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Strategic Relations between Corporate Social Responsibility and Partial Privatization Policy with Foreign Penetration

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Abstract

This study considers a strategic interplay between corporate social responsibility (CSR) and privatization policy in a mixed market, and investigates the impact of the order of sequential games. We compare the different timeline of the game between the privatization-then-CSR and the reverse case of CSR-then-privatization, and highlight the significant role of the foreign shareholding ratio of the CSR-firm. We show that partial privatization is always optimal regardless of the timeline of the game, but the privatization-then-CSR yields a lower (higher) degree of privatization while a higher (lower) level of CSR than the CSR-then-privatization when the foreign penetration is sufficiently low (high). We also show that privatization-then-CSR can be a unique equilibrium in an endogenous timing game but socially desirable only when the foreign penetration is neither sufficiently low nor high.

Keywords: Strategic CSR, Partial privatization, Foreign penetration, Mixed market

JEL Classification: C72, H42, L13, M14

1. Introduction

In the literature of mixed oligopolies, where the public firm plays an important leading role in an imperfect competition market wherein it competes with private firms, one of policy issues is the decision by the government on whether to or how much privatize the public firms.¹ In his seminal paper, Matsumura (1998) showed that a public firm should be partially privatized in a mixed duopoly market under moderate conditions with increasing costs and homogeneous products. Since then, a number of researches in such fields as industrial economics, public economics, international economics, financial economics, and development economics, have analyzed the robustness of partial privatization policies with focusing on various aspects of economic phenomena.²

The literature on mixed oligopolies usually assumes that private firms maximize their own profits. That is, the previous works regard profit maximization as the sole objective of a private firm. However, since Porter and Kramer (2006) present a systematic analysis linking comparative advantage to corporate social responsibility (CSR), CSR activities have now become imperative research topics.³ Accordingly, recent researches on mixed oligopoly markets have also analyzed different forms of market competition wherein public firm competes with private firms that might adopt CSR activities. For example, Ouattara (2017) and Kim et al. (2019) examined the optimal privatization policies in the context of CSR activities in a mixed market with homogeneous products. Dong et al. (2018) and Dong and Wang (2019) considered the state-holding corporations in mixed oligopolies with multiple products and analyzed the relations between CSR and optimal privatization policy.

All these works adopted a standard approach in the timeline of the game where the government can commit an optimal privatization policy and then firms compete with strategic instruments. It is plausible to set this type of sequential order from the divergence between the decisions on firm level and those on government level, which can constrain firms' strategic spaces. However, this timeline might not be always realistic and practical. In the process of policy-making, if the government

¹ It is quite usual to observe that public firms are significant parts of the economy for many countries, such as China, India, Korea and Japan, especially, in steel, automobile, airline, finance, banking and other industries.

² For example, Lee (2006), Matsumura and Shimizu (2010), and Lee et al. (2013) provided current policy issues on the optimal privatization in mixed oligopolies.

³ In reality, according to the PWC Global CEO survey (2016), 64% of the CEOs see CSR as a core part of their business and 59% of them believe social values are important to attract top employees. For recent studies, see Wang, et al. (2012), Chang et al. (2014), Lambertini and Tampieri (2015), Leal et al. (2018), Xu and Lee (2019), and Cho et al. (2019).

cannot commit credibly to the stringency of the policy, firms might have strategic incentives because the government has an ex-post possibility to ratchet up flexible policy.⁴

In the recent literature of privatization, some papers also allowed different timelines of the game when the firms interact with the government in a time-inconsistent framework in which strategic commitment is the heart of the analysis.⁵ Ino and Matsumura (2010) discussed two Stackelberg models in mixed markets and examined output commitment by a public firm. Ino and Miyaoka (2020) extended the analysis in the open economy while Haraguchi and Matsumura (2020a) examined implicit protectionism by a public firm under the technology transfer from foreign firms. In a free-entry mixed market, Xu et al. (2017) and Chen et al. (2019) examined the timing of privatization policies with a linear demand and a specific symmetric quadratic cost, while Lee et al. (2018) generalized the different timeline of entry-then-privatization model. Haraguchi and Matsumura (2020b) also discussed how the lack of commitment to future privatization policies might lead to the worst welfare outcomes. However, no papers attempted to analyze the strategic relations between corporate social responsibility and optimal privatization policy.

In this paper, we investigate a relationship between the optimal privatization policy and firm's strategic decision on CSR, and emphasize a strategic interplay in the timing of commitment of these two policies. We consider not only the ability of the government to commit the optimal policy but also that of the firm to commit credibly to the strategic level of CSR before or after the government chooses the policies. In particular, we examine the timing of decisions when either the government or the private firm can choose the timing of decisions, sequentially and simultaneously, and investigate the impact of the order of the different movements. We then highlight the significant role of the foreign shareholding ratio of the CSR-oriented firm.

We formulate two different scenarios, a "privatization-then-CSR" case, and a "CSR-then-privatization" case. In the former case, the government decides the optimal privatization in the first stage, and then the private firm chooses the strategic CSR in the second stage, while in the latter case, the order of the movements is reversed. We also consider an endogenous timing game and examine a simultaneous movement case in which the government and the private firm can choose

⁴ In the literature of environmental regulation, Poyago-Theotoky and Teerasuwannajak (2002) and Moner-Colonques and Rubio (2015) examined emission tax when the regulator is not able to commit. They showed that firms undertake increased abatement activities generating less pollution, which might result in higher welfare. However, they concentrated on the private market where both firms only maximize their profits under environmental policies. Recently, some works examined the time inconsistency problem with the CSR firms. See, for example, Leal et al. (2018), Garcia et al. (2018), Lee et al. (2018), and Xu and Lee (2018).

⁵ For some discussion on the practical evidence of the commitment issue in the real examples, see the papers cited in Lee et al. (2018) and Ino and Miyaoka (2020).

the decision timing simultaneously. We then provide the equilibrium of the analysis and its policy implications on the timeline of the game and foreign penetration.

These findings are in contrast to the results in the previous literature of mixed oligopolies. As the foreign presence in the private firm ownership increases, Lin and Matsumura (2012) shows that it monotonically decreases the optimal degree of privatization in a short-run equilibrium while Cato and Matsumura (2012) and Xu et al. (2017) show that it monotonically increases the optimal degree of privatization in the long-run equilibrium. However, we find that the non-monotonicity result holds in the presence of CSR. Further, Ouattara (2017) and Kim et al. (2019) show that active involvement of CSR monotonically decreases the optimal degree of privatization, regardless of nationality. However, we find that the non-monotonicity result holds in both different timelines of the game in the presence of foreign ownership. Finally, Xu et al. (2017) and Lee et al. (2018) showed that the timeline influences the optimal degree of privatization in the opposite direction but monotonically, depending on the foreign ownership. However, our findings show that the non-monotonicity might occur in the presence of CSR, depending on the timeline of the game.

On the other hand, we also show that the privatization-then-CSR case yields a lower (higher) profit to the private firm while a higher (lower) welfare to the government than the CSR-then-privatization case when the foreign penetration is sufficiently low (high). It implies that the incentive of choosing the timing of the game differs between the government and the private firm, and it depends crucially on foreign penetration. In an endogenous timing game, we show that both sequential choice and simultaneous choice can be an equilibrium, but the privatization-then-CSR case is not only a unique equilibrium but also socially desirable when the foreign penetration is neither sufficiently low nor high.

The remainder of this paper is organized as follows. Section 2 presents the basic model in which a partially privatized public firm competes with a private firm with CSR activities in a mixed duopoly. Section 3 analyzes two different scenarios: the privatization-then-CSR case and the CSR-then-privatization case, respectively, and Section 4 compares the main results between two cases. Section 5 analyzes a simultaneous model and then considers an endogenous timing game in a mixed duopoly. Section 6 concludes the study.

2. The model

We consider a mixed duopoly in which both public and private firms produce homogeneous products in the same market. We assume possibly different objectives between the two firms. Firm 1 is a partially privatized public firm that cares for only some portion of social welfare. Firm 2 is a

private firm that might engage in consumer-friendly CSR activities, but it is partially owned by foreign investors.

Inverse demand is given by: $p = 1 - Q$, where $Q = q_1 + q_2$ denotes total market output and q_i denotes quantities supplied by each firm. Then, consumer surplus is represented as $CS = \frac{1}{2}Q^2$. Each firm's cost function is given as: $C_i(q_i) = \frac{c_i}{2}q_i^2, i = 1, 2$ where $c_1 = 1 \geq c_2 = c > 0$ without loss of generality and $c \in (0,1]$ represents cost differences between the public and private firms.⁶ Note also that each firm's marginal cost is q_1 and cq_2 , respectively. The profit of the firm is given as:

$$\begin{aligned}\pi_1 &= p_1q_1 - \frac{1}{2}q_1^2, \\ \pi_2 &= p_2q_2 - \frac{c}{2}q_2^2.\end{aligned}\tag{1}$$

We follow the standard organizational assumption in Matsumura (1998) that the objective function of the managers of the public firm is given as:

$$U = (1 - \theta)W + \theta\pi_1,\tag{2}$$

where $\theta \in [0, 1]$ represents the degree of privatization, of which portion is owned by domestic private owners, and it is determined by a welfare-maximizing government. That is, there exists a separation between the public ownership and private ownership. Thus, the manager of the public firm maximizes the weighted average of social welfare and the profit, depending on the degree of privatization. Here, $\theta = 0$ denotes that firm 1 is a fully nationalized public firm.

On the other hand, the private firm has also a different organization in a managerial delegation contract in which output production decisions are delegated to a manager. That is, there exists a separation between ownership and management. The owner of the firm wants to maximize the profit but specifies a portion of consumer surplus as a CSR-initiative in an incentive contract with the manager.⁷ Then, the manager of the private firm maximizes the profit of the firm plus a fraction of

⁶ One justification of cost difference is that the public firm might invest more in the public activities rather than CSR-firm in order to increase consumer's well-being, for example, of the people in the low-income level or in the remoted local areas. In specific, in the objective functions in (2) and (3), we have $U = \pi_1 + (1 - \theta)CS + (1 - \theta)(1 - \beta)\pi_2$ while $V = \pi_2 + \alpha CS$. Thus, as far as $1 - \theta > \alpha$ in the weights on CS , the public firm concerns more on the consumers than the CSR-firm. We can show that it is true in the following analysis.

⁷ A consumer-friendly CSR initiative is regarded as that the firm adopts consumer surplus as a proxy for its own CSR concerns. In the managerial delegation contract, the firm may strategically use the CSR initiative as a commitment device to expand the outputs and thus the firm that adopts CSR obtains higher profit than its profit-seeking competitors. For recent discussion on the theoretical relation between managerial delegation and CSR, see Lambertini and Tampieri (2015), Lee and Park (2019) and Garcia et al. (2019)

consumer surplus in production. The objective function of the manager of the private firm is given as:

$$V = \pi_2 + \alpha CS, \quad (3)$$

where $\alpha \in [0,1]$ represents the level of consumer-friendly CSR. That is, the managerial contract assigns a weight to consumer surplus in its objective function. Then, it is sensible that as the firm places a higher incentive on CSR, it produces output aggressively. Here, $\alpha = 0$ denotes a pure profit-maximizing private firm. Note also that the investor of the private firm strategically chooses its incentive level of CSR in order to maximize its profit π_2 in Eq. (1).

Finally, considering the foreign ownership share of the private firm, we define producer surplus as $PS = \pi_1 + (1 - \beta)\pi_2$, where $\beta \in [0,1]$ is the foreign penetration in the private firm.⁸ We define the social welfare as the sum of consumer surplus and producer surplus:

$$W = CS + PS. \quad (4)$$

In the following analysis, we consider two different scenarios regarding the timeline of the game, a privatization-then-CSR case, and a CSR-then-privatization case. The game of each scenario runs as follows. As for the first scenario, the privatization-then-CSR case, the government decides the optimal degree of privatization in the first stage, and then after observing this policy, the owner of a private firm determines the strategic level of CSR in the second stage. As for the second scenario, the CSR-then-privatization case, the owner of the private firm commits the level of CSR in the first stage, and then, after observing this commitment, the government decides the optimal degree of privatization in the second stage. Finally, the two firms compete in quantities in both scenarios. We solve the subgame perfect Nash equilibrium through backward induction.

3. The analysis

3.1 Privatization-then-CSR case

We first consider a standard case that the government chooses the optimal degree of privatization at the beginning of the game. In a Cournot model, two firms choose quantities simultaneously in the final stage. Then, the manager of a public firm takes the differentiation of U in Eq. (2) with respect to q_1 while that of the private firm takes the differentiation of V in Eq. (3) with respect to q_2 , respectively, which yield the followings:

⁸ We can interpret the foreign penetration as indicating the level of market openness in financial markets. See Haraguchi and Matsumura (2014), Xu et al. (2017) and Lee et al. (2018).

$$\begin{aligned}\frac{\partial U}{\partial q_1} &= \theta(1 - 3q_1 - q_2) + (1 - \theta)(1 - 2q_1 - (1 - \beta)q_2) = 0, \\ \frac{\partial V}{\partial q_2} &= 1 - q_1 - 2q_2 - cq_2 + (q_1 + q_2)\alpha = 0.\end{aligned}\quad (5)$$

From Eq. (5), we obtain the equilibrium outputs

$$q_1 = \frac{1+c+\beta-\beta\theta-\alpha}{3+2c+\beta+(2+c-\beta)\theta-(1+\beta+\theta-\beta\theta)\alpha}, \quad q_2 = \frac{1+\theta+\alpha}{3+2c+\beta+(2+c-\beta)\theta-(1+\beta+\theta-\beta\theta)\alpha}.\quad (6)$$

A few remarks are in order. First, the output of the public firm is decreasing in the level of CSR, while the output of the private firm is increasing in the level of CSR, i.e., $\frac{\partial q_1}{\partial \alpha} < 0$ and $\frac{\partial q_2}{\partial \alpha} > 0$. Second, the output of the public firm is increasing in foreign penetration, while the output of the private firm is decreasing in foreign penetration, i.e., $\frac{\partial q_1}{\partial \beta} > 0$ and $\frac{\partial q_2}{\partial \beta} < 0$. Third, the output of the public firm is decreasing in the degree of privatization, while the output of the private firm is increasing in the degree of privatization, i.e., $\frac{\partial q_1}{\partial \theta} < 0$ and $\frac{\partial q_2}{\partial \theta} > 0$. Finally, the output of the public firm is increasing in cost differences, while the output of the private firm is decreasing in cost differences, i.e., $\frac{\partial q_1}{\partial c} > 0$ and $\frac{\partial q_2}{\partial c} < 0$.

The profits of the firm and social welfare are given, respectively

$$\begin{aligned}\pi_1 &= \frac{(1+c-\alpha+\beta-\beta\theta)(1+c-\beta+2\theta+2c\theta+\beta\theta-\alpha-2\beta\alpha-2\theta\alpha+2\beta\theta\alpha)}{2(3+2c+\beta+(2+c-\beta)\theta-(1+\beta+\theta-\beta\theta)\alpha)^2}, \\ \pi_2 &= \frac{(1+\theta+\alpha)(2+c-2\alpha-c\alpha-2\alpha\beta+2\theta+c\theta-2\alpha\theta+2\alpha\beta\theta)}{2(3+2c+\beta+(2+c-\beta)\theta-(1+\beta+\theta-\beta\theta)\alpha)^2}, \\ W &= \frac{\{(1+\theta)(7+7c+2c^2+2\beta+c\beta+3\theta+c\theta-6\beta\theta-3c\beta\theta)-2\alpha(1+c+2\beta+c\beta+3\theta+2c\theta-\beta\theta-c\beta\theta-2\beta^2\theta+\theta^2-3\beta\theta^2+2\beta^2\theta^2)- (1+c-2\beta-c\beta-2\beta^2-2\beta\theta+2\beta^2\theta)\alpha^2\}}{2(3+2c+\beta+(2+c-\beta)\theta-(1+\beta+\theta-\beta\theta)\alpha)^2}.\end{aligned}\quad (7)$$

In the second stage, the owner of the private firm chooses the level of CSR that maximizes its profit. The differentiation of π_2 in Eq. (7) with respect to α yields:⁹

$$\alpha = \frac{(1+\theta)(1-\beta+\beta\theta)}{c(2+\theta)+(3+\theta)(1+\beta+\theta-\beta\theta)}.\quad (8)$$

Note that the level of CSR is decreasing in foreign penetration and cost difference, i.e., $\frac{\partial \alpha}{\partial \beta} < 0$ and $\frac{\partial \alpha}{\partial c} < 0$. That is, if the foreign penetration in the private firm increases, this firm will choose a lower level of CSR. Further, an increase in the cost of the private firm leads to a lower level of CSR. Note

⁹ In the below, we can show that the interior solutions exist in the privatization-then-CSR case, i.e., $\alpha \in [0,1]$ in the possible regions of $\theta \in [0,1]$ and $\beta \in [0,1]$.

also that the level of CSR is non-monotone in the degree of privatization, i.e., $\frac{\partial \alpha}{\partial \theta} < 0$ when $\beta \leq \beta_1$ and $\frac{\partial \alpha}{\partial \theta} > 0$ when $\beta > \beta_1$.¹⁰ Thus, the effect of privatization on the level of CSR depends on foreign penetration. In particular, the level of CSR is decreasing in privatization when the foreign shareholding ratio is low, while it is increasing in privatization when the foreign shareholding ratio is high. This represents that foreign penetration plays an important role in the strategic relation between the two instruments. In particular, CSR activities and privatization policy are substitutable when the foreign penetration is low, while both policies complement each other when the foreign penetration is high.

The resulting social welfare is

$$W = \frac{(1+\theta)\{(2(7+10c+4c^2+10\beta+6c\beta+\beta^2)+4(7+7c+2c^2-2\beta-3c\beta-3\beta^2))\theta + (17+11c+2c^2-28\beta-15c\beta+6\beta^2)\theta^2 + (3+c-8\beta-3c\beta+4\beta^2)\theta^3\}}{2(2+\theta)^2(4+2\beta+3\theta-2\beta\theta)^2}. \quad (9)$$

In the first stage, the government chooses the degree of privatization that maximizes social welfare. The differentiation of W in Eq. (9) with respect to θ yields the optimal degree of privatization. As it is difficult to obtain the explicit outcomes in the equilibrium, we assume $c = 1$ in the below analysis and then take numerical simulations with $\beta \in [0,1]$.¹¹ Table 1 shows the equilibrium outcomes in this model, where subscript ‘‘P’’ denotes the equilibrium outcome of this game (**P**rivatization-then-CSR case).

<Table 1>

From Table 1, we show that the optimal privatization is partial privatization in a privatization-then-CSR case. Moreover, the effects of foreign penetration on optimal privatization and strategic CSR are different. In particular, foreign ownership reduces the strategic level of CSR, while influences the optimal degree of privatization non-monotonically. That is, as foreign penetration increases, the optimal privatization takes an inversed-U shape while the strategic CSR always decreases. This result differs from the result in Lin and Matsumura (2012), who shows that an increase in the foreign presence in the private firm monotonically decreases the optimal degree of privatization.¹² However, when the foreign penetration is low, which supports a higher level of CSR, it increases the degree of privatization. The opposite result can be obtained when the foreign penetration is high. It also shows that marginal cost of the CSR-firm is lower than that of the public

¹⁰ Note that β_1 satisfies that $c - 2\beta^2(1 - \theta)^2 - (1 + \theta)^2 + \beta(9 + c + 10\theta + 4c\theta + 5\theta^2 + c\theta^2) = 0$.

¹¹ Note that we can check the results in the ranges of $c \in (0,1]$ using the figures and tables, and show that our main propositions still hold. Detailed analysis will be provided by authors upon request.

¹² In a free entry mixed market, Matsumura and Kato (2005) showed that full nationalization is the optimal without foreign penetration while Cato and Matsumura (2012), Xu et al. (2017) and Lee et al. (2018) showed that the government always chooses partial privatization when there is foreign ownership in private firms.

firm. This is because the public firm produces more than the private firm at equilibrium. In addition, the effects of foreign penetration on the output of the private firm and the public firm are opposite. In particular, as foreign penetration increases, the output of the private firm decreases while the output of the public firm and total market output increases. Finally, the profit of the private firm and social welfare decrease as foreign penetration increases.

3.2 CSR-then-privatization case

We then consider the reverse case that the private firm can commit the level of strategic CSR before the government chooses the optimal degree of privatization. Using the equilibrium outcomes in the last stage, the differentiation of W in Eq. (7) with respect to θ yields:¹³

$$\theta = \frac{(1-\alpha)(1-\alpha-c\alpha+\alpha\beta+c\alpha\beta+\alpha\beta^2)}{1+3c+c^2-\alpha-2c\alpha+4\beta+2c\beta-2\alpha\beta+c\alpha\beta+\alpha^2\beta+\alpha\beta^2-\alpha^2\beta^2}. \quad (10)$$

A few remarks are in order. First, the privatization has non-monotonicity with regard to foreign penetration, and its impact on privatization depends on foreign penetration in CSR-then-privatization case, i.e., $\frac{\partial\theta}{\partial\beta} \leq 0$ when $\beta \leq \beta_2$.¹⁴ Thus, the degree of privatization is decreasing in foreign penetration when the foreign penetration is low, while it is increasing in foreign penetration when the foreign penetration is high. Second, the effect of production cost difference on privatization is independent of foreign penetration, i.e., $\frac{\partial\theta}{\partial c} < 0$. Thus, an increase in the cost of the private firm leads to a higher degree of privatization. Third, privatization has also non-monotonicity with regard to CSR activities, and the degree of privatization is increasing in CSR only when the cost difference is low but foreign penetration is high, otherwise, the degree of privatization is decreasing in CSR,¹⁵ That is, we have that: (i) if $0 < c \leq c_3$, $\frac{\partial\theta}{\partial\alpha} \leq 0$ when $\beta \leq \beta_3$; and (ii) if $c_3 < c \leq 1$, $\frac{\partial\theta}{\partial\alpha} < 0$ where $c_3 = \frac{4-8\alpha+\alpha^2}{4\alpha+\alpha^2-2}$. Hence, privatization policy and CSR activities complement each other in the CSR-then-privatization case.

By substituting Eq. (10) into π_2 in Eq. (7), we obtain the profit function of the private firm:

¹³ In the below, we show that the interior solutions exist in the CSR-then-privatization case, i.e., $\theta \in [0, 1]$ in the possible regions of $\alpha \in [0,1]$ and $\beta \in [0,1]$.

¹⁴ Note that β_2 satisfies that $-2(2+c)+7\alpha+c(3+c)^2\alpha-(2+c)^2\alpha^2+\alpha^3+c\alpha^3+(2c(3+c)\alpha-2(-1+c)\alpha^2-2\alpha^3-2c\alpha^3)\beta+(2(2+c)\alpha-3\alpha^2+2\alpha^3+c\alpha^3)\beta^2=0$.

¹⁵ Note that β_3 satisfies that $(2(2+c)-4(2+c)\alpha+\alpha^2-c\alpha^2)\beta^3+(4+3c(3+c)-2(4+3c(3+c))\alpha+\alpha^2+2c\alpha^2-c^2\alpha^2)\beta^2+(-5+c(-5+c(2+c))+4\alpha-2c(-2+c(2+c))\alpha+\alpha^2+3c\alpha^2+3c^2\alpha^2)\beta-1-c(5+c(5+c))+2\alpha+2c(2+c)^2\alpha-\alpha^2-3c\alpha^2-2c^2\alpha^2=0$.

$$\pi_2 = \frac{(2+c+\alpha+\alpha\beta-\alpha^2\beta)(4+4c+c^2-6\alpha-6c\alpha-c^2\alpha+2\alpha^2+2c\alpha^2-2\alpha\beta-c\alpha\beta-c\alpha^2\beta)}{2(5+2\beta+c(7+2c+\beta))-2(2+2c+\beta)\alpha+(1+c-c\beta)\alpha^2}. \quad (11)$$

In the first stage, the owner of the private firm chooses the level of strategic CSR that maximizes its profit. The differentiation of π_2 in Eq. (11) with respect to α yields the strategic level of CSR. Again, we assume $c = 1$ in the below analysis and then take numerical simulations with $\beta \in [0,1]$. Table 2 shows the equilibrium outcomes in this model, where subscript ‘‘C’’ denotes the equilibrium outcome of this game (CSR-then-privatization case).

<Table 2>

From Table 2, we show that the optimal privatization is partial privatization in a CSR-then-privatization case. Moreover, the effects of foreign penetration on optimal privatization and strategic CSR are the same. That is, as foreign penetration increases, both the optimal privatization and strategic CSR decrease. Thus, foreign ownership reduces not only the level of strategic CSR but the optimal degree of privatization. This is in sharp contrast to the result in the privatization-then-CSR case. It also shows that marginal cost of the CSR-firm is lower than that of the public firm in the CSR-then-privatization case. In addition, the effects of foreign penetration on the output of the private firm and the public firm are opposite. In particular, as foreign penetration increases, the output of the private firm decreases while the output of the public firm and total market output increases. Thus, similar to the privatization-then-CSR case, both profit of the private firm and social welfare decrease as foreign penetration increases. In sum, if the government privatizes the public firm which competing with a private firm with CSR activities, not only the share of foreign ownership but also the timeline of the game matter on the optimal privatization policy.

4. Comparisons

In this section, we will compare the equilibrium outcomes between the two scenarios and discuss some policy-relevant implications. We will focus on the case of $c = 1$, but main findings still hold in the ranges of $c \in (0, 1]$ with minor modifications.¹⁶

Proposition 1: *The privatization-then-CSR case yields a lower (higher) degree of privatization while a higher (lower) level of CSR than the CSR-then-privatization case when the foreign penetration is sufficiently low (high).*

Proof: Comparisons show that: (i) $\theta^P \underset{>}{\leq} \theta^C$ when $\beta \underset{>}{\leq} 0.2939$; and (ii) $\alpha^P \underset{>}{\geq} \alpha^C$ when $\beta \underset{>}{\leq} 0.9488$.

¹⁶ In Appendix, we provide the sensitivity analysis of the propositions.

Proposition 1 implies that the two cases might yield opposite decisions of the government and the owner of a private firm, depending upon foreign penetration. In particular, when the share of foreign ownership is low, i.e., $0 \leq \beta < 0.2939$, in the privatization-then-CSR case the optimal degree of privatization is lower (higher) but the strategic level of CSR is higher (lower) than that in the CSR-then-privatization case. By contrast, when the share of foreign ownership is sufficiently high, i.e., $0.9488 < \beta \leq 1$, the reversed result is obtained. However, when the share of foreign ownership is intermediate, i.e., $0.2939 < \beta < 0.9488$, both the optimal degree of privatization and the strategic level of CSR are higher in the privatization-then-CSR case. Therefore, the effect of foreign penetration is imperative not only on the optimal decisions of the government and the private firm, but also on the strategic timing of commitment on CSR of the private firm. We can explain the intuition behinds these results.

As an extreme case, when the private firm is largely owned by domestic investors, the government can set a lower degree of privatization, which can bring about a higher level of CSR (i.e., $\frac{\partial \alpha}{\partial \theta} < 0$ when $0 \leq \beta < \beta_1$) in a standard model of the privatization-then-CSR case where the government can commit its privatization policy before the private firm moves. This policy can reduce the production cost in the industry (cost-saving effect) and increase total outputs (output-substitution effect).¹⁷ However, in a CSR-then-privatization case where the private firm can commit to its CSR before the government moves, it engages in a lower level of CSR in order to induce a higher degree of privatization.¹⁸ (i.e., $\frac{\partial \theta}{\partial \alpha} < 0$ if $0 \leq \beta < \beta_3$). Hence, the decisions on the privatization and CSR can be opposite. As the other extreme case, on the other hand, when the private firm is largely own by foreign investors, the results can be reversed in both the privatization-then-CSR case and the CSR-then-privatization case.

Finally, when the share of foreign ownership is neither high nor low, both the decision of CSR and that of privatization have monotonicity in either case, but both decisions are higher in the privatization-then-CSR case during the interaction of the cost-saving effect and output-substitution effect. In the following proposition 2, we can confirm the changes in the outputs in both cases.

In sum, if the government privatizes the public firm under the strategic CSR of a private firm, not only the foreign ownership but also the timeline matter. As a result, the policy implications are contradictory when privatization is implemented in the presence of CSR under the different environments of market liberalization.

¹⁷ In the presence of CSR-firm, the optimal privatization policy depends on the output-substitution effect and cost-saving effect among the firms. See Kim et al (2019).

¹⁸ In the presence of foreign penetration, the optimal privatization policy can be reversed depending on the different timeline in a free entry mixed market. See Xu et al. (2017) and Lee et al. (2018)

Proposition 2: *The privatization-then-CSR case yields higher (lower) market output and lower (higher) market price than those in the CSR-then-privatization case when the foreign penetration is low (high).*

Proof: Comparisons show that $Q^P \geq Q^C$ and $P^P \leq P^C$ when $\beta \leq 0.7111$.

From Table 1 and 2, partial privatization is optimal and thus the output of a public firm is always higher than that of the private firm irrespective of foreign penetration in both timelines of the game. It also show that irrespective of foreign penetration, the output of the public (private) firm in the privatization-then-CSR is lower (higher) than that in the CSR-then-privatization case, i.e., $q_1^C > q_1^P > q_2^P > q_2^C$. Since the timeline of the game affects different decisions of the government and the owner of the private firm, as shown in proposition 1, the two cases yield opposite output decisions of the managers of both firms. However, Proposition 2 states that in the privatization-then-CSR case yields higher total market output than that in the CSR-then-privatization case except for the case when foreign ownership is sufficiently high. Thus, the cost-saving effect might outweigh the output-substitution effect in determining optimal decisions between the government and the owner of a private firm. In particular, when the private firm is largely own by domestic investors, the government decides a lower degree of privatization under the privatization-then-CSR case, which encourages a higher level of CSR and increases higher total market output than that in the CSR-then-privatization case. The results are mostly beneficial to both the government and the owner of a private firm, as shown in the below proposition.

Proposition 3: *The privatization-then-CSR case yields a lower (higher) profit to the private firm while a higher (lower) welfare to the government than the CSR-then-privatization case when the foreign penetration is sufficiently low (high).*

Proof: Comparisons show that: (i) $\pi_2^P \leq \pi_2^C$ when $\beta \leq 0.1904$; and (ii) $W^P \geq W^C$ when $\beta \leq 0.9459$.

Proposition 3 also implies that the two cases yield opposite payoffs to the government and the owner of a private firm, depending upon foreign penetration. If the private firm is largely own by domestic investors, both the owner of the private firm and the government prefers the privatization-then-CSR case. However, if the private firm is largely own by foreign investors, the reverse preferences appear. Finally, in the intermediate case of foreign penetration, both the government and the owner of the private firm have opposite preferences. In the following section, using these findings, we will investigate the incentives of endogenous timing of the game between the government and the owner of the private firm.

5. Endogenous timing game

We adopt an observable delay game formulated by Hamilton and Slutsky (1990) and analyze the timing of the movement between the government and the owner of the private firm. In particular, the government chooses the timing of a privatization policy that maximizes welfare while the owner of the private firm chooses the timing of CSR commitment that maximizes the profit of the private firm. Then, we consider an endogenous timing game, in which both government and the owner of the private firm simultaneously chooses whether to move early ($T_i = 1$) or late ($T_i = 2$). Table 3 provides the payoff matrix of the observable delay game in this game. If both choose the same period, the equilibrium is a simultaneous-move game, which is denoted as the superscript S in Table 3. Otherwise, the equilibrium is a sequential-move game of the privatization-then-CSR case or the CSR-then-privatization case.

<Table 3>

5.1 Simultaneous case

We first analyze the simultaneous case where both the government and the owner of the private firm move at the same time. Then, using the equilibrium outcomes in the final stage in Eq. (7), we can take both differentiations of welfare with respect to θ and of the profit of firm 2 with respect to α , simultaneously and independently. Table 4 shows the equilibrium outcomes in this model.

<Table 4>

Comparing the equilibrium outcomes in the three models in Figure 1, we have the following lemmas.

<Figure 1>

Lemma 1: $\theta^C > \theta^S$ and $\theta^P \underset{>}{\leq} \theta^S$ when $\beta \underset{>}{\leq} 0.024$.

Proof: Comparisons show that: (i) $\theta^C > \theta^S > \theta^P$ when $0 \leq \beta < 0.024$; (ii) $\theta^C > \theta^P \geq \theta^S$ when $0.024 \leq \beta < 0.294$; and (iii) $\theta^P \geq \theta^C > \theta^S$ when $0.294 \leq \beta < 1$.

Lemma 1 states that the optimal degree of privatization in a simultaneous case is always lower than that in the CSR-then-privatization case, and it is also lower than that in the privatization-then-CSR case except when the foreign penetration is sufficiently low. Thus, the simultaneous case will less privatize than the other sequential cases.

Lemma 2: $\alpha^P > \alpha^S$ and $\alpha^C \underset{>}{\leq} \alpha^S$ when $\beta \underset{>}{\leq} 0.914$.

Proof: Comparing the strategic levels of CSR yields: (i) $\alpha^P > \alpha^S > \alpha^C$ when $0 \leq \beta < 0.914$; (ii) $\alpha^P > \alpha^C \geq \alpha^S$ when $0.914 \leq \beta < 0.949$; and (iii) $\alpha^C \geq \alpha^P > \alpha^S$ when $0.949 \leq \beta \leq 1$.

Lemma 2 states that the strategic level of CSR in a simultaneous case is always lower than that in the privatization-then-CSR case, but it will be higher than that in the CSR-then-privatization case except when the foreign penetration is sufficiently high. Thus, as shown in proposition 1, foreign ownership influences the opposite decisions of the government and the owner of a private firm in the different sequential games, and thus the simultaneous case will be intermediate between the two sequential cases.

Lemma 3: *Comparing the profits of the private firm yields the following relationships:*¹⁹

- (i) $\pi_2^C > \pi_2^S > \pi_2^P$ when $0 \leq \beta < 0.017$;
- (ii) $\pi_2^C > \pi_2^P \geq \pi_2^S$ when $0.017 \leq \beta < 0.190$;
- (iii) $\pi_2^P \geq \pi_2^C > \pi_2^S$ when $0.190 \leq \beta < 0.742$;
- (iv) $\pi_2^P > \pi_2^S \geq \pi_2^C$ when $0.742 \leq \beta \leq 1$.

Proof: Comparing the profits yields: (a) $\pi_1^P \underset{>}{\leq} \pi_1^S$ when $\beta \underset{>}{\leq} 0.037$; $\pi_1^P \underset{>}{\leq} \pi_1^C$ when $\beta \underset{>}{\leq} 0.676$; $\pi_1^C \underset{>}{\geq} \pi_1^S$ when $\beta \underset{>}{\leq} 0.919$; (b) $\pi_2^P \underset{>}{\leq} \pi_2^S$ when $\beta \underset{>}{\leq} 0.017$; $\pi_2^P \underset{>}{\leq} \pi_2^C$ when $\beta \underset{>}{\leq} 0.190$; $\pi_2^C \underset{>}{\geq} \pi_2^S$ when $\beta \underset{>}{\leq} 0.742$.

Lemma 3 states that the equilibrium profit of the private firm depends on foreign penetration and the order of privatization and CSR policies. In particular, the CSR-then-privatization case yields the highest profit of the private firm when the foreign penetration is sufficiently low, i.e., $0 \leq \beta \leq 0.190$, while it yields the lowest profit when the foreign penetration is sufficiently high, $0.742 \leq \beta \leq 1$. Reversely, the privatization-then-CSR case yields the highest social welfare when the foreign penetration is not sufficiently low, i.e., $0.190 \leq \beta \leq 1$, while it yields the lowest profit when the foreign penetration is sufficiently low, i.e., $0 \leq \beta < 0.017$. Thus, foreign penetration provides the opposite profit rankings to the private firm.

Lemma 4: *Comparing the social welfares yields the following relationships:*

- (i) $W^P \geq W^S > W^C$ when $0 \leq \beta < 0.927$;
- (ii) $W^P > W^C \geq W^S$ when $0.927 \leq \beta < 0.946$;
- (iii) $W^C \geq W^P > W^S$ when $0.946 \leq \beta \leq 1$.

¹⁹ Note that if $c \in (0, 3/4]$, we have $\pi_2^C > \pi_2^S$ and thus, (iv) disappears.

Proof: Comparing the social welfare yields: (a) $W^P \geq W^S$ and the equality holds only when $\beta = 0$; (b) $W^S \underset{<}{\geq} W^C$ when $\beta \underset{>}{\leq} 0.927$; (c) $W^P \underset{<}{\geq} W^C$ when $\beta \underset{>}{\leq} 0.946$.

Lemma 4 states that the equilibrium social welfare depends on foreign penetration and the order of privatization and CSR policies. In particular, the privatization-then-CSR case yields the highest social welfare when the foreign penetration is not sufficiently high i.e., $0 \leq \beta < 0.946$, while the CSR-then-privatization case the highest social welfare when the foreign penetration is sufficiently high, i.e., $0.946 \leq \beta \leq 1$. However, when the foreign penetration is not sufficiently low, i.e., $0.927 \leq \beta \leq 1$, the lowest social welfare could be obtained in the simultaneous case. In the opposite, when the private firm fully owned by the domestic investor, the highest social welfare could be obtained in the privatization-then-CSR case.

5.2 Equilibrium of an endogenous timing game

We can finally provide the Nash equilibrium of the endogenous timing game between the government and the owner of the private firm.

Proposition 4: *In an endogenous timing game:*

- (i) *when $\beta \in [0, 0.017)$, the simultaneous-move outcome, $(T_1, T_2) = (1, 1)$, is the unique equilibrium outcome;*
- (ii) *when $\beta = 0.017$, the simultaneous-move outcome, $(T_1, T_2) = (1, 1)$, and the privatization-then-CSR outcome, $(T_1, T_2) = (1, 2)$, are the equilibrium outcomes;*
- (iii) *when $\beta \in (0.017, 1]$, the privatization-then-CSR outcome, $(T_1, T_2) = (1, 2)$, is the unique equilibrium outcome.*

Proof: From Lemma 3 and 4, we can obtain that: (a) $\pi_2^P \underset{<}{\geq} \pi_2^S$ when $\beta \underset{>}{\leq} 0.017$; (b) $\pi_2^C \underset{<}{\geq} \pi_2^S$ when $\beta \underset{>}{\leq} 0.742$; (c) $W^S \underset{<}{\geq} W^C$ when $\beta \underset{>}{\leq} 0.927$; and (d) $W^P \geq W^S$.

Proposition 4 reports the equilibrium of an endogenous timing game in which foreign ownership matters but both the sequential case and the simultaneous case could be an equilibrium. In particular, the simultaneous case can be a unique equilibrium only when the foreign penetration is sufficiently low, i.e., $0 \leq \beta < 0.017$, while the privatization-then-CSR case can be a unique equilibrium otherwise. It also states that the CSR-then-privatization case can never be an equilibrium in an endogenous timing game. However, from Lemma 4, the CSR-then-privatization case can lead to the highest social welfare when the foreign penetration is sufficiently high, i.e., $0.946 < \beta \leq 1$.

Proposition 5: *The privatization-then-CSR is socially desirable when the foreign penetration is neither sufficiently low nor high.*

Proof: From Lemma 4 and Proposition 4, we can show that the privatization-then-CSR case is a Nash equilibrium and yields the highest welfare among three scenarios when $0.017 \leq \beta \leq 0.946$.

Proposition 5 states that the privatization-then-CSR case can be a unique equilibrium in an endogenous timing game and it is also socially desirable when the foreign penetration is neither sufficiently low nor high. Thus, a standard approach in the modeling of the timeline of the game between the government and the firms is feasible and desirable only when the foreign penetration is intermediate.²⁰ This also implies that a flexible privatization policy in a time-inconsistent framework, which lacks the commitment to future privatization policy, may lead to the worst social welfare.²¹

6. Conclusions

This study considers an interplay between the privatization policy and CSR, and investigates the impact of the order of the sequential games. We highlight the significant role of the foreign shareholding ratio and show that partial privatization is always optimal regardless of the timeline of the game. We also show that the privatization-then-CSR case yields a lower degree of privatization while a higher level of CSR than the CSR-then-privatization case when the foreign penetration is sufficiently low, while the opposite result is obtained when it is high. Therefore, foreign penetration is an important factor to determine the optimal decisions between the government and the private firm. We also find that the incentive of choosing the timing of movement might differ, depending on foreign penetration. Finally, we show that the privatization-then-CSR game is a unique equilibrium in an endogenous timing game and it is also socially desirable when the foreign penetration is neither sufficiently low nor high. These findings support the standard approach in modeling the optimal privatization policy in a mixed oligopoly.

A limitation of this study is that we assume that neither the privatization policy nor foreign ownership affects the production cost. Although these are standard assumptions in the literature on mixed oligopolies, an extension in this direction may be interesting. One possible way of modeling is incorporating technology licensing and spillovers among the firms.²² Finally, as open market

²⁰ Note that from footnote 19, if $c \in (0, 3/4]$, $(T_1, T_2) = (2, 1)$ can be an equilibrium outcome. Thus, the CSR-then-privatization is an equilibrium and socially desirable when the foreign penetration is relatively high. See Appendix.

²¹ In a free entry mixed market, flexible privatization policy can provide welfare loss in the absence of commitment. See Xu et al. (2017), Lee et al. (2018) and Haraguchi and Matsumura (2020b).

²² Chang et al. (2016) and Wang et al. (2016) presented models of international licensing in private oligopolies, while Kim et al. (2018) and Wang et al. (2020) analyzed public licensing in mixed oligopolies.

policy on liberalization enlarges more foreign penetration, the new entry might affect the competition modes among the firms, such as Stackelberg leadership or price competition, which affect the optimal policy of the government.²³ This also remains for future research.

Appendix: The sensitivity of the propositions

Proposition A1: *Main findings in Proposition 1 hold, except $\alpha^P > \alpha^C$ if $c \in (0, \frac{1}{4}]$.*

It implies that the privatization-then-CSR case yields a lower (higher) degree of privatization than the CSR-then-privatization case when the foreign penetration is sufficiently low (high) irrespective of the value of c . However, if $c \in (0, \frac{1}{4}]$, the privatization-then-CSR case always yields a higher level of CSR than the CSR-then-privatization case irrespective of the foreign penetration.

Proposition A2: *Main findings in Proposition 2 hold when $c \in (0, 1]$.*

Proposition A3: *Main findings in Proposition 3 hold when $c \in (0, 1]$.*

Proposition A4: *Main findings in Proposition 4 hold, but the CSR- then- privatization can be an equilibrium outcome when the foreign penetration is high if $c \in (0, \frac{3}{4}]$.*

Proposition A5: *Main findings in Proposition 5 hold, but the CSR- then- privatization is socially desirable when the foreign penetration is high if $c \in (0, \frac{3}{4}]$.*

It implies that the privatization-then-CSR case can be an equilibrium in an endogenous timing game and socially desirable when the foreign penetration is neither low nor high irrespective of the value of c . However, if $c \in (0, \frac{3}{4}]$, the CSR-then-privatization can be also an equilibrium and socially desirable when the foreign penetration is relatively high. Thus, the modeling of the opposite timeline of the game between the government and the firms is also feasible and desirable when the cost difference is not so small and the foreign penetration is sufficiently high.

Reference

²³ Pal (1998) and Matsumura and Ogawa (2010) argued that the private leadership is more robust and Ino and Matsumura (2010) showed that private leadership provides the highest social welfare in free-entry mixed markets. However, public leadership is also supported in Wang and Mukherjee (2012), Wang and Lee (2013) and Chen et al. (2018). Also, Gelves and Heywood (2013) found that mergers of public and private firms can improve welfare under public leadership.

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TABLES

| β | θ^P | α^P | q_1^P | q_2^P | Q^P | P^P | π_1^P | π_2^P | W^P |
|---------|------------|------------|---------|---------|---------|---------|-----------|-----------|---------|
| 0 | 0.10570 | 0.19960 | 0.35327 | 0.25612 | 0.60939 | 0.39061 | 0.07559 | 0.06724 | 0.32851 |
| 0.1 | 0.12416 | 0.17356 | 0.36459 | 0.24720 | 0.61179 | 0.38821 | 0.07508 | 0.06541 | 0.32109 |
| 0.2 | 0.13539 | 0.15055 | 0.37576 | 0.23893 | 0.61469 | 0.38531 | 0.07419 | 0.06352 | 0.31392 |
| 0.3 | 0.14163 | 0.12967 | 0.38681 | 0.23110 | 0.61792 | 0.38208 | 0.07298 | 0.06160 | 0.30701 |
| 0.4 | 0.14430 | 0.11038 | 0.39777 | 0.22361 | 0.62137 | 0.37863 | 0.07150 | 0.05966 | 0.30035 |
| 0.5 | 0.14433 | 0.09238 | 0.40861 | 0.21638 | 0.62499 | 0.37502 | 0.06975 | 0.05773 | 0.29392 |
| 0.6 | 0.14238 | 0.07546 | 0.41933 | 0.20937 | 0.62870 | 0.37130 | 0.06778 | 0.05582 | 0.28774 |
| 0.7 | 0.13888 | 0.05948 | 0.42992 | 0.20257 | 0.63248 | 0.36752 | 0.06559 | 0.05393 | 0.28178 |
| 0.8 | 0.13417 | 0.04435 | 0.44035 | 0.19596 | 0.63631 | 0.36370 | 0.06320 | 0.05207 | 0.27606 |
| 0.9 | 0.12848 | 0.02999 | 0.45062 | 0.18953 | 0.64015 | 0.35986 | 0.06063 | 0.05024 | 0.27055 |
| 1 | 0.12202 | 0.01637 | 0.46071 | 0.18328 | 0.64399 | 0.35601 | 0.05789 | 0.04845 | 0.26525 |

TABLE 1 Equilibrium outcomes in the privatization-then-CSR case

| β | θ^C | α^C | q_1^C | q_2^C | Q^C | P^C | π_1^C | π_2^C | W^C |
|---------|------------|------------|---------|---------|---------|---------|-----------|-----------|---------|
| 0 | 0.18795 | 0.02525 | 0.35685 | 0.21923 | 0.57608 | 0.42392 | 0.08760 | 0.06891 | 0.32244 |
| 0.1 | 0.16861 | 0.02507 | 0.37032 | 0.21478 | 0.58510 | 0.41490 | 0.08508 | 0.06605 | 0.31569 |
| 0.2 | 0.15316 | 0.02473 | 0.38324 | 0.21048 | 0.59372 | 0.40628 | 0.08227 | 0.06336 | 0.30921 |
| 0.3 | 0.14053 | 0.02429 | 0.39564 | 0.20633 | 0.60197 | 0.39804 | 0.07921 | 0.06084 | 0.30298 |
| 0.4 | 0.13001 | 0.02378 | 0.40755 | 0.20232 | 0.60987 | 0.39013 | 0.07595 | 0.05846 | 0.29700 |
| 0.5 | 0.12111 | 0.02324 | 0.41901 | 0.19845 | 0.61745 | 0.38255 | 0.07251 | 0.05622 | 0.29124 |
| 0.6 | 0.11348 | 0.02267 | 0.43003 | 0.19471 | 0.62474 | 0.37526 | 0.06891 | 0.05411 | 0.28571 |
| 0.7 | 0.10686 | 0.02210 | 0.44064 | 0.19111 | 0.63175 | 0.36825 | 0.06518 | 0.05211 | 0.28037 |
| 0.8 | 0.10106 | 0.02152 | 0.45087 | 0.18762 | 0.63849 | 0.36151 | 0.06135 | 0.05023 | 0.27523 |
| 0.9 | 0.09594 | 0.02095 | 0.46073 | 0.18426 | 0.64499 | 0.35501 | 0.05743 | 0.04844 | 0.27028 |
| 1 | 0.09138 | 0.02039 | 0.47024 | 0.18101 | 0.65126 | 0.34874 | 0.05343 | 0.04674 | 0.26550 |

TABLE 2 Equilibrium outcomes in the CSR-then-privatization case

| Government/The owner of firm 2 | $T_2 = 1$ | $T_2 = 2$ |
|--------------------------------|------------------|------------------|
| $T_1 = 1$ | (W^S, π_2^S) | (W^P, π_2^P) |
| $T_1 = 2$ | (W^C, π_2^C) | (W^S, π_2^S) |

TABLE 3 Payoff matrix in an endogenous timing game

| β | θ^S | α^S | q_1^S | q_2^S | Q^S | P^S | π_1^S | π_2^S | W^S |
|---------|------------|------------|---------|---------|---------|---------|-----------|-----------|---------|
| 0 | 0.10927 | 0.19957 | 0.35258 | 0.25631 | 0.60889 | 0.39111 | 0.07574 | 0.06740 | 0.32851 |
| 0.1 | 0.11255 | 0.17325 | 0.36707 | 0.24641 | 0.61348 | 0.38652 | 0.07451 | 0.06488 | 0.32108 |
| 0.2 | 0.11382 | 0.14940 | 0.38076 | 0.23719 | 0.61794 | 0.38206 | 0.07298 | 0.06249 | 0.31390 |
| 0.3 | 0.11365 | 0.12756 | 0.39374 | 0.22855 | 0.62229 | 0.37772 | 0.07121 | 0.06021 | 0.30697 |
| 0.4 | 0.11239 | 0.10741 | 0.40611 | 0.22040 | 0.62650 | 0.37350 | 0.06922 | 0.05803 | 0.30029 |
| 0.5 | 0.11028 | 0.08872 | 0.41792 | 0.21267 | 0.63060 | 0.36940 | 0.06705 | 0.05595 | 0.29385 |
| 0.6 | 0.10747 | 0.07132 | 0.42925 | 0.20534 | 0.63458 | 0.36542 | 0.06473 | 0.05395 | 0.28766 |
| 0.7 | 0.10408 | 0.05505 | 0.44012 | 0.19834 | 0.63846 | 0.36154 | 0.06227 | 0.05204 | 0.28170 |
| 0.8 | 0.10020 | 0.03981 | 0.45058 | 0.19166 | 0.64224 | 0.35776 | 0.05969 | 0.05020 | 0.27597 |
| 0.9 | 0.09589 | 0.02550 | 0.46066 | 0.18527 | 0.64593 | 0.35407 | 0.05700 | 0.04844 | 0.27046 |
| 1 | 0.09120 | 0.01268 | 0.46890 | 0.17978 | 0.64868 | 0.35133 | 0.05480 | 0.04700 | 0.26519 |

TABLE 4 Equilibrium outcomes in a simultaneous case