

Research Note

Mixed Duopoly, Privatization, Subsidization and Partial Foreign Ownership

Kazuhiro Ohnishi¹ 

Department of Economics, Institute for Economic Sciences, Osaka, Japan

Abstract

The seminal work by White (1996) examines the welfare effects of production subsidies in a mixed Cournot oligopoly market where a state-owned public firm competes with fully domestic-owned private firms, and presents the following two main results. First, if production subsidies are utilized only before privatization, domestic economic welfare is always lowered by privatization. Second, if production subsidies are utilized before and after privatization, then domestic economic welfare is not changed by privatization. This paper examines the welfare effects of production subsidies in a mixed Cournot duopoly model where a state-owned public firm competes with a private firm that is partially foreign owned. The paper presents the following two main results. First, if subsidies are used only before privatization, then there is a reduction in domestic economic welfare. Second, if subsidies are used before and after privatization, then domestic economic welfare is raised by privatization. The paper finds that the second result is in contrast with that obtained by White (1996).

Keywords: Partial foreign ownership, privatization, quantity competition, subsidization.

¹ Corresponding author's Email: ohnishi@e.people.or.jp

Introduction

Since the first work by Merrill and Schneider (1966), the theoretical analysis of mixed markets that incorporate state-owned public firms has been widely performed by many economists. For example, White (1996) investigates how production subsidies may influence the privatization decision in a mixed Cournot oligopoly market where a state-owned public firm competes against fully domestic-owned private firms. The state-owned firm aims to maximize domestic economic welfare while the private firms aim to maximize their own profits. White presents the following two main results. First, if production subsidies are utilized only before privatization of the state-owned public firm, then there is a reduction in domestic economic welfare. Second, if production subsidies are utilized before and after privatization, then domestic economic welfare is not changed by privatization.

In this paper, we adopt a quantity-setting mixed market model where a private firm is partially foreign owned. Fjell and Pal (1996) consider a mixed Cournot oligopoly model in which a state-owned public firm competes with both domestic and foreign private firms, and suggest a setting that allows for situations intermediate between the usual cases of (total) domestic or foreign ownership of the private firms. Fernández-Ruiz (2009) examines firms' decisions to hire managers in a mixed Cournot duopoly model where a state-owned public firm competes against a foreign private firm. Fernández-Ruiz considers a setting in which a part of the foreign private firm's profit can be included in the domestic welfare function, and demonstrates that the result is in contrast with that of the case where the public firm competes with the fully domestic private firm. In addition, Ohnishi (2012) considers a mixed Cournot duopoly model in which a private firm competes against a state-owned public firm, and examines the welfare effects of domestic and foreign ownership of the private firm. Ohnishi shows that domestic consumer surplus is maximized by full foreign ownership of the private firm, while domestic economic welfare is maximized by full domestic ownership of the private firm. Ohnishi finds that neither domestic consumer surplus nor domestic economic welfare is maximized by partial foreign ownership of the private firm.

We investigate the welfare effects of domestic production subsidies in a mixed Cournot duopoly model where a state-owned public firm competes against a partially foreign-owned private firm. We solve and compare the following four games: unsubsidized mixed duopoly, subsidized mixed duopoly, unsubsidized private duopoly, and subsidized private duopoly.

Basic Setting

Consider a market comprising a state-owned public firm (firm 0) and a partially foreign-owned private firm (firm 1). Both firms produce imperfectly substitutable goods. Throughout this paper, subscripts 0 and 1 represent firm 0 and firm 1, respectively. In addition, when i and j are used to represent firms in an expression, they should be understood to refer to 0 and 1 with $i \neq j$. We do not consider the possibility of entry or exit.

The inverse demand function is given by $P = a - Q$, where P is the market price, and Q is the total quantity of output in the market.

Firm 0's profit π_0 is given by

$$\pi_0 = Pq_0 - \frac{1}{2}q_0^2 + sq_0, \quad (1)$$

where q_0 represents firm 0's output and s is the subsidy.

Firm 1's profit π_1 is given by

$$\pi_1 = Pq_1 - \frac{1}{2}q_1^2 + \lambda sq_1, \quad (2)$$

where q_1 represents firm 1's output and $\lambda \in [0,1]$ is the level of domestic ownership. Firm 1 is paid λsq_1 by the government. Firm 1 aims to maximize its own profit given by (2).

Domestic economic welfare W is given by

$$\begin{aligned} W &= \frac{Q^2}{2} + Pq_0 - \frac{1}{2}q_0^2 + sq_0 + \lambda \left(Pq_1 - \frac{1}{2}q_1^2 + sq_1 \right) - sq_0 - \lambda sq_1 \\ &= \frac{Q^2}{2} + Pq_0 - \frac{1}{2}q_0^2 + \lambda \left(Pq_1 - \frac{1}{2}q_1^2 \right), \end{aligned} \quad (3)$$

where $Q^2/2 = (q_0 + q_1)^2/2$ denotes domestic consumer surplus. Firm 0 aims to maximize domestic economic welfare. If $\lambda = 1$, firm 1 is fully domestic owned. On the other hand, if $\lambda = 0$, firm 1 is fully foreign owned and its profit is excluded from domestic economic welfare. For the sake of simplicity, we assume $\lambda = 0.5$. In this paper, our equilibrium concept is subgame perfection.

Results

In this section, we examine the following four cases: unsubsidized mixed duopoly, subsidized mixed duopoly, unsubsidized private duopoly and subsidized private duopoly.

Unsubsidized Mixed Duopoly

In this case, firms 0 and 1 simultaneously and independently choose their own output levels, and the equilibrium solution is decided in a Cournot fashion. From (2) and (3), we derive the equilibrium values of outputs, profits, domestic consumer surplus and domestic economic welfare:

$$q_0^M(0) = \frac{5}{11}a, \quad q_1^M(0) = \frac{2}{11}a, \quad (4)$$

$$Q^M(0) = \frac{7}{11}a, \quad (5)$$

$$\pi_0^M(0) = \frac{15}{242}a^2, \quad \pi_1^M(0) = \frac{12}{242}a^2, \quad (6)$$

$$CS^M(0) = \frac{49}{242}a^2, \quad (7)$$

$$W^M(0) = \frac{35}{121}a^2. \quad (8)$$

Note that $\pi_0^M(0)$ is strictly positive. Also note that $q_0^M(0)$ and $\pi_0^M(0)$ are respectively higher than $q_1^M(0)$ and $\pi_1^M(0)$.

Subsidized Mixed Duopoly

There are two stages. In stage one, the government sets the subsidy to maximize domestic economic welfare. In stage two, firms 0 and 1 simultaneously and independently choose their own output levels conditional on the subsidy. As usual, the game is solved by backward induction. Starting from stage two, we obtain the reaction functions in quantities:

$$q_0^M(s) = \frac{10a-s}{22}, \quad q_1^M(s) = \frac{2a+2s}{11}. \quad (9)$$

We now consider the first stage of the game. In stage one, taking into account how firms will react to the subsidy, the government sets the subsidy to maximize (3). Therefore, we obtain the domestic welfare maximizing subsidy as follows:

$$s^M = \frac{8}{3}a. \quad (10)$$

Notice that the government sets a positive subsidy. We can obtain the following equilibrium values:

$$q_0^M(s) = \frac{1}{3}a, \quad q_1^M(s) = \frac{2}{3}a, \quad (11)$$

$$Q^M(s) = a, \quad (12)$$

$$\pi_0^M(s) = \frac{5}{6}a^2, \quad \pi_1^M(s) = \frac{2}{3}a^2, \quad (13)$$

$$CS^M(s) = \frac{1}{2}a^2, \quad (14)$$

$$W^M(s) = \frac{1}{3}a^2. \quad (15)$$

Note that domestic consumer surplus is maximized when subsidies are used. Also note that $\pi_1^M(s) - \frac{1}{2} \cdot s^M \cdot q_1^M(s) = -\frac{2}{9} \cdot a^2 < 0$.

By comparing (4) – (8) with (11) – (15), we can state the following proposition.

Proposition 1: When optimal subsidies are used in a mixed duopoly, they decrease firm 0's output and increase firm 1's output and domestic economic welfare.

Unsubsidized Private Duopoly

In this case, firm 0 is privatized as a fully domestic-owned firm. Firms 0 and 1 simultaneously and independently set their own output levels, and the equilibrium is decided in a Cournot fashion. We obtain the equilibrium values of outputs, profits, domestic consumer surplus and domestic economic welfare:

$$q_0^P(0) = q_1^P(0) = \frac{1}{4}a, \quad (16)$$

$$Q^P(0) = \frac{1}{2}a, \quad (17)$$

$$\pi_0^P(0) = \pi_1^P(0) = \frac{3}{32}a^2, \quad (18)$$

$$CS^P(0) = \frac{1}{8}a^2, \quad (19)$$

$$W^P(0) = \frac{17}{64}a^2, \quad (20)$$

We compare the two unsubsidized regimes (Unsubsidized Mixed Duopoly and Unsubsidized Private Duopoly). We state the following proposition.

Proposition 2: In the absence of subsidies, privatization lowers each firm's output and domestic economic welfare.

Proposition 2 states that domestic economic welfare is not maximized by privatization in the presence of a private firm.

Next, we compare the unsubsidized private duopoly outcomes with those of subsidized mixed duopoly.

Proposition 3: When optimal subsidies are used only before privatization in a mixed duopoly, domestic economic welfare is lower after privatization.

Proposition 3 states that the use of optimally chosen subsidies yields higher domestic welfare than privatization policy.

Subsidized Private Duopoly

In this case, firm 0 is a fully domestic-owned private firm. At stage one, the government sets the subsidy to maximize domestic economic welfare. At stage two, firms 0 and 1 noncooperatively set their own output levels conditional on the subsidy. We obtain the reaction functions in quantities:

$$q_0^P(s) = \frac{4a + 5s}{16}, \quad q_1^P(s) = \frac{4a + s}{16}. \quad (21)$$

The domestic welfare maximizing subsidy is obtained as follows:

$$s^P = \frac{136}{222}a. \quad (22)$$

Note that the government sets a positive subsidy. We obtain the following equilibrium values:

$$q_0^P(s) = \frac{49}{111}a, \quad q_1^P(s) = \frac{32}{111}a, \quad (23)$$

$$Q^P(s) = \frac{81}{111}a, \quad (24)$$

$$\pi_0^P(s) = \frac{2401}{8214}a^2, \quad \pi_1^P(s) = \frac{512}{4107}a^2, \quad (25)$$

$$CS^P(s) = \frac{729}{2738}a^2, \quad (26)$$

$$W^P(s) = \frac{1258}{4107}a^2. \quad (27)$$

By comparing (16) – (20) with (23) – (27), we can state the following proposition.

Proposition 4: When optimal subsidies are used in a private duopoly, each firm's output and domestic economic welfare can be raised.

The result of Proposition 4 is the same as that of standard subsidy analysis in the private market literature.

Finally, we compare the two subsidized regimes (Subsidized Mixed Duopoly and Subsidized Private Duopoly).

Proposition 5: When optimal subsidies are used before and after privatization in a mixed duopoly, they decrease firm 1's output and increase firm 0's output and domestic economic welfare.

White (1996) demonstrates that when optimal subsidies are used before and after privatization in a mixed oligopoly market where private firms are fully domestic owned, the optimal subsidy and economic welfare are unchanged. Therefore, we find that the result of Proposition 5 is in contrast with that obtained by White (1996).

Conclusion

We have investigated the welfare effects of domestic production subsidies in a mixed Cournot duopoly model where a state-owned public firm competes with a partially foreign-owned private firm. We have examined four games: unsubsidized mixed duopoly, subsidized mixed duopoly, unsubsidized private duopoly, and subsidized private duopoly. As a result, we have shown that when the subsidized mixed duopoly game and the subsidized private duopoly game are compared, optimally chosen subsidies decrease the partially foreign-owned private firm's output and increase the state-owned public firm's output and domestic economic welfare. This result has been obtained for the specific functional form of linear demand and quadratic cost. Therefore, we will extend the analysis done in this paper for general nonlinear demand function in the near future.

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