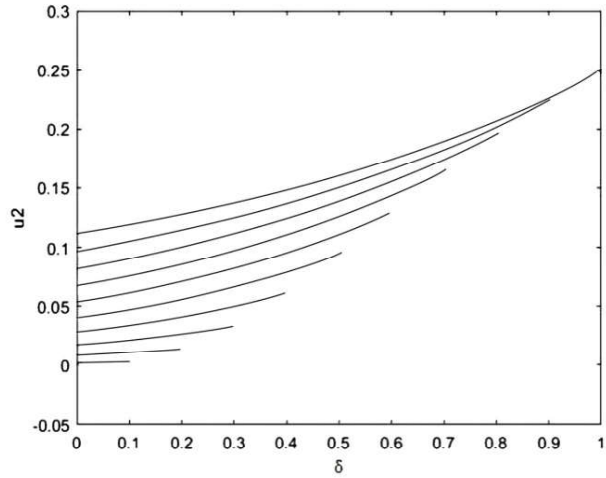

Figure. 1. The relation between U_2 and δ

Note: The values of β corresponding to the curves from top to bottom are: 0, 0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9

We depict that higher value of δ leads to higher U_2 under different value of β in *Figure 1*. Therefore, firm 2 will hold shares as much as possible in firm 1.

Then we analyze the decision-making of the proportion of state-owned shares in domestic government assuming that $m = n = 0$ and $a = 1$. The relation between W and β is shown in *Fig. 2*.

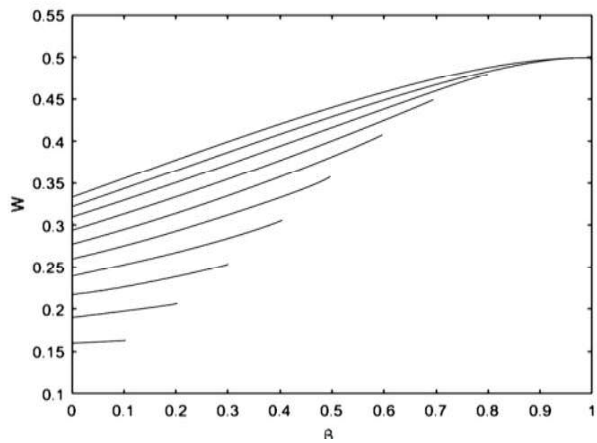

Figure. 2. The relation between W and β

Note: The values of δ corresponding to the curves from top to bottom are: 0,0 .1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9

In *Figure 2*, we can see that there is a positive correlation between β and W under different values of δ. Therefore, the best choice is to achieve complete nationalization for the domestic government? And firm 2 has no chance to cross own firm 1 in that case.

Proposition 1: If there is no marginal cost both in two enterprises, the more shares of firm 1 held by firm 2, the more profit can be obtained. While for the government, the higher proportion of state-owned shares, the more social welfare can be obtained. In that case, firm 1 will be completely nationalized and firm 2 will not hold any shares in firm 1.

Firm 1 implements cross-ownership to firm 2.

Assuming that firm 1 cross owns firm 2, $0 \le \delta \le 1$. The utility function will change to $U_1 = \beta W + (1-\beta)(\pi_1 + \delta\pi_2)$, $U_2 = \pi_2$, the domestic social welfare is given by $W = \pi_1 + \delta\pi_2 + CS$

Let us first consider stage 3 of the game

$$\frac{\partial U_1}{\partial q_1} = -2q_1 + \beta q_1 - q_2 - (\delta - \delta\beta)q_2 + \beta q_2 + a = 0 \qquad (7)$$

$$\frac{\partial U_2}{\partial q_2} = -2q_2 - q_1 + a = 0 \qquad (8)$$

It is straight forward to deduce that

$$q_1 = \frac{a(\delta - \beta - \delta\beta - 1)}{\delta + \beta - \delta\beta - 3} \qquad (9)$$

$$q_2 = \frac{a(\beta - 1)}{\delta + \beta - \delta\beta - 3} \qquad (10)$$

By substituting Equation (9) and (10) in U_1 and W, we deduce

$$U_1 = (\frac{\beta}{2} - 1)q_1^2 + (\frac{\beta}{2} - \delta + \delta\beta)q_2^2 + (\beta - \delta + \delta\beta - 1)q_1q_2 + aq_1 + a(\delta - \delta\beta)q_2 - \beta m - (1 + \delta - \beta - \delta\beta)n$$

$$W = -\frac{1}{2}q_1^2 + (\frac{1}{2} - \delta)q_2^2 - \delta q_1 q_2 + aq_1 + a\delta q_2 - \beta m - (1 - \beta + \delta)n$$

Then move to stage 2 to study the optimal cross-ownership that firm 1 chooses. We assume that $m = n = 0$ and $a = 1$, the values of U_1 and the relation between U_1 and δ are as follows (Fig. 3 and Fig.4):

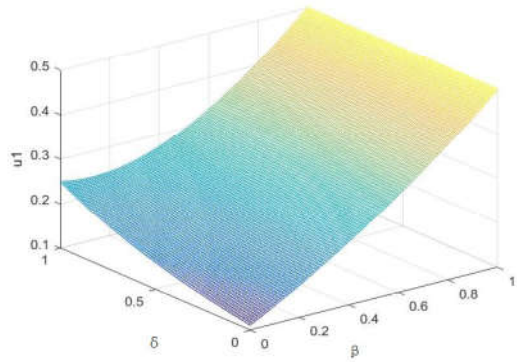

Figure 3. Value of U_1.

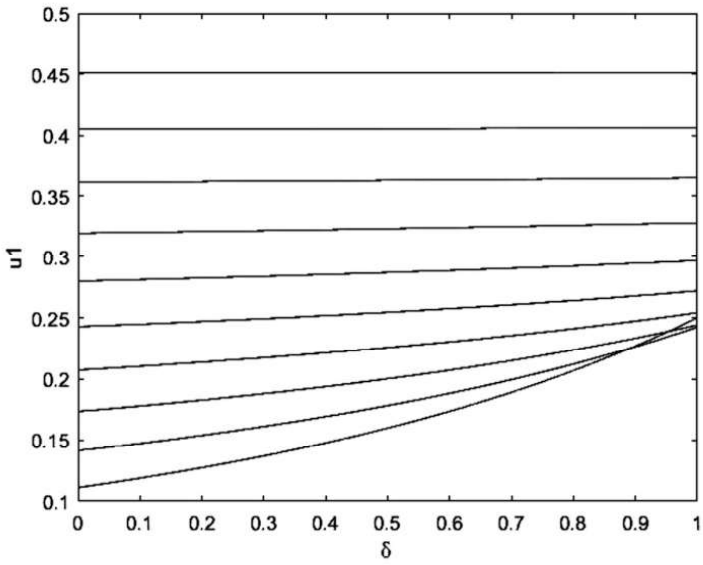

Figure 4. Correlation between U_2 and δ.

Note: The values of U_1 from top to bottom are: 0.9,0.8,0.7,0.6,0.5,0.4,0.3,0.2,0.1,0

Figure 3 and *Figure 4* show that the values of β is greater than 0, there is a positive correlation between U_1 and δ when $\beta < 1$, so the more shares of firm 2 held by firm1, the better. Furthermore, there is a positive correlation between β and $\frac{\partial U_1}{\partial \delta}$ .The higher value of $\frac{\partial U_1}{\partial \delta}$, the enhancing effect of cross-ownership to firm's utility is more significant. It can be proved that when $\beta = 1$, the value of U_1 is determined at 0.5 and would not be affected by the value of δ.

Finally, let's turn to stage 1 and assume $m = n = 0$ and $a = 1$, the values of W and the relation between W and β are as follows (*Figure 5* and *Figure 6*):

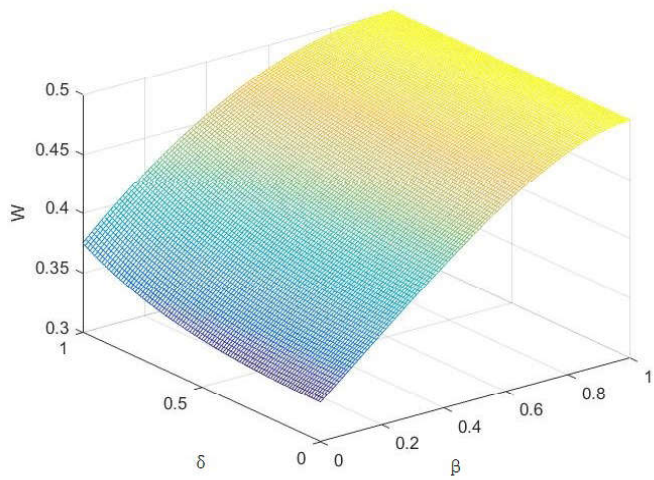

Figure 5. Value of W

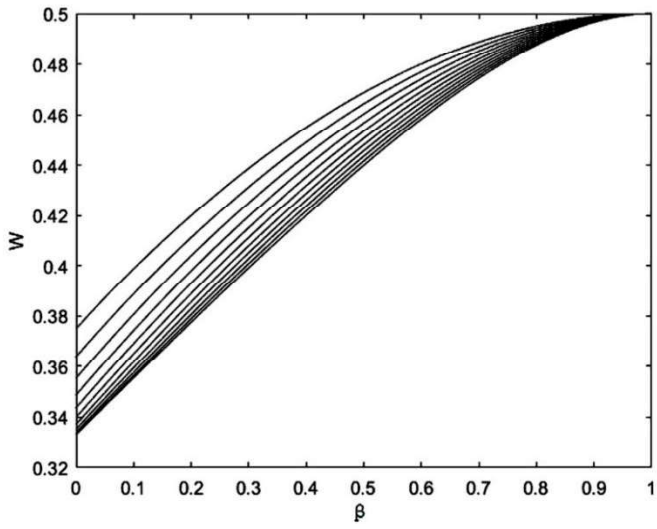

Figure. 6 The relation between W and β

Note: The values of δ from top to bottom are: 1,0.9,0.8,0.7,0.6,0.5,0.4,0.3,0.2,0.1,0

Figure 5 and *Figure 6* show the values of W is greater than 0. Meanwhile, there is a positive correlation between β and social welfare regardless of the values of δ. So the value of $\frac{\partial W}{\partial \beta}$ will be higher if δ increases, which means that the increase of the proportion of state-owned shares will lead to a more significant effect on promoting social welfare. Therefore, complete nationalization should be taken from the perspective of home government.

Proposition 2: Assuming no marginal cost exist, the more shares of firm 2 held by firm 1, the more enhancing effect to firm's utility. So the full cross-ownership is the optimal choice. The increase of the proportion of state-owned shares in firm 1 will lead to a more significant effect on the promotion on domestic social welfare. Finally the state-owned enterprise will adopt complete nationalization and firm 1 will cross owns firm 2 completely.

Firm 1 enters into the foreign market and cross own enterprise in host country

Now the original assumptions are changed as state-owned firm 1 enters into firm 2's host country. So the firm 1 becomes a foreign firm and firm 2 becomes a domestic firm. We study the cross-ownership arrangement and optimal proportion of state-owned shares in this case. We assume that firm 1 cross own (δ) of firm 2. The utility functions are $U_1 = \beta W_1 + (1-\beta)(\pi_1 + \delta\pi_2)$ and $U_2 = \pi_2$ respectively. The social welfare in the home country of firm 1is given by

$W_1 = \pi_1 + \delta\pi_2$,the social welfare in the country of firm 2 is given by

$W_2 = (1-\delta)\pi_2 + CS$

First, we analyzes the stage 3 of the game. Based on $\frac{\partial U_1}{\partial q_1} = -2q_1 - (1+\delta)q_2 + a = 0$ and $\frac{\partial U_2}{\partial q_2} = -2q_2 - q_1 + a = 0$, we can obtain $q_1 = \frac{a(1-\delta)}{3-\delta}$ and $q_2 = \frac{a}{3-\delta}$, then substitute back we can deduce

$$W_1 = \frac{a^2}{(3-\delta)^2} - \beta m - (1+\delta-\beta)n \qquad (11)$$

Let's now move to stage 2 of the game. We assume that the decision-making of cross-ownership and proportion of state-owned shares are finally decided by the home government of firm 1 for the reason that the overseas investments of state-owned enterprise usually depends on the governmental vigorous support and intervention and they are responsible for implementing the state's overseas strategy. Based on (11), we can deduce that $\frac{\partial W_1}{\partial \delta} = \frac{2a^2}{(3-\delta)^3} - n$. When $\frac{a^2}{4} \le n$, $\frac{\partial W_1}{\partial \delta} \le 0$, the optimal strategy is not to hold any shares in firm 2. We also note that $\frac{\partial W_1}{\partial \delta} \ge 0$ if $\frac{4a^2}{27} \ge n$ That is, the optimal strategy is to hold shares in firm 2 as much as possible. When $\frac{2a^2}{27} < n < \frac{a^2}{4}$ and $\delta \in [0, 3-\sqrt[3]{\frac{2a^2}{n}}]$, $W_1(\delta)$ is a monotonically

decreasing function. While $W_1(\delta)$ is a monotonically increasing function when $\delta \in (3-\sqrt[3]{\frac{2a^2}{n}},1]$ .It can be proved that $W_1(\delta)$ will reach the maximum value when $\frac{2a^2}{27} < n \le \frac{5a^2}{36}$ and $\delta = 1$ .While when n in the range of $\frac{5a^2}{36} < n < \frac{a^2}{4}$ and $\delta = 0$, $W_1(\delta)$ will be maximized.

Finally, let's move to stage 1 of the game, $\frac{\partial W_1}{\partial \beta} = n - m$,if $m = n$,there is no relation between W_1 and β ; if $m > n$,there is a negative correlation between W_1 and β ;if $m < n$, there is a positive correlation between W_1 and β .

Proposition 3: Firm 1 enters into foreign market and cross owns firm 2 in host country. If the private capital efficiency is less than a certain level ($n > \frac{5a^2}{36}$), firm 1 will not cross owns firm 2 while if the private capital efficiency is more than the level ($n \le \frac{5a^2}{36}$), it will cross owns firm 2. If the efficiency of state-owned capital is the same as private capital, the proportion of state-owned shares will exert no impact on the social welfare; if the state-owned capital efficiency is lower than the private capital, the complete privatization is the optimal choice; if the state-owned capital efficiency is higher than the private capital, the complete nationalization is the optimal choice.

Conclusion

This paper studied the international cross-ownership and the proportion of state-owned shares in three cases. Two factors distinguish this study from others. First, it is considered that the domestic state-owned enterprise cross own the foreign firm. Second, this paper explores cross-ownership to the foreign enterprise in host country. Conclusions are as follows:

Firstly, if state-owned firm 1 is cross owned by foreign firm 2, firm 1 will be completely nationalized under certain conditions and firm 2 can't cross own it. If firm1cross owns firm 2, firm 1 will cross own it completely and achieve complete nationalization under certain conditions.

Secondly, when firm 1cross owns firm2 in host country, if the private capital efficiency is less than a certain level ($n > \frac{5a^2}{36}$), firm 1 will not cross own it. If the private capital efficiency is more than the level, it will cross own it completely. If the efficiency of state-owned capital is the same as private capital, the proportion of state-owned shares will exert no impact on the social welfare; if the state-owned capital efficiency is lower than the private capital, the complete privatization is the optimal choice; if the state-owned capital efficiency is higher than the private capital, the complete nationalization is the optimal choice.

The conclusions above indicate that privatization doesn't necessarily improve social welfare, the complete nationalization can be the optimal choice under certain conditions such as the state-owned capital is efficient. Therefore, the government should not blindly pursue privatization only. Meanwhile, these conclusions also exert significant effect on the cross-border mergers and acquisitions.

Acknowledgements

The research is Supported by "The Fundamental Research Funds for the Central Universities" (NO.N172304021) and "the Natural Science Foundation of Hebei Province of China" (NO.G2018501047) and "The Social Science Foundation of Liaoning Province of China" (NO.L17BJY011)

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