Do Firms Always Choose Excess Capacity?

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Abstract

We analyze the capacity choice of firms in a long−run mixed oligopoly market, in which firms decide not only production quantity but also capacity scale. Our main purpose is to show that while a profit−maximizing firm maintains over capacity as a strategic device, a firm pursuing non−pure profit chooses under capacity.

1 Introduction

It is commonly recognized that maintaining excess capacity plays an essential role as a strategic device in the oligopoly market. Excess capacity results often hold not only in the pure oligopoly market where profit-maximizing firms compete with each other, but also in the market where they compete with so-called labor-managed firms. In this paper, we reexamine the excess capacity result using a model of mixed duopoly market, where a profit-maximizing (private) firm competes with a welfare-maximizing (public) firm[1] . Our result shows that while the private firm ops to maintain over capacity, the public firm chooses under capacity.

In various contexts, it has been found that firms maintain excess capacity to make their rivals reduce output levels or to deter market entry. Dixit (1980), Brander and Spencer (1983) and Horiba and Tsutsui (2000) show that the investment needed to expand production capacity tends to be excessive in the pure oligopoly model. Stewart (1991), Zhang (1993), and Haruna (1996) extend the model into a non-pure oligopoly situation where profit-maximizing firms compete with labor-managed firms. One of the interesting conclusions they reach is that labor-managed firms have a greater incentive to choose excess capacity than profit-maximizing firms.

The study most relevant to ours is provided by Wen and Sasaki (2001). They examine the capacity choice in the framework of a repeated mixed duopoly and conclude that the excess capacity held by the public firm sustains the subgame perfect equilibrium. In this paper, a different result from that of Wen and Sasaki will be obtained since we make a different assumption about cost function and the structure of a game. In our model, the objective of a non-profit maximizing firm provides the key factor. The mechanism is related to the results of Harris and Wiens (1980) and Pal (1998), in which they find that being a welfare-maximizing public firm Stackelberg follower increases social welfare. We show in this paper that the public firm chooses to play the role of market follower by choosing under capacity in the Cournot mixed market. In order to highlight the possible difference in the firms' incentives for choosing capacity levels, we shall present a model of a mixed duopoly situation.

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[1] See De Fraja and Delbono (1990) and Nett (1993) for general reviews of the mixed oligopoly model.

2   Model

To describe the essence as simply as possible, we consider a mixed duopoly market. There are two firms operating in a homogeneous good market with inverse demand given by

$$p = a - Q = a - (q_a + q_b), \qquad a > 0 \tag{1}$$

where p is market price and Q is total output. q_i denotes the output of firm $i(= a, b)$. While firm a is a profit-maximizing private firm, firm b has an objective that is different from simple profit maximization. In this paper, we assume that firm b is a public firm maximizing the social surplus which is a summation between the consumer surplus and the firms' profit.

The firms have different technologies, represented by the cost function, $C_i(q_i, x_i)$, where q_i and x_i are the production quantity and capacity of firm i, respectively. We assume that firms first choose the production capacity (plant size, etc.). After observing the plant size in the first stage, firms then determine the desired production quantity.

For simplicity, following Vives (1986) and Horiba and Tsutsui (2000), we specify the cost function as

$$C_i(q_i, x_i) = m_i q_i + (q_i - x_i)^2. \tag{2}$$

Under this U-shaped cost function, the long-run average cost is minimized when quantity equals production capacity, $q_i = x_i$. In this paper we assume $m_a < m_b$; the private firm can produce more efficiently than the public firm at the efficient production-capacity level[2] .

The objective function of firm a is the profit given by

$$\pi_a = p q_a - m_a q_a - (q_a - x_a)^2. \tag{3}$$

The public firm b maximizes the social surplus described by

$$SS = \frac{Q^2}{2} + \pi_a + \pi_b, \tag{4}$$

where $Q^2/2$ is the consumer surplus and $\pi_b (= p q_b - m_b q_b - (q_b - x_b)^2)$ is the profit of firm b.

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[2] We see no reason to assume $m_a \geq m_b$ because it would yield zero output for the private firm.

3 Equilibrium

Following the standard equilibrium concept, we solve the model from the second stage. Given their production capacities, the maximization problem of each firm yields

$$q_a = \frac{a - m_a + 2x_a - q_b}{4}, \tag{5}$$

$$q_b = \frac{a - m_b + 2x_b - q_a}{3}. \tag{6}$$

By solving (5) and (6), we obtain the output levels as

$$q_a = \frac{2a + m_b - 3m_a - 2x_b + 6x_a}{11}, \tag{7}$$

$$q_b = \frac{3a - 4m_b + m_a + 8x_b - 2x_a}{11}. \tag{8}$$

In the first stage, firms know that their decision regarding the capacity level affects their output decision in the second stage. Hence, we can formulate the maximization problem of the private firm as follows:

$$\max_{q_a} \quad \pi_a = (a - q_a - q_b)q_a - m_a q_a - (q_a - x_a)^2,$$
$$\text{s.t.} \quad (7) \text{ and } (8).$$

Solving the problem, we have

$$x_a = \frac{12}{49}(2a + m_b - 3m_a - 2x_b). \tag{9}$$

Similarly, the maximization problem for the public firm can be formulated as

$$\max_{q_b} \quad SS = \frac{(q_a + q_b)^2}{2} + (a - q_a - q_b)q_a - m_a q_a - (q_a - x_a)^2$$
$$+ (a - q_a - q_b)q_b - m_b q_b - (q_b - x_b)^2,$$
$$\text{s.t.} \quad (7) \text{ and } (8),$$

which yields

$$x_b = a - m_b - \frac{14}{31}(m_b - m_a + 2x_a). \tag{10}$$

From (7)-(10), production quantity and capacity level are given by

$$x_a = \frac{12}{7}(m_b - m_a) \tag{11}$$

$$x_b = a - 3m_b - 2m_a \tag{12}$$

$$q_a = \frac{11}{7}(m_b - m_a) \tag{13}$$

$$q_b = (a - 3m_b - 2m_a) + \frac{m_b - m_a}{7} \tag{14}$$

If we compare x_i and q_i, the following result can be obtained.

Result. In the mixed duopoly market, neither firm chooses the most efficient capacity level associated with the equilibrium output. While the private firm chooses over capacity, $x_a > q_a$, the public firm chooses under capacity, $x_b < q_b$.

Since the output-capacity difference imposes additional costs on the social surplus, it seems unreasonable for a public firm to maintain under capacity. However, there is a simple mechanism that justifies such behavior. To maximize the social surplus, it is desirable for a public firm to have total outputs provided by the private firm so that the price is set at private firm's long-run marginal cost; $p = m_a$. This implies that the public firm tries to make the private firm produce more while the public firm produces less[3] . Since there is a negative relationship between the capacity level of public firm and the output level of private firm, the public firm can improve the social surplus by reducing its own capacity. On the other hand, enlarging the production share in the market is desirable for the private firm. Hence, the private firm chooses over capacity while the public firm chooses under capacity as a strategic device.

4 Concluding Remarks

It is commonly believed that maintaining excess capacity benefits profit-maximizing firms. Furthermore, the excess capacity result has often been applied to non-profit maximizing firms, i.e., labor-managed and public firms. Conversely, in this paper,

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[3] This tendency has been pointed out by Pal (1998) when examining the endogenous order of moves in a mixed oligopoly market. In Pal's model, both public and private firms first announce when (what period) they will choose their quantity levels. After the announcement, they select the output levels. The results show that one of the equilibrium outcomes is that the private firm produces in the first period, implying that it acts as a Stackelberg leader and provides total output, whereas the public firm announces it will produce in the second period and chooses zero output in the first period.

we have shown that the public firm might choose under capacity so as to maximize the social surplus. This happens primarily because a welfare-maximizing firm prefers to act as a Stackelberg follower in the mixed duopoly market. It wants to induce the more efficient private firm to expand its output level. Since there is a negative relationship between the capacity level of public firm and the output level of private firm, a public firm can improve the social surplus by reducing its own capacity from the efficient level, inducing the private firm to produce more.

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