Economics Bulletin

Volume 29, Issue 1

Excessive entry in a bilateral oligopoly

Arijit Mukherjee
University of Nottingham

Abstract

In a supplementary note to Ghosh and Morita ("Social desirability of free entry: a bilateral oligopoly analysis," 2007, IJIO), an example has been used to show that the condition for insufficient entry holds under the right-to-manage model of a vertically related industry. Using a linear demand curve, this note makes it clear that excessive entry rather than insufficient entry is quite common under a right-to-manage model, and shows that excessive entry occurs if the cost of entry is not very high.

I would thank an anonymous referee of this journal for helpful comments and suggestions. The initial version of this paper was written when Arijit Mukherjee visited Kobe University, Japan, in 2008. The hospitality of Kobe University is greatly acknowledged. The usual disclaimer applies.
Citation: Arijit Mukherjee, (2009) "Excessive entry in a bilateral oligopoly", *Economics Bulletin*, Vol. 29 no.1 pp. 199-204.
Submitted: Nov 24 2008. **Published:** February 24, 2009.

1. Introduction

Ghosh and Morita (2007a) show that, in the case of a bilateral oligopoly with "efficient bargaining", entry is always insufficient if the suppliers of the intermediate products have sufficiently high bargaining power.[1] In a supplementary note to that paper, they used a numerical example to show that the condition for insufficient entry would hold under a "right-to-manage" model of a vertically related industry. However, since they were interested in insufficient entry, they did not pay much attention to show how likely it was to have insufficient entry under a right-to-manage model. Using a linear demand curve, we show that the occurrence of excessive entry rather than insufficient entry is quite common under a right-to-manage model. Unless the cost of entry is very high, entry is socially excessive rather than insufficient. Thus, we make the role of the entry cost clear in determining excessive or insufficient entry.

2. The model and the results

Let us consider an industry with a large number of symmetric downstream firms, each of whom must decide whether or not to enter the downstream sector. In the case of entry, each downstream firm needs to incur an entry cost K. If n downstream firms enter, each of them is paired with an upstream firm. The upstream firms provide inputs to the respective downstream firms. We assume that the upstream firms have full bargaining power and determine the input prices. The respective downstream firms purchase the inputs according to their requirements. The downstream firms transform the inputs to a final homogeneous good with a constant marginal cost, which is normalized to zero. For simplicity, we assume that the cost of producing the input is zero. We also assume that the downstream firms have symmetric production technology, and each downstream firm requires one input to produce one unit of output. It is worth mentioning that a downstream firm can use only the inputs produced by the upstream firm which is paired with this downstream firm.

We assume that the inverse market demand function is

$$P = a - q \,, \tag{1}$$

where the notations have usual meanings.

We consider the following game. At stage 1, the downstream firms decide whether or not to enter the industry. At stage 2, the upstream firm set the input prices simultaneously for the respective downstream firms. At stage 3, the downstream firms compete like Cournot oligopolists to determine their equilibrium outputs, and buy the inputs according to their requirements. The profits are realized. We solve the game through backward induction.

Given that n downstream firms have entered and the ith upstream firm, $i = 1,2,...,n$, charged w_i as the per-unit price for its input, the ith downstream firm, $i = 1,2,...,n$, maximizes the following expression to determine its output:

$$\underset{q_i}{Max}(a - q - w_i)q_i - K \,. \tag{2}$$

Note that K is sunk at the output stage and $q = \sum_{i=1}^{n} q_i$.

The equilibrium output of the ith downstream firm is

[1] In another paper, Ghosh and Morita (2007b) show insufficient entry in a vertical structure, where the intermediate products are sold through the market instead of vertical negotiations.

$$q_i = \frac{a - nw_i + \sum_{\substack{j=1 \\ i \neq j}}^{n} w_j}{n+1}, \qquad i = 1,2,...,n. \qquad (3)$$

Since each downstream firm requires one input to produce one unit of output, (3) also shows the input demand faced by the ith upstream firm, $i = 1,2,...,n$. The ith upstream firm maximizes the following expression to determine w_i:

$$\underset{w_i}{Max} \frac{w_i (a - nw_i + \sum_{\substack{j=1 \\ i \neq j}}^{n} w_j)}{n+1}, \qquad i = 1,2,...,n. \qquad (4)$$

Given the symmetry of the firms, the equilibrium input prices are $w_1^* = w_2^* ... = w_n^* = \frac{a}{n+1}$. As the number of firms in the downstream sector increases, it reduces the equilibrium input price.

The equilibrium net profit of the ith downstream firm which has decided to enter the downstream sector is

$$\pi_i = \frac{a^2 n^2}{(n+1)^4} - K. \qquad (5)$$

For the analytical convenience, we consider the number of firms as a continuous variable. Hence, entry in the downstream sector occurs until the net profit of a new entrant is zero. Given the symmetry of the firms, the free entry equilibrium number of firms in the downstream sector is given by the zero profit condition:

$$\pi_i = 0$$

or $$\frac{a^2 n^2}{(n+1)^4} = K. \qquad (6)$$

Given K, condition (6) shows the number of firms entering the downstream sector in the free entry equilibrium. It follows from (6) that, if the cost of entry (i.e., K) falls, the number of firms in the free entry equilibrium increases.

Now determine the welfare maximizing number of firms, where welfare is given by the sum of the total net profits of the downstream firms, the total profits of the upstream firms and consumer surplus. Following the literature on excess-entry theorem, we consider the second-best problem of welfare maximization. That is, we determine welfare maximizing number of firms subject to Cournot behavior of the firms. Hence, the social planner can control the number of firms entering the downstream sector, but it cannot control the output choice behavior of the firms.

If n downstream firms produce, it follows from (5) that the net profit of the ith downstream firm is $\pi_i = \frac{a^2 n^2}{(n+1)^4} - K$, $i = 1,2,...,n$. The total net profit of the downstream firms is

$$n\pi_i = \frac{a^2 n^3}{(n+1)^4} - nK. \qquad (7)$$

Given that the equilibrium input prices are $w_1^* = w_2^* ... = w_n^* = \frac{a}{n+1}$, the equilibrium amount of input supplied by the ith upstream firm is $q_i = \frac{an}{(n+1)^2}$, $i = 1,2,...,n$. The profit of the ith upstream firm is $U_i = \frac{a^2 n}{(n+1)^3}$, $i = 1,2,...,n$. The total profit of the upstream firms is

$$nU_i = \frac{a^2 n^2}{(n+1)^3}. \tag{8}$$

Since the total final goods production is $nq_i = \frac{an^2}{(n+1)^2}$, consumer surplus, which is $\frac{(nq_i)^2}{2}$, is

$$CS = \frac{a^2 n^4}{2(n+1)^4}. \tag{9}$$

The social planner chooses n to maximize social welfare (which is the sum of (7), (8) and (9)):

$$\underset{n}{Max} W = \underset{n}{Max} \frac{a^2 n^3}{(n+1)^4} - nK + \frac{a^2 n^2}{(n+1)^3} + \frac{a^2 n^4}{2(n+1)^4}$$

$$= \underset{n}{Max} \frac{a^2 n^2 (n^2 + 4n + 2)}{2(n+1)^4} - nK. \tag{10}$$

The welfare maximizing n is

$$\frac{2a^2 n(2n+1)}{(n+1)^5} = K. \tag{11}$$

It follows from (11) that as the cost of entry (i.e., K) falls, the welfare maximizing number of firms increases.

Proposition 1: (i) *The welfare maximizing number of firms is lower than the number of firms in the free entry equilibrium, if the welfare maximizing number of firm is at least 4. In this situation, entry is excessive from the social point of view.*
(ii) If the welfare maximizing number of firm is at most 3, the number of firms in the free entry equilibrium is lower than the welfare maximizing number of firms, and entry is insufficient in this situation.[2]
Proof: Assume that (11) holds, i.e., we determine the welfare maximizing number of firms. Comparing left hand sides (LHSs) of (6) and (11) at the welfare maximizing number of firms, we get that

$$\frac{a^2 n^2}{(n+1)^4} \gtreqless \frac{2a^2 n(2n+1)}{(n+1)^5}$$

if $$n^2 - 3n - 2 \gtreqless 0. \tag{12}$$

[2] Though, in our analysis, we consider the number of firms as a continuous variable, while writing this proposition we keep in mind that the number of firms in reality takes integer values. Hence, we avoid writing the number of firms between 3 and 4 in the proposition.

LHS of (12) is convex in n, and it is negative for $n \in [1, \frac{3+\sqrt{17}}{2})$, while it is positive for $n > \frac{3+\sqrt{17}}{2}$.

(i) If the welfare maximizing number of firm is at least 4, we get that $\frac{a^2 n^2}{(n+1)^4} > \frac{2a^2 n(2n+1)}{(n+1)^5} = K$, i.e., the number of firms in the free entry equilibrium is greater than the welfare maximizing number of firms, which implies that entry is excessive in this situation.

(ii) If the welfare maximizing number of firm is at most 3, we get that $\frac{a^2 n^2}{(n+1)^4} < \frac{2a^2 n(2n+1)}{(n+1)^5} = K$, which implies that the number of firms in the free entry equilibrium is lower than the welfare maximizing number of firms. Hence, entry is insufficient in this situation. Q.E.D.

It follows from (6) and (11) that both the number of firms in the free entry equilibrium and the welfare maximizing number of firms increase with lower K. Hence, Proposition 1(i) suggests that *entry is excessive if the cost of entry is not very high* so that the welfare maximizing number of firm is at least 4.

The reason for the difference between our result and that of Ghosh and Morita (2007) with efficient bargaining is attributable to the different bargaining structures considered in these papers. In Ghosh and Morita (2007), the upstream agents bargain over both the input prices and the input quantities. The possibility of bargaining over the input quantities helps the upstream and the downstream agents to choose the input quantity in a way so that they can maximize their post-entry joint profits, which are divided between them by the input prices according to their bargaining powers. As the bargaining power of the downstream agent falls, it reduces the downstream agent's share of the post-entry joint profit and therefore, it reduces its incentive for entry. If the bargaining power of the upstream agents is very high, it significantly reduces the downstream agents' incentives for entry, and creates insufficient entry from the social point of view.

In contrast, in our analysis, the upstream agents cannot determine the input quantities, and therefore, the joint profit maximizing role of the input quantities are not present here. Instead, we have the standard case of "double marginalization", and the upstream agents must be careful about the effects of the input prices on the input demands. Hence, in our analysis, even if the upstream agents have full bargaining power, the post-entry profits of the downstream agents remain significant, thus providing significant incentives for entry. Further, higher competition in the product market helps to reduce the input price, thus reinforcing the "business stealing incentive" of the new entrant. Hence, if the cost of entry is not very high, the number of downstream firms entering the industry is not very small, and the equilibrium input price is not very high. In this situation, significant business stealing incentive remains for the new entrant, thus creating excessive entry for not very high entry costs. If the entry cost is very high, the number firms entering the market is small, and therefore, the equilibrium input price is very high, which, in turn, reduces the business stealing incentive significantly and creates insufficient entry for high entry costs.

We have shown excessive entry with full bargaining power of the upstream agents. However, it must be clear that as the bargaining power of the upstream agents falls, it reduces the equilibrium input price for a given number of downstream agents, thus increasing the incentive for entry by raising the post-entry profits of the downstream agents. Hence, the case of excessive entry increases with lower bargaining power of the upstream agents. On the extreme case of no bargaining power of the upstream agents, our analysis coincides with the previous works on excessive entry without a vertical structure, where entry is always socially excessive.

3. Conclusion

Using a linear demand curve, we show that excessive entry rather than insufficient entry is quite common under a right-to-manage model. Unless the cost of entry is very high, entry is socially excessive. Thus, this note shows the role of the entry cost in determining the excessive or insufficient entry under a right-to-manage model, thus complementing the recent work by Ghosh and Morita (2007a).

References

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