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Foreign Penetration and Privatization Policy

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Abstract

Partial privatization is implementable only if private investors have incentives to purchase the shares of public firms. With this obvious fact in mind, we reconsider partial privatization in a mixed oligopoly in which one domestic public firm competes with multinational firms. We show that if the fraction of foreign ownership of multinational firms is large, the government cannot help choosing the privatization policy under which the profit of the privatized firm is equal to zero, instead of implementing the welfare-maximizing degree of privatization. Furthermore, using a linear demand model, we find that the optimal policy changes from the zero-profit degree of privatization to full nationalization once the fraction of foreign ownership exceeds a certain level.

Keywords: Partial Privatization; International Competition; Mixed Oligopoly

JEL Classification: F12; L33

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1. Introduction

In developing and even developed countries, *mixed oligopolies* with competition between private and public firms operate in several industries such as steel, energy, airlines, telecommunications, and banking. One of the important issues in a mixed oligopoly is privatization. Recently, following WTO guidelines, many countries have been privatizing public firms, relaxing market regulations, and liberalizing their capital markets. This has enabled private investors to buy shares of foreign firms competing with local firms in mixed oligopolistic markets. For instance, in the steel industry of Taiwan, the government-managed China Steel Corporation competes with private firms, which may be foreign-owned. Royal Mail, which is a partially privatized postal service company in the United Kingdom, competes with foreign companies such as Deutsche Post and PostNL.

In spite of worldwide waves of privatization and foreign penetration, the exact opposite can be observed in some countries: nationalization and renationalization of privatized firms. In recent years, private banks such as the Snoras bank in Lithuania and the SNS bank in the Netherlands have been nationalized one after another. Furthermore, in Argentina, some companies have been renationalized. For example, Fábrica Argentina de Aviones, an aircraft manufacturer, and YPF, an energy company, were renationalized in 2010 and 2012 respectively. Why can nationalization and renationalization occur despite worldwide trends toward privatization and foreign penetration? The main purpose of this paper is to answer this question.

In this paper, we construct a mixed oligopoly model wherein one domestic public firm competes with multinational private firms, and investigate how partial (or full) privatization of the public firm is affected by the ownership structure of the multinational firms.[1] This formulation concerns with two important aspects in mixed oligopolies. The first one is multinational private firms' nationalities. We regard the multinational firms as the private firms owned by both domestic and foreign private

[1] Papers on mixed oligopoly have proliferated against the backdrop of worldwide privatization. For example, see De Fraja and Delbono (1989), Anderson, de Palma, and Thisse (1997), Ishida and Matsushima (2009), Scrimitore (2013), Matsumura and Tomaru (2013, 2014), and Wang, Lee, and Hsu (2014).

investors. Thus, the private firms have not only the feature of domestic firms but also the features of foreign firms. There are many papers on mixed oligopoly where a public (or partially privatized) firm competes with foreign private firms. Fjell and Pal (1996) first introduced foreign private firms into mixed oligopoly models and explored an impact of foreign competition on the equilibrium output of a public firm and the equilibrium welfare. Van Long and Stähler (2009) investigated the relationship between the optimal policies in the international mixed duopoly and privatization. They showed that the optimal tariff on foreign firm's output is independent from the degree of privatization, while the optimal production subsidy for the domestic public (or privatized) firm increases with the degree of privatization. Mukherjee and Suetrong (2009) considered an international mixed duopoly wherein a foreign private firm chooses exports to a domestic country with one public firm or FDI. They showed that the optimal degree of privatization relies crucially on the entry mode of foreign firm.[2] All these firms focus on the situation where private firms are owned by foreign investors, Instead, we consider mixed ownership of private firms by domestic and foreign investors.

The second aspect is to consider partial privatization. Matsumura (1998), who developed an elegant model of partial privatization, showed that neither full privatization nor full nationalization is optimal in a closed economy.[3] In other words, partial privatization is desirable from the viewpoint of welfare. However, Matsumura and Kanda (2005), taking into account the free entry by private firms, showed that full nationalization is desirable. Wang and Chen (2010) extended these models by introducing foreign private firms. They showed that partial privatization is the best policy regardless of whether the entry of foreign private firms is restricted or not. Again, these studies did not consider

[2] For other studies on mixed oligopolies with foreign competitors, see Pal and White (1998), Matsushima and Matsumura (2006), Han and Ogawa (2008), Heywood and Ye (2009), Inoue, Kamijo, and Tomaru (2009), Lin and Matsumura (2012), Wang, Wang, and Zhao (2009), and Wang and Lee (2013).

[3] Matsumura's (1998) approach to partial privatization is frequently used in recent studies on mixed oligopoly. For example, see Matsumura and Kanda (2005), Kumar and Saha (2008), Jain and Pal (2012), Wang, Lee, and Hsu (2014), and Dijkstra, Mathew and Mukherjee (2014).

that private firms are multinational firms, so they differ from our model.

Our model is closely related to two strands of existing works. One stream has addressed the issue of under-pricing by public firms and partially privatized firms. Fjell and Pal (1996) showed that the public firm in a mixed oligopoly sets its output such that its price is lower than its marginal cost. This under-pricing is attributed to the fact that an improvement in the terms of trade due to overly aggressive behavior by the public firm enhances domestic welfare. Recently, Ghosh et al. (2014) have shown that the under-pricing result holds even in a differentiated mixed oligopoly with foreign competition. Under-pricing implies that the public firm with a constant marginal cost earns negative profits in the presence of foreign competition. This negative profit result is carried over to our model with private multinational firms. We show that the privatized firm may earn negative profits if the fraction of foreign ownership of multinational firms is high.

The other research strand, which pertains to our model, has explored the impact of the ownership structure of multinational firms on the optimal privatization policy. Wang and Chen (2011), who, like us, considered a mixed oligopoly with multinational firms, showed that the optimal degree of privatization is negatively related to the fraction of foreign ownership of multinational firms. Cato and Matsumura (2012) extended their model by considering free entry of multinational firms, and showed that Wang and Chen's (2011) result is completely reversed in the long run.

Although their results are interesting, they failed to capture an important reality—the feasibility of privatization policy. As stated above, a privatized firm can earn negative profits when it competes with multinational firms. If private investors were rational, they would desist from purchasing the shares of firms that are expected to earn negative profits in the future. This implies that the government could not implement partial privatization if the privatized firm were expected to earn negative profits as a result. In sum, a big problem in Wang and Chen (2011) and Cato and Matsumura (2012) is that they ignore the fact that partial privatization is implementable only if private investors have incentives to purchase the shares of public firms. With this somewhat obvious fact in mind, we reconsider the optimal privatization policy in a mixed oligopoly with multinational firms.

We find that when the degree of foreign ownership of multinational firms is not large, the government chooses the welfare-maximizing degree of privatization. However, this is not the case for a sufficiently large fraction of foreign ownership. A large fraction of foreign ownership can give the privatized firm negative profits, so the government cannot implement the welfare-maximizing privatization policy. Instead, it is forced to choose the degree of privatization under which the privatized firm's profits are zero. Furthermore, using the linear demand model, we show that the optimal privatization policy has some interesting characteristics. The optimal degree of privatization decreases with foreign ownership when the fraction of foreign ownership is small, but increases with foreign ownership when the fraction of foreign ownership is in an intermediate range. After the fraction of foreign ownership becomes sufficiently large, there is full nationalization. This non-monotonic relationship between the degree of privatization and the ownership structure of multinational firms contrasts sharply with the results of Wang and Chen (2011) and Cato and Matsumura (2012), who find a monotonic relationship.

The remainder of this paper is organized as follows. Section 2 presents the basic framework. Section 3 explains the major results in a general demand setting. In Section 4, we use a linear demand model to illustrate our main results more specifically. The final section concludes.

2. The model

Consider quantity competition among $(n+1)$ firms producing a homogeneous good in the domestic country. The inverse demand function is $P = P(Q)$, where P is the price and Q is the total amount of the good. One of the firms is a privatized firm, which is owned by the domestic government and by private domestic shareholders. The other firms are private multinational firms, which are owned by private investors, both domestic and foreign. We use "0" to denote the privatized firm and "i"($i = 1,2,\dots,n$) to denote the multinational firms. We consider the following cost structure for these firms. The constant marginal cost of firm *0* is $c_0 > 0$, while all the multinational firms have an identical marginal cost c_1. We assume that the privatized firm is less efficient than the multinational firms, that is, $c_0 > c_1$.[4] Furthermore, we normalize c_1 to 0.

An important feature in our model is the relationship between the ownership structure of each firm and the objective function of the firm. Like the multinational firms, the privatized firm is owned by two types of owners. In spite of this similarity, ownership structure affects the objective functions of the privatized firm and the multinational firms differently. To understand this difference, we first consider multinational firms. Assuming a symmetric ownership structure in all *n* multinational firms, let us denote the fraction of foreign ownership in each multinational firm by $\alpha \in [0,1]$. Although there are two different types of owners, domestic and foreign investors, both of them share the common aim of maximizing their capital gains and income gains. Accordingly, each multinational firm maximizes its profit, which is the source of the investors' gains:

$$\pi^i(q_i, Q_{-i}) \coloneqq (P(Q) - c_1)q_i = P(Q)q_i, \quad i = 1,2,\dots,n,$$

where $Q_{-i} = \sum_{k \neq i} q_k$ and q_j is the output of firm j. Thus, the ownership structure of multinational firms, α, does not affect their objective functions.

On the other hand, firm 0 is owned by domestic private investors who expect firm 0 to maximize its profit:

$$\pi^0(q_0, Q_{-0}) \coloneqq (P(Q) - c_0)q_0.$$

However, it is also owned by the government, which expects firm 0 to maximize welfare:

$$W(q_0, Q_{-0}, \alpha) \coloneqq \int_0^Q P(z)dz - P(Q)Q + \pi^0(q_0, Q_{-0}) + (1-\alpha)\sum_{i=1}^n \pi^i(q_i, Q_{-i}). \tag{1}$$

This ownership structure implies that the interests of different types of owners are in conflict, so it is

[4] Studies on mixed oligopoly usually posit this assumption. If a welfare-maximizing public firm is more efficient than private firms, the private firms produce nothing in equilibrium. The public firm chooses its output to equalize its marginal cost to the price, which implies that the private firms' profits are negative if they produce. We follow the existing literature by positing the assumption for this technical reason.

not easy to answer the question of what the privatized firm maximizes. Answering this difficult question is beyond the scope of this paper; we follow the formulation of partial privatization suggested by Matsumura (1998). We assume that firm 0 maximizes the weighted sum of its profit and welfare, depending on the distribution of shares between the government and the private investors. More specifically, using $\theta \in [0,1]$ to denote the degree of privatization (i.e., the fraction of shares held by private investors), the objective function of firm 0 is given by

$$V(q_0, Q_{-0}, \alpha, \theta) \coloneqq \theta\pi^0(q_0, Q_{-0}) + (1-\theta)W(q_0, Q_{-0}, \alpha).$$

This function clearly shows that the ownership structure of firm 0 affects its objective function. As privatization proceeds (i.e., with an increase in θ), firm 0 puts more emphasis on its profit. In particular, $\theta = 0$ for a fully nationalized firm, which maximizes welfare, while $\theta = 1$ for a fully privatized firm, which is profit seeking.

Note that our model can be interpreted as an international trade model. The last term on the right-hand side of (1) denotes the dividends that the domestic investors receive from their multinational firms. It can be rewritten as $n(1-\alpha)\pi^i$ under the assumption that the multinational firms are symmetric. This provides an alternative interpretation that firm 0 competes with $n(1-\alpha)$ domestic private firms and $n\alpha$ foreign private firms. Thus, our model can be regarded as an international trade model wherein the domestic country imports $n\alpha q_i = \alpha Q_{-0}$ from foreign firms.

3. The optimal degree of privatization

To explore the optimal privatization policy, we solve for the equilibrium of the two-stage game in which the welfare-maximizing government decides on the degree of privatization $\theta \in [0,1]$ in the first stage, while all firms choose their outputs independently and simultaneously in the second stage. As usual, we use backward induction to derive the subgame perfect Nash equilibrium of this game.

Let us start with the second stage. For this analysis, we assume the following:

Assumption 1. *There exists $\bar{Q} > 0$ such that $P(\bar{Q}) = 0$. For $Q \leq \bar{Q}$, the inverse demand function* *satisfies* $P'(Q) < 0$ *and* $P''(Q) \geq 0$.

Assumption 2. $\pi_{12}^{i}(q_j, Q_{-j}) < 0$ *for any* $j \in \{0,1,\dots,n\}$, *where the subscript denotes the derivative with respect to i-th argument*.

Assumptions 1 and 2 ensure that the second-order conditions for maximization (i.e., $V_{11} < 0$ and $\pi_{11}^{i} < 0$) are satisfied for all firms. They also guarantee strategic substitutability, not only for each multinational firm's strategy, but also for firm 0's strategy (i.e.,$V_{12} < 0$). Moreover, the own effect on the marginal benefits for each firm is greater than the cross effect, that is, $|V_{11}| > |V_{12}|$ and $|\pi_{11}^{i}| > |\pi_{12}^{i}|$. It follows from the greater own effect that the slope of each firm's reaction function is lower than 1 in absolute value (please see the Appendix).

Before presenting all the equilibrium conditions of the second stage, it is convenient to scrutinize the first-order condition for firm 0, which will facilitate our understanding of the main results that follow. Firm 0 sets its output to maximize V, or

$$0 = V_1(q_0, Q_{-0}, \alpha, \theta) = (P(Q) + \theta P'(Q) q_0 - c_0) - (1 - \theta) P'(Q) \alpha Q_{-0} \qquad (2)$$

This way of writing the first-order condition of firm 0 highlights the fact that the degree of privatization θ and the level of foreign penetration α leverage the optimal strategy for firm 0.

We call the first term on the right-hand side of (2) the *profit-motivation effect*. A part of the first term, $(P(Q) + \theta P'(Q) q_0)$, lies between two extreme values, the price $P(Q)$ and the marginal revenue $P(Q) + P'(Q) q_0$. Since this term is monotonically increasing in θ for given output levels, the *profit-motivation effect* represents the degree to which firm 0 exercises its pricing power. As the degree of privatization rises (an increase in θ), firm 0 puts more emphasis on its profit and this profit-motivation effect decreases its incentive to expand its production.

The second term on the right-hand side of (2) represents the *terms-of-trade effect*. Recall that αQ_{-0} can be interpreted as imports from foreign firms. In light of this, a decrease in P

corresponds to an improvement in the terms of trade for the domestic country.[5] This improvement in the terms of trade provides firm 0 with a stronger incentive to produce. As we can easily verify from (2), an increase in θ weakens the terms-of-trade effect, thereby inducing firm 0 to reduce its output. This is because firm 0 puts less emphasis on the welfare enhancement through improving the terms of trade. On the other hand, since an increase in α boosts the volume of imports αQ_{-0}, the terms-of-trade effect is reinforced, and as a result, firm 0's production expands.

Now we present the equilibrium conditions in the second stage. For simplicity, we assume that a unique symmetric equilibrium exists and that all firms produce positive amounts of goods in equilibrium.[6] The equilibrium, in which firm 0 chooses $q_0^*(\theta,\alpha)$ and each multinational firm chooses a common strategy $q_1^*(\theta,\alpha)$, is characterized by the following equation system:

$$\mathrm{V}_1(q_0^*(\theta,\alpha), nq_1^*(\theta,\alpha), \alpha, \theta) = 0,$$

$$\pi_1^1\big(q_1^*(\theta,\alpha), q_0^*(\theta,\alpha) + (n-1)q_1^*(\theta,\alpha)\big) = 0.$$

Straightforward computation shows that

$$\frac{\partial q_0^*}{\partial \alpha} = -\frac{[\pi_{11}^1 + (n-1)\pi_{12}^1]V_{13}}{J} \geq 0, \qquad \frac{\partial q_1^*}{\partial \alpha} = \frac{\pi_{12}^1 V_{13}}{J} \leq 0,$$
$$\frac{\partial q_0^*}{\partial \theta} = -\frac{[\pi_{11}^1 + (n-1)\pi_{12}^1]V_{14}}{J} < 0, \qquad \frac{\partial q_1^*}{\partial \theta} = \frac{\pi_{12}^1 V_{14}}{J} > 0,$$

where J is the Jacobian determinant, that is, $J = V_{11}\pi_{11}^1 - V_{12}\pi_{12}^1 + (n-1)\pi_{12}^1(V_{11} - V_{12}) > 0$, and use is made of $V_{13} = -(1-\theta)P'(Q)nq_1^* \geq 0$ and $V_{14} = P'(Q)(q_0^* + n\alpha q_1^*) < 0$. The intuitions behind these comparative statics results are simple, but important for what follows. Increasing imports $n\alpha q_1^*$ due to a rise in α enhances firm 0's marginal benefits from output expansion through the terms-of-trade effect ($\partial q_0^*/\partial\alpha \geq 0$). On the other hand, an increase in θ makes firm 0 produce less through the profit-motivation effect and the terms-of-trade effect

[5] In partial equilibrium models with one importing country, a representative consumer in the country consumes two goods; one is a good produced in an imperfectly competitive market; and the other is a *numeraire* good produced in a competitive market. In this case, the importing country has to export the *numeraire* good to balance its international payment. Therefore, P is regarded as the terms of trade in our model.

[6] When c_0 is not so large, there is a unique equilibrium in which all firms produce and multinational firms choose the same strategy. Please see the Appendix.

($\partial q_0^*/\partial\theta < 0$). Both $\partial q_1^*/\partial\alpha \le 0$ and $\partial q_1^*/\partial\theta > 0$ are attributed to strategic substitution.

Note that $Q^*(\theta,\alpha) = q_0^*(\theta,\alpha) + nq_1^*(\theta,\alpha)$ is decreasing in θ and not decreasing in α.[7] This result implies that the equilibrium price increases with θ and does not increase with α. More importantly, we should also notice that firm 0 could earn negative profits. It follows from the first-order condition of firm 0 that

$$P\big(Q^*(0,\alpha)\big) - c_0 = \alpha P'\big(Q^*(0,\alpha)\big)nq_1^*(0,\alpha) \le 0,$$
$$P\big(Q^*(1,\alpha)\big) - c_0 = -P'\big(Q^*(1,\alpha)\big)q_0^*(1,\alpha) > 0.$$

Combining these results with the observation that the equilibrium price is monotonically increasing in θ, we find that there exists a unique $\bar{\theta}(\alpha) \in [0,1)$ such that $P\left(Q^*(\bar{\theta}(\alpha),\alpha)\right) = c_0$. Therefore, we have

$$\pi^{0*}(\theta,\alpha) \coloneqq \pi^0\big(q_0^*(\theta,\alpha), nq_1^*(\theta,\alpha)\big) \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} 0 \;\Leftrightarrow\; \theta \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} \bar{\theta}(\alpha).$$

In particular, $\bar{\theta}(\alpha) = 0$ when $\alpha = 0$ and $\bar{\theta}(\alpha) > 0$ when $\alpha > 0$. The profit of firm 0 is negative for sufficiently small θ unless all multinational firms are owned only by domestic investors. Moreover, the threshold $\bar{\theta}(\alpha)$ increases with α, so that the profit of firm 0 is likely to be negative as α becomes greater.

The negative profit result has additional significance. The possibility of negative profits creates a serious problem: the government may not be able to implement partial privatization. Suppose that the government holds all the shares in firm 0 and that its shareholding causes negative profits. From the continuity of π^{0*}, a small increase in θ still leaves firm 0 with negative profits. Since private investors do not get any benefits from holding firm 0 shares, the government cannot find any buyers in the stock market. Accordingly, such a small increase in θ is not feasible. The above illustration suggests that the government's ability to control the degree of privatization be restricted. Put

[7] These outcomes emanate from the fact that the slope of the multinational firms' aggregate reaction function is less than 1 in absolute value. Please see the Appendix with regard to this point.

differently, the feasible set of privatization policy Ω consists of two components, nationalization and the degrees of privatization under which firm 0 earns non-negative profits.[8]

Proposition 1. *Given a fraction of foreign ownership* α, *the feasible set for privatization policy is* $\Omega = \{0\} \cup [\bar{\theta}(\alpha), 1]$. *Moreover, an increase in* α *narrows the feasible set, that is,* $\bar{\theta}'(\alpha) > 0$.

We now turn to the first stage. In this stage, the government sets the degree of privatization θ to maximize the reduced form of welfare, anticipating firms' responses in the subsequent stage:

$$W^*(\theta,\alpha) \coloneqq \begin{cases} W^1(\theta,\alpha) = W(q_0^*(\theta,\alpha), nq_1^*(\theta,\alpha), \alpha) & if\ \theta \in \Omega \\ W^2(\alpha) = W(q_0^*(0,\alpha), nq_1^*(0,\alpha), \alpha) & if\ \theta \notin \Omega \end{cases}$$

The function $W^1(\theta,\alpha)$ denotes the welfare for the degrees of privatization under which firm 0's profit is not negative. If we ignore the non-negative profit condition, the optimal privatization policy is characterized by $\hat{\theta}(\alpha) \coloneqq argmax_{\theta\in[0,1]}\, W^1(\theta,\alpha)$. As pointed out by Mukherjee and Suetrong (2009), we can see $\hat{\theta}(\alpha)$ as the optimal privatization policy in the presence of income transfers from consumers to firm 0. Assuming that such income transfers are feasible, Wang and Chen (2011) show that partial privatization is socially desirable in a mixed oligopoly with foreign penetration, irrespective of α. They also show that the optimal degree of privatization decreases with α.

Under the non-negative profit condition, on which we focus in this paper, the optimal policy is defined as $\theta^*(\alpha) \coloneqq argmax_{\theta\in[0,1]}\, W^*(\theta,\alpha)$. A question arises about how the non-negative profit condition affects optimization for the government. This question can be broken up into two sub-questions. One is whether the desirability of partial privatization remains unchanged. The other is how the relationship between α and the optimal degree of privatization can be altered. To answer these questions, we compare the optimal privatization policy in the absence of the non-negative profit condition, $\hat{\theta}(\alpha)$, and that in the presence of the condition, $\theta^*(\alpha)$.

We begin by confirming the properties of $\hat{\theta}(\alpha)$ found by Wang and Chen (2011).

[8] Alternatively, like Bennet and La Manna (2012), we can incorporate the non-negative profit condition into firm 0's output choice decision, with firm 0 selecting its output under the non-negative profit constraint in the second stage. This story leads to the same result, if private investors must pay positive sales commissions to broker houses when they purchase firm 0's shares. The shares of firm 0 would not be bought by the investors for whom the non-negative profit constraint binds, since they make a net loss once the sales commission is taken into account.

Differentiating W^1 with respect to θ, we have

$$W_1^1(\theta,\alpha) = W_1\frac{\partial q_0^*}{\partial\theta} + nW_2\frac{\partial q_1^*}{\partial\theta}$$

$$= \frac{V_{14}\{\theta P'(Q^*)(q_0^* + \alpha n q_1^*)[\pi_{11}^1 + (n-1)\pi_{12}^1] + n(1-\alpha+n\alpha)P(Q^*)\pi_{12}^1\}}{J},$$

where use is made of the first-order conditions of firms 0 and 1. To ascertain whether partial privatization is desirable, it is sufficient to show that $W_1^1(0,\alpha) > 0$ and $W_1^1(1,\alpha) < 0$. The former inequality is immediate, because

$$W_1^1(0,\alpha) = \frac{n(1-\alpha+n\alpha)P\big(Q^*(0,\alpha)\big)\pi_{12}^1 V_{14}}{J} > 0. \tag{3}$$

On the other hand, a certain condition is required to obtain the latter inequality. Consider the situation where firm 0's marginal cost is not so high that $c_0 < \bar{P} := \left[\frac{\pi_{11}^1 - \pi_{12}^1}{\pi_{11}^1 + (n-1)\pi_{12}^1}\right]P(Q^*)$. In this case, we have

$$W_1^1(1,\alpha) = \frac{V_{14}[\pi_{11} + (n-1)\pi_{12}^1]}{J}\left\{c_0 - \left[\frac{(1+n\alpha)\pi_{11}^1 - \pi_{12}^1}{\pi_{11}^1 + (n-1)\pi_{12}^1}\right]P\big(Q^*(1,\alpha)\big)\right\} < 0 \tag{4}$$

Therefore, it follows from (3) and (4) that the optimal policy is partial privatization. This is summarized in Proposition 2.

Proposition 2. *Suppose that income transfers are feasible. If firm 0's marginal cost is not too large, the optimal policy is partial privatization regardless of* α*, that is,* $\hat{\theta}(\alpha) \in (0,1)$.

Let us explain the reasoning behind Proposition 2. Suppose that $\theta = 0$. In this case, firm 0 produces too much because of the profit-motivation and the terms-of-trade effects. This overproduction distorts the production allocation in the domestic country. If the government raises θ, the overproduction problem is resolved, and as a result, welfare increases. Thus, the government never chooses $\theta = 0$. On the contrary, suppose that $\theta = 1$ and that firm 0's marginal cost c_0 is sufficiently small. In this case, firm 0 has little incentive to produce. This insufficient production worsens the terms-of-trade (or, consumer surplus). If the government tries to reduce θ, there are two effects on welfare. One is the improvement in the terms-of-trade; and the other is an increase in production cost incurred by firm 0. When firm 0's marginal cost c_0 is small, the former welfare effect dominates the latter. Therefore, the government does not choose $\theta = 1$.

Note that the optimal degree of privatization in the presence of income transfers is not always decreasing in α. As shown by Wang and Chen (2011), when the inverse demand is linear, it is monotonically decreasing in α, that is, $\hat{\theta}'(\alpha) < 0$.[9] However, this is not necessarily the case in a general demand setting. Invoking the fact that the sign of $\hat{\theta}'(\alpha)$ is the same as that of W_{12}^1 around the neighborhood of $\theta = \hat{\theta}(\alpha)$, we have

$$W_{12}^1 = \left[W_{11}\left(\frac{\partial q_0^*}{\partial \theta}\right)\left(\frac{\partial q_0^*}{\partial \alpha}\right) + 2nW_{12}\left(\frac{\partial q_0^*}{\partial \theta}\right)\left(\frac{\partial q_1^*}{\partial \alpha}\right) + n^2 W_{22}\left(\frac{\partial q_1^*}{\partial \theta}\right)\left(\frac{\partial q_1^*}{\partial \alpha}\right)\right] \\ + \left[W_1\left(\frac{\partial^2 q_0^*}{\partial \alpha \partial \theta}\right) + nW_2\left(\frac{\partial^2 q_1^*}{\partial \alpha \partial \theta}\right)\right] + \left[W_{13}\left(\frac{\partial q_0^*}{\partial \theta}\right) + nW_{23}\left(\frac{\partial q_1^*}{\partial \theta}\right)\right],$$

where use is made of $(\partial q_0^*/\partial \alpha)(\partial q_1^*/\partial \theta) = (\partial q_0^*/\partial \theta)(\partial q_1^*/\partial \alpha)$. The first and the second terms on the right-hand side represent the indirect effect on marginal welfare through the adjustment of outputs. In particular, the first term can be reduced to

$$\frac{V_{13}V_{14}P'(Q^*)^2(2n\alpha\pi_{12}^1 + W_{11})}{J^2} \geq 0.$$

This implies that the indirect effect can be positive. On the other hand, the third term shows the direct effect, which has a negative impact on marginal welfare, since it can be reduced to

$$W_{13}\left(\frac{\partial q_0^*}{\partial \theta}\right) + nW_{23}\left(\frac{\partial q_1^*}{\partial \theta}\right) = -\frac{nP(Q^*)V_{14}\pi_{11}^1}{J} < 0.$$

Thus, the sign of $\hat{\theta}'(\alpha)$ depends on the strength of the direct effect relative to the indirect effect.

We are finally ready to discuss the optimal degree of privatization under the non-negative profit condition $\theta^*(\alpha)$. In order to consider the optimal privatization policy, we provide the following useful result:

Lemma 1. *There exists some* $\tilde{\alpha}$ *such that* $\hat{\theta}(\tilde{\alpha}) = \bar{\theta}(\tilde{\alpha})$. *In particular, if* $\hat{\theta}(\alpha)$ *is decreasing, then (i)* $\tilde{\alpha}$

[9] This outcome will be confirmed in the next section.

is unique, (ii) $\tilde{\alpha} \in \left(0, \frac{1}{2}\right)$ *when* $P''(Q^*) \neq 0$, *and (iii)* $\tilde{\alpha} = \frac{1}{2}$ *when* $P''(Q^*) = 0$.

Proof: Evaluating W_1^1 at $\theta = \bar{\theta}(\alpha)$, we obtain

$$W_1^1(\bar{\theta}(\alpha), \alpha) = \frac{nc_0 V_{14}(-\alpha\pi_{11}^1 + \pi_{12}^1)}{J}.$$

Let us define $F(\alpha) \coloneqq -\alpha\pi_{11}^1 + \pi_{12}^1$. From the definition of $\hat{\theta}(\alpha)$, we have $F(\alpha) = 0 \Leftrightarrow \bar{\theta}(\alpha) = \hat{\theta}(\alpha)$. The function F is continuous and satisfies $F(0) = -\pi_{12}^1 < 0$ and $F\left(\frac{1}{2}\right) = \frac{1}{2}P''(Q^*)q_1^* \geq 0$ with equality if and only if $P''(Q^*) = 0$. Thus, from the intermediate value theorem, we find that when $P''(Q^*) > 0$, there exists some $\tilde{\alpha} \in (0,1)$ such that $F(\tilde{\alpha}) = 0$. Moreover, one of them is $\tilde{\alpha} = \frac{1}{2}$ when $P''(Q^*) = 0$.

If $\hat{\theta}(\alpha)$ is decreasing, $\hat{\theta}(\alpha) - \bar{\theta}(\alpha)$ is also decreasing. This ensures that there exists a unique $\tilde{\alpha} \in (0,1)$ such that $F(\tilde{\alpha}) = 0$. ■

Lemma 1 states that a sufficiently large α gives rise to negative profits for firm 0 under $\theta = \hat{\theta}(\alpha)$ if $\hat{\theta}(\alpha)$ is decreasing. In other words, when the proportion of foreign ownership of multinational firms is large, the optimal degree of privatization, $\hat{\theta}(\alpha)$, is not feasible in the absence of income transfers. The intuition behind Lemma 1 is very simple. Suppose that α is large. In this case, firm 0 behaves aggressively due to the terms-of-trade effect. This implies that even a small degree of ownership by the welfare-maximizing government (a very large θ) makes the price so low that the profit of firm 0 is negative.

From Lemma 1, we immediately obtain the following proposition:

Proposition 3. *Suppose that* $\hat{\theta}'(\alpha) < 0$. *The optimal degree of privatization* $\theta^*(\alpha)$ *is (i)* $\hat{\theta}(\alpha)$ *for* $\alpha \in [0, \tilde{\alpha}]$ *and (ii)* $\bar{\theta}(\alpha)$ *for* $\alpha \in (\tilde{\alpha}, \tilde{\alpha} + \varepsilon)$ *where* $\varepsilon > 0$ *is a very small, real number.*

Note that $\theta^*(\alpha)$ is not a monotonic function. This is a big difference from Wang and Chen (2011). Furthermore, Proposition 3 is also different from the results of Cato and Matsumura (2012) who explore long run effects of foreign penetration on privatization policies. They show that the optimal degree of privatization increases with α. Unlike these studies, we consider the feasibility of privatization. We find that the optimal degree of privatization is reduced as foreign penetration proceeds, but only up to a threshold level of foreign ownership, after which the direction of changes in the degree of privatization is reversed. Proposition 3 has an important implication. Consider countries that regulate foreign ownership heavily. In such countries, deregulation accompanies nationalization. On the other hand, in countries that allow foreign investors to buy private firms, further deregulation of foreign ownership may generate privatization.

Unfortunately, despite this interesting implication, there is one problem with Proposition 3. The problem is that we cannot verify the optimal degree of privatization for α much larger than $\tilde{\alpha}$ (e.g., $\alpha = 1$). This stems from the fact that welfare under $\theta = 0 \in \Omega$ can be higher than that under $\theta = \bar{\theta}(\alpha)$. Thus, we cannot rule out the possibility that for some levels of foreign ownership, the government selects full nationalization instead of $\theta = \bar{\theta}(\alpha)$. To ascertain whether the government switches its privatization policy from $\theta = \bar{\theta}(\alpha)$ to $\theta = 0$, we explicitly derive the optimal degree of privatization by using a linear demand model in the next section.

4. A linear demand case

To examine the case with linear demand, suppose that $P(Q) = a - Q$, where a is a positive constant. Furthermore, we also assume that $c_0 < a/(n^2 + 3n + 1)$. This assumption corresponds to the condition $c_0 < \bar{P}$ in the previous section. The equilibrium conditions in the second stage yield the equilibrium outputs and firm 0's profits as

$$q_0^*(\theta,\alpha) = \frac{[1 + n\alpha(1-\theta)]a - (n+1)c_0}{1 + \theta + n[\theta + \alpha(1-\theta)]}, \qquad q_1^*(\theta,\alpha) = \frac{\theta a + c_0}{1 + \theta + n[\theta + \alpha(1-\theta)]},$$

$$\pi^{0*}(\theta,\alpha) = q_0^*(\theta,\alpha) \cdot \frac{\theta a - \{\theta + n[\theta + \alpha(1-\theta)]\}c_0}{1 + \theta + n[\theta + \alpha(1-\theta)]}.$$

All the firms produce in equilibrium under the assumption that $c_0 < a/(n^2 + 3n + 1)$. In addition, it is straightforward to show that $\bar{\theta}(\alpha) = \mathrm{n\alpha c_0}/\{\mathrm{a} - [1 + \mathrm{n}(1-\alpha)\mathrm{c_0}]\}$ lies in $[0,1)$ and is monotonically increasing. Thus, the feasible set of privatization, $\Omega = \{0\} \cup [\bar{\theta}(\alpha), 1]$, contracts as α increases.

The welfare function that the government attempts to maximize in the first stage is given by

$$W^*(\theta,\alpha)=\begin{cases} W^1(\theta,\alpha)=\dfrac{A}{2\{1+\theta+n[\theta+\alpha(1-\theta)]\}^2} & \text{if } \theta\in\Omega \\ W^2(\alpha)=\dfrac{(1+n\alpha)^2a^2-2(1+n\alpha)^2ac_0+(1+2n+2\alpha n^2)c_0^2}{2(1+2n\alpha)^2} & \text{if } \theta\notin\Omega \end{cases}$$

where

$$\begin{aligned} A={}&\{1+2\theta+n[2+2(2-\theta)\theta]+2n^2[\theta+\alpha(1-\theta)]\}c_0^2 \\ &+\{1+2\theta+n^2[\theta+\alpha(1-\theta)]^2+2n(\alpha+\theta+\theta^2-2\alpha\theta^2)\}a^2 \\ &-2\{1+n^2\alpha(1-\theta)[\theta+\alpha(1-\theta)]+2\theta+n[\theta+\alpha(2+\theta-\theta^2)]\}ac_0. \end{aligned}$$

As the first step toward deriving $\theta^*(\alpha)$, we consider the optimal degree of privatization with income transfers, $\hat{\theta}(\alpha)$. Since it can be easily shown that $W_1^1(0,\alpha)>0$ and $W_1^1(1,\alpha)<0$, the optimal policy $\hat{\theta}(\alpha)$ satisfies

$$W_1^1\big(\hat{\theta}(\alpha),\alpha\big)=0 \;\;\Leftrightarrow\;\; \hat{\theta}(\alpha)=\frac{n[1+(n-1)\alpha]c_0}{(1+2n\alpha)a-(n+1)[1+n(1-\alpha)]c_0}.$$

It follows from simple calculation that this degree of privatization decreases with α. Moreover, the solution to the equation $\hat{\theta}(\alpha)=\bar{\theta}(\alpha)$ is $\alpha=\frac{1}{2}$. Coupled with the monotonic properties of $\hat{\theta}(\alpha)$ and $\bar{\theta}(\alpha)$, we get

$$\hat{\theta}(\alpha)\begin{Bmatrix}>\\=\\<\end{Bmatrix}\bar{\theta}(\alpha)\;\Leftrightarrow\;\alpha\begin{Bmatrix}<\\=\\>\end{Bmatrix}\frac{1}{2}.$$

This implies that the government can set $\theta=\hat{\theta}(\alpha)$ as the optimal privatization policy if $\alpha\le\frac{1}{2}$, while it cannot otherwise.

Finally, we would like to derive $\theta^*(\alpha)$ explicitly. As pointed out in the previous section, the government may switch the optimal degree of privatization from $\theta=\bar{\theta}(\alpha)$ to $\theta=0$ for sufficiently large α. We ascertain this possibility and next turn to the derivation of $\theta^*(\alpha)$. To do so, let us start from a comparison of $W^1(\bar{\theta}(\alpha),\alpha)$ and $W^1(0,\alpha)=W^2(\alpha)$. Taking the difference of these two welfare functions, we have

$$W^1(\bar{\theta}(\alpha),\alpha) - W^2(\alpha) = -\frac{c_0^2 n^2 \alpha[2n\alpha^2 + (3-2n)\alpha - 2]}{2(1+n\alpha)^2}.$$

Note that $2n\alpha^2 + (3-2n)\alpha - 2 = 0 \Leftrightarrow \alpha = \bar{\alpha} := \left(2n - 3 + \sqrt{4n^2 + 4n + 9}\right)/4n$ and $\bar{\alpha} \in \left(\frac{2}{3}, 1\right)$.

Using this $\bar{\alpha}$ gives rise to the following relationship:

$$W^1(\bar{\theta}(\alpha),\alpha) \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} W^2(\alpha) \;\Leftrightarrow\; \alpha \begin{Bmatrix} < \\ = \\ > \end{Bmatrix} \bar{\alpha}.$$

Therefore, the government has an incentive to fully nationalize firm 0 when the level of foreign ownership is larger than $\bar{\alpha}$. The above discussion is summarized in Proposition 4.

Proposition 4. *Suppose that the demand is linear. The optimal degree of privatization under the non-negative profit condition for firm 0 is*

$$\theta^*(\alpha) = \begin{cases} \hat{\theta}(\alpha) = \dfrac{n[1+(n-1)\alpha]c_0}{(1+2n\alpha)a - (n+1)[n(1-\alpha)-1]c_0} & \text{if } \alpha \in \left[0, \dfrac{1}{2}\right) \\ \bar{\theta}(\alpha) = \dfrac{n\alpha c_0}{a - [n(1-\alpha)+1]c_0} & \text{if } \alpha \in \left[\dfrac{1}{2}, \bar{\alpha}\right) \\ 0 & \text{if } \alpha \in [\bar{\alpha}, 1] \end{cases}$$

Figure 1 illustrates Proposition 4. As observed from this figure, $\hat{\theta}(\alpha)$ is a downward sloping curve whereas $\bar{\theta}(\alpha)$ is an upward sloping curve. Furthermore, these curves intersect at $\alpha = \frac{1}{2}$. These observations indicate that the government cannot choose $\hat{\theta}(\alpha)$ as the optimal privatization policy for $\alpha \geq \frac{1}{2}$. Accordingly, for α in this range, the government replaces $\theta = \hat{\theta}(\alpha)$ with $\bar{\theta}(\alpha)$. Interestingly, once α reaches $\bar{\alpha}$, the government drastically changes its privatization policy from$\theta = \bar{\theta}(\alpha)$ to $\theta = 0$ (full nationalization).

We now explain the intuition behind Proposition 4. First, suppose that α is small. As stated in the previous section, an increase in α makes firm 0 act aggressively due to the terms-of-trade effect. This aggressive behavior of firm 0 reduces the efficiency of production allocation. In other words, when the inefficient firm 0 increases its production, the total cost in the domestic country goes up. To correct the inefficiencies in production allocation, the government reduces θ in an attempt to decrease firm 0's production via the terms-of-trade and the profit-motivation effects.

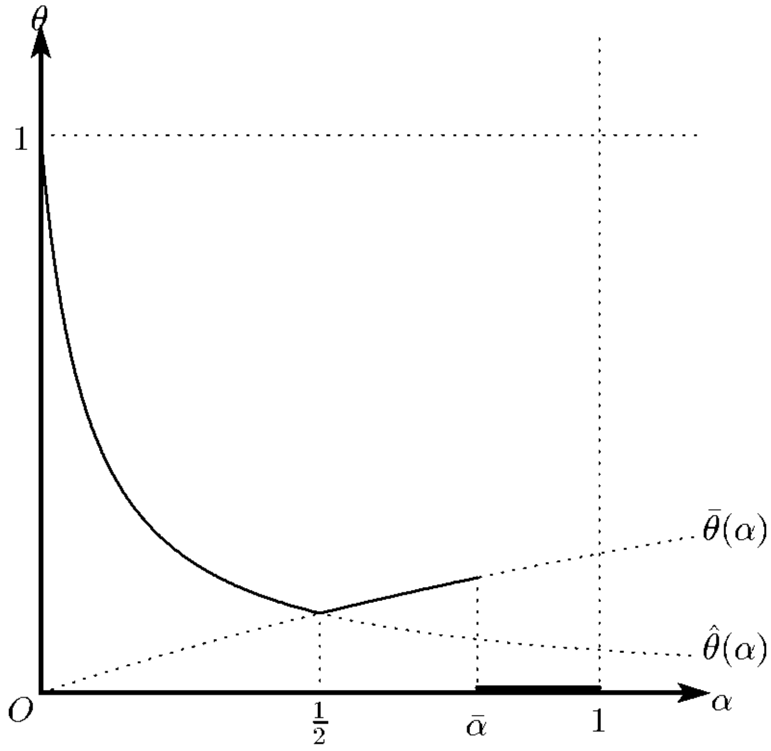

Figure 1: The schedule of the optimal degree of privatization

Next, let α be in an intermediate range. At an intermediate level of foreign ownership, firm 0 overproduces. Thus, an increase in α reduces the price so much that firm 0 earns negative profits for a wider range of θ. Then, instead of $\hat{\theta}(\alpha)$, the government cannot help selecting $\bar{\theta}(\alpha)$ so as not to violate the non-negative profit condition. Moreover, to keep firm 0's profits at zero for a larger α, the government has to alleviate firm 0's aggressive behavior by increasing θ. Finally, let us consider a sufficiently large α. In this case, the government chooses a higher degree of privatization to counteract overly aggressive behavior by firm 0. In other words, firm 0 is like a profit-maximizer. This implies that the consumer surplus drops drastically. Too resolve this, the government has an incentive to switch the privatization policy from $\theta = \bar{\theta}(\alpha)$ to $\theta = 0$ (full nationalization).

5. Conclusion

Existing studies on international mixed oligopolies have shown that state-owned public firms and partially privatized firms can earn negative profits when they compete with foreign or multinational firms. Since rational investors would refrain from holding the shares of firms whose profits are negative, the government would not find buyers in stock markets if the privatized firms' profits are expected to be negative after privatization. This implies that the government's privatization policy is restricted to the set under which privatized firms earn non-negative profits. Our focus in this paper is on this limited privatization policy.

Using a mixed oligopoly wherein one domestic public firm competes with multinational firms, we have analyzed the privatization of the public firm. More specifically, we have investigated the degree of privatization chosen by the government as optimal, out of the limited privatization policy set. We have also explored how this degree of privatization is affected by the extent of foreign ownership of the competing multinational firms.

We have found that the government chooses the welfare-maximizing degree of privatization when the proportion of foreign ownership of multinational firms is not large. However, we have shown that this is not the case for a sufficiently large fraction of foreign ownership. A large fraction of foreign ownership can induce aggressive behavior in the privatized firm, resulting in negative profits. Therefore, the government cannot implement the welfare-maximizing privatization policy. Instead, it chooses the degree of privatization under which the privatized firm's profits are zero. Furthermore, using the linear demand model, we have shown that the optimal degree of privatization first decreases and then increases in the extent of foreign ownership; however, full nationalization is implemented for a sufficiently large fraction of foreign ownership.

Our paper is a first step in considering the feasibility of privatization policy. Thus, our model is overly simple in the sense that it has ignored some real aspects. First, we have assumed that private foreign investors cannot purchase shares in the privatized firm in the domestic country. As shown by Lin and Matsumura (2012), the optimal privatization policy can be affected by the foreign ownership of the privatized firm. This sort of foreign ownership should be incorporated into our model in future research. Second, we have posited that the privatized firm competes with only multinational private firms with a symmetric ownership structure. However, in reality, there are various types of private firms such as domestically owned firms, foreign firms, and multinational firms. In addition, ownership structure can vary among multinational firms. We need to incorporate these features into our model.

Despite ignoring the above real-world complexity in our model, we hope that the feasibility of privatization policy discussed by this paper will provide useful ideas for solving other important issues. For example, one might examine other industrial or trade policies. It would be interesting to investigate whether a policy mix consisting of privatization and these policies can restore Wang and Chen's (2011) result regarding the monotonic relationship between the optimal degree of privatization and the fraction of foreign ownership in multinational firms.

Appendix

Reaction functions and their properties

The quasi-reaction function of each multinational firm $R^i(Q_{-i})$ satisfies $P(Q) + P'(Q)R^i(Q_{-i}) = 0$. Differentiating both sides of this equation with respect to Q, we have

$$R^{i\prime}(Q) = -\frac{P'(Q) + P''(Q)R^i(Q)}{P'(Q)} \in (-1{,}0).$$

The aggregate quasi-reaction function of all the multinational firms is $Q_{-0} = \sum_{i=1}^{n} R^i\,(Q)$. Solving this for Q_{-0}, we obtain their aggregate reaction to firm 0's strategy as $Q_{-0} = R(q_0)$. From the definition of R,

$$R'(q_0) = -\frac{nR^{i\prime}(Q)}{1 - nR^{i\prime}(Q)} \in (-1{,}0), \quad R(\bar{Q}) = 0.$$

Next, we consider the reaction function of firm 0, $R^0(Q_{-0}, \alpha, \theta)$. This function satisfies $V_1(R^0(Q_{-0}, \alpha, \theta), \alpha, \theta) = 0$, and thus, we have

$$R_1^0(Q_{-0}, \alpha, \theta) = -\frac{V_{12}}{V_{11}} \in (-1{,}0),$$

$$R_2^0(Q_{-0}, \alpha, \theta) = -\frac{V_{13}}{V_{11}} \geq 0,$$

$$R_3^0(Q_{-0}, \alpha, \theta) = -\frac{V_{14}}{V_{11}} < 0.$$

Furthermore, evaluating the first-order condition of firm 0 at $q_0 = \bar{Q}$ for $Q_{-0} = 0$,

$$V_1(\bar{Q}, 0, \alpha, \theta) = -c_0 + \theta P'(\bar{Q})\bar{Q} < 0.$$

It follows from the second-order condition that $\bar{Q} > R^0(0, \alpha, \theta)$.

The existence of equilibrium

Lemma 2. *Suppose that $c_0 < P\big(R(0)\big)$. There exists a unique equilibrium where all firms produce and all multinational firms choose a common strategy.*

Proof: From the fact that (i) $-1 < R'(q_0) < 0$, (ii) $-1 < R_1^0(Q_{-0}, \alpha, \theta) < 0$, and (iii) $\bar{Q} > R^0(0, \alpha, \theta)$, it is sufficient to show that $R^0(R(0), \alpha, \theta) > 0$ (see Figure 2.) For $Q_{-0} = R(0)$,

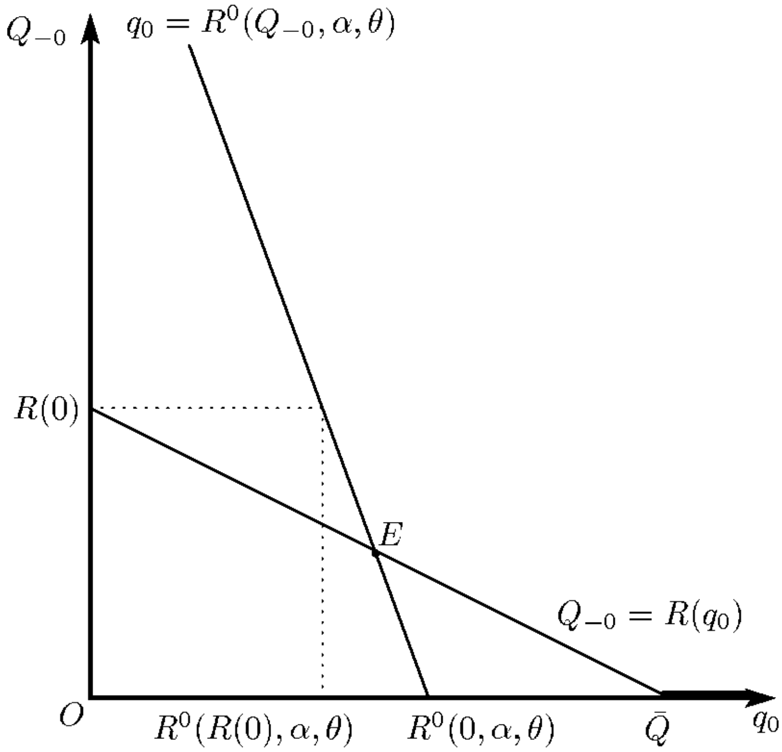

Figure 2: Existence of equilibrium

$$
\begin{aligned}
V_1(0, R(0), \alpha, \theta) &= P(R(0)) - c_0 - \alpha(1-\theta)P'(R(0))R(0), \\
&= [1 + n\alpha(1-\theta)]P(R(0)) - c_0 \qquad \text{(by the definition of } R(q_0)\text{)} \\
&\geq P(R(0)) - c_0.
\end{aligned}
$$

Therefore, $R^0(R(0), \alpha, \theta) > 0$, because of the second-order condition of firm 0 and the assumption that $P(R(0)) > c_0$. ■

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