E C O N O M I C S   B U L L E T I N

Entry in a Stackelberg perfect equilibrium

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Abstract

This paper considers welfare effects of entry when the incumbent firm behaves like a Stackelberg leader in the product market. In contrast to the existing literature, we show that entry may increase welfare for any cost asymmetries between the firms. Using a general demand function we show the condition for welfare improving entry.

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1. Introduction

Does entry always increase welfare? In an interesting paper, Klemperer (1988) shows that, if the firms compete like Cournot oligopolists, entry reduces welfare if the (constant) marginal cost of the entrant is sufficiently higher than that of the incumbent. The reason for this result is as follows. On one hand, entry increases the total output in the industry, which tends to increase welfare by increasing consumer surplus. On the other hand, entry reduces the output of the cost efficient incumbent. Since the entrant is cost inefficient than the incumbent, the business stealing effect of entry creates production inefficiency in the industry, which tends to reduce welfare under entry. If the cost of the entrant is very high compared to the incumbent, the production inefficiency effect dominates the total output increasing effect of entry, and entry reduces welfare.

However, it is well known that either incumbency advantage or cost efficiency may allow a firm to be a dominant player in the product market, thus making the incumbent a Stackelberg leader in the product market (see, e.g., Dixit, 1980, Basu, 1995, Hamilton and Slutsky, 1990 and van Damme and Hurkens, 1999). We show that if the incumbent behaves like a Stackelberg leader, entry always increases welfare for the demand function considered in Klemperer (1988). Hence, leadership by the incumbent eliminates product inefficiency which occurs under Cournot competition.[1]

Using a general demand function we show the condition under which the output of the incumbent Stackelberg leader is higher under entry than under no entry,[2] and this condition is always satisfied under linear demand function. We show that our basic result holds for an arbitrary number of entrants, who behave like Stackelberg followers. Hence, our results suggest that entry should be more encouraged in industries with dominant incumbent firms, thus may have important implications for competition policies.

Recently, Ghosh and Saha (2007) consider a model with free entry and extend the line of research conducted by Klemperer (1988). They show that entry can be socially excessive in the absence of scale economies. However, like Klemperer (1988), Ghosh and Saha (2007) also assume that the firms compete like Cournot oligopolists.[3]

The remainder of the paper is organized as follows. Section 2 describes the model and derives the main result of the paper. Section 3 concludes.

2. Cournot vs. Stackelberg competition

Let us consider an economy with an incumbent and an entrant. Both firms can produce a homogeneous product with the constant marginal cost of production c_i. However, each consumer incurs a 'switching cost' $s > 0$ for switching from the incumbent's product to the entrant's product (see, Klemperer, 1988). Therefore, the effective marginal cost of the entrant is $(c_i + s) \equiv c > c_i$.[4] For simplicity, assume that there is no other cost of production or entry. We consider two situations to see the effects of entry: (i) when there

[1] It follows from Clarke and Collie (2003) that, if the market demand function is linear, entry always increases welfare if the firms compete in prices.

[2] While discussing the case of general demand function, Klemperer (1988) shows that entry may always reduce welfare by reducing the output of the incumbent. In contrast, we show that in a Stackelberg model, entry may never reduce output of the incumbent, and therefore, entry may always increase welfare.

[3] There is another literature, which shows that entry may reduce welfare in the presence of scale economies (see, e.g., Stiglitz, 1981, Spence, 1984, Tandon, 1984, Schmalensee, 1976, von Weizsäcker, 1980a, b, Mankiw and Whinston, 1986 and Suzumura and Kiyono, 1987).

[4] Instead of switching cost, the different marginal cost of the firms may be the outcome of technological differences. For example, if the incumbent is a technology leader, the expiration of patent on one of its old technologies may create entry of a firm with relatively higher marginal cost of production.

is no entry and the incumbent is monopolist, and (ii) when there is entry and the market structure is duopoly.

Let us assume that the inverse market demand function is $p(q)$, with $p' < 0$ and $p'' \leq 0$, and the notations have the usual meanings.[5]

If the incumbent is monopolist, which is the case under no entry, it maximizes the following expression to determine its output:

$$\underset{q_i^m}{Max}(p(q_i^m) - c_i)q_i^m . \quad (1)$$

The equilibrium output of the incumbent is determined by the following equation:

$$p(q_i^m) - c_i + q_i^m p' = 0 . \quad (2)$$

2.1. Cournot competition

Now, consider the output choice under entry when the firms compete like Cournot duopolists.

The incumbent and the entrant maximize the following expressions respectively to determine their outputs:

$$\underset{q_i^e}{Max}(p(q_i^e + q_e^e) - c_i)q_i^e \quad (3)$$

$$\underset{q_e^e}{Max}(p(q_i^e + q_e^e) - c)q_e^e . \quad (4)$$

The equilibrium outputs of the incumbent and the entrant are determined by solving the following expressions:

$$p(q_i^e + q_e^e) - c_i + q_i^e p' = 0 \quad (5)$$

$$p(q_i^e + q_e^e) - c + q_e^e p' = 0 . \quad (6)$$

It follows from (2), (5) and (6) that, if the entrant produces positive output, the output of the incumbent is lower under entry than under no entry.

The industry output can be found by adding the equations (5) and (6), which gives the condition:

$$2p(q^e) - (c_i + c) + q^e p' = 0 , \quad (7)$$

where $q^e = q_i^e + q_e^e$.

2.2. Stackelberg competition

Let us now consider the output choice under entry when the incumbent behaves like a Stackelberg leader.

Given the output choice of the incumbent, the entrant maximizes the following expression to determine its output:

$$\underset{q_e^e}{Max}(p(q_i^e + q_e^e) - c)q_e^e . \quad (8)$$

The optimal output of the entrant is determined by the following equation:

$$p(q_i^e + q_e^e) - c + q_e^e p' = 0 . \quad (9)$$

[5] Our assumption on the second derivative of the demand function is sufficient to ensure that the marginal revenues of the firms are decreasing with respect to the outputs of the competitors, and it is also enough to satisfy the second order conditions for maximization in our analysis. It follows from Bulow et al. (1985) that if the marginal revenues of the firms are increasing with respect to the outputs of the competitors, which can happen for constant elasticity demand functions, the incumbent produces more under entry than under no entry even under Cournot competition. Hence, in this situation, entry always increases welfare under Cournot competition.

The implicit function $q_e^e(q_i^e)$, which shows the entrant's reaction function, can be found from equation (9), and the slope of this implicit function, i.e., $q_e^{e'}$, is negative.

Hence, the incumbent maximizes the following expression to determine its output:

$$\underset{q_i^e}{Max}(p(q_i^e + q_e^e(q_i^e)) - c_i)q_i^e, \tag{10}$$

since the incumbent internalizes the output strategy of the entrant, which can be found from the entrant's reaction function $q_e^e(q_i^e)$. So, the equilibrium output of the incumbent is determined by the following equation:

$$p(q_i^e + q_e^e(q_i^e)) - c_i + q_i^e p' + q_i^e p' q_e^{e'} = 0. \tag{11}$$

If the entrant produces positive outputs under both Cournot and Stackelberg competition, we get from (5), (6), (9) and (11) that the equilibrium output of the incumbent (entrant) is higher (lower) under Stackelberg competition than under Cournot competition. The industry output under Stackelberg competition can be found by adding the equations (9) and (11). We get that the industry output is higher under Stackelberg competition than under Cournot competition, which is also higher than the incumbent's monopoly output.

So, the outputs of the incumbent and the industry are higher under Stackelberg competition compared to Cournot competition, which implies that the possibility of welfare reducing entry is lower under the former competition than the latter. However, it is yet to see whether entry can increase welfare under Stackelberg competition for any cost asymmetries between the firms.

Proposition 1: *Assume $c = c_i$. If the absolute slope of the entrant's reaction function corresponding to the incumbent's monopoly output, q_i^m, is not lower than the absolute slope of the incumbent's isoprofit curve at the output combination $(q_i^m, q_e^e(q_i^m))$, i.e., $-q_e^{e'}(q_i^m) \geq \frac{p(q_i^m + q_e^e(q_i^m)) - c_i + q_i^e p'}{q_i^m p'}$, the incumbent's output under Stackelberg competition is not lower than its monopoly output if the entrant produces positive output in the market. Therefore, in this situation, entry does not reduce welfare under Stackelberg competition for any cost asymmetries between the firms.*

Proof: If both firms produce positive outputs then, as the marginal cost of the entrant increases, it reduces the entrant's equilibrium output and increases the equilibrium output of the incumbent. So, if the incumbent's output under Stackelberg competition is greater than or equal to its monopoly output when the entrant's marginal cost is $c = c_i$, the incumbent produces more under entry than under no entry for $c > c_i$, if the entrant produces positive output in the market.

If the entrant's marginal cost is $c = c_i$, the incumbent, under Stackelberg competition, does not produce lower than its monopoly output if and only if

$$p(q_i^m + q_e^e(q_i^m)) - c_i + q_i^e p' + q_i^m p' q_e^{e'} \geq 0$$

or

$$-q_e^{e'}(q_i^m) \geq \frac{p(q_i^m + q_e^e(q_i^m)) - c_i + q_i^e p'}{q_i^m p'}, \tag{12}$$

where the left hand side (LHS) of (12) shows the absolute slope of the entrant's reaction function and the right hand side (RHS) of (12) shows the absolute slope of the incumbent's isoprofit curve.[6] Q.E.D.

Using (2) and the expression for $q_e^{e'}$, which is $\frac{-(p' + q_e^e p'')}{2p' + q_e^e p''}$ (where the denominator is negative due to the second order condition of entrant's profit maximization), and after rearrangement, we can re-write condition (12) as:

$$\frac{q_i^m}{q_e^e(q_i^m)} \leq 2 + \frac{q_e^e p''}{p'}. \tag{13}$$

If the demand function is linear, i.e., $p'' = 0$, LHS of (13) is equal to RHS of (13). For example, if the inverse demand function is $p = a - bq$, we get $q_i^m = \frac{(a - c_i)}{2b}$ and $q_e^e(q_i^m) = \frac{(a - c_i)}{4b}$. So, both LHS and RHS of (13) are 2. Hence, if the incumbent behaves like a Stackelberg leader, entry does not reduce the equilibrium output of the incumbent compared to no entry, if the firms have the same marginal cost. Since, higher marginal cost of the entrant increases the output of the incumbent, it immediately implies that if $c > c_i$, the output of the incumbent is higher under entry than under no entry. So, unlike Cournot competition, entry under Stackelberg competition does not create production inefficiency by reducing the output of the incumbent. As a result, if the incumbent behaves like a Stackelberg leader, entry always increases welfare for linear demand function considered in Klemperer (1988).

It must be clear that condition (12) or (13) can also hold for non-linear demand functions since, given that $q_e^{e'}$ is negative and the entrant's equilibrium output is positive, it follows from (2) and (11) that if $q_i^e = q_i^m$, then at $q_e^e = 0$, we get $p(q_i^m) - c_i + q_i^m p' + q_i^m p' q_e^{e'} > 0$. Since the incumbent internalizes the output strategy of the entrant, the incumbent's marginal profit is positive at the combination of zero output of the entrant and the monopoly output of the incumbent, which encourages the incumbent to produce more than its monopoly output. While the positive output of the entrant reduces the incumbent's equilibrium output, the incumbent can still find it profitable to produce more than its monopoly output under entry.

The reason for the above finding is as follows. If the incumbent produces its monopoly output, it leaves positive residual demand for the entrant. A positive output by the entrant reduces price of the product, and destroys the incumbent's possibility of earning its monopoly profit. Since, the positive output by the entrant reduces the price anyway, it can induce the incumbent to increase its market share by producing more than its monopoly output. The Stackelberg competition provides the incumbent the power to commit to this higher output before the output choice of the entrant. Further, the incentive for higher production by the incumbent increases with the higher marginal cost of the entrant, since the higher marginal cost of the entrant induces the entrant to react

[6] The isoprofit curve of the incumbent is $(p(q_i^e + q_e^e(q_i^e)) - c_i)q_i^e = K$, where K is a constant. Slope of the isoprofit curve is $\frac{\partial q_e^e}{\partial q_i^e} = \frac{-(p - c_i + q_i^e p')}{q_i^e p'}$.

less aggressively for a given output of the incumbent. Hence, under Stackelberg competition, the incumbent's commitment to output before the entrant's output choice helps to avoid production inefficiency under entry, thus increasing welfare under entry for any cost asymmetries between the firms due to the positive effect of higher competition under entry.

It must be noted that Proposition 1 provides a strong sufficient condition for the welfare improving entry. Because, even if (12) does not hold, welfare may increase with entry if $c > c_i$. If both firms produce positive outputs then, as the marginal cost of the entrant increases, it increases the equilibrium output of the incumbent. So, the possibility of higher output of the incumbent under entry than under no entry is higher for $c > c_i$ than for $c = c_i$. As a result, if $c > c_i$, a weaker condition than (12) can ensure welfare improving entry.

As a final remark, if the incumbent behaves like a Stackelberg leader, entry increases welfare for any arbitrary number of entrants. As already mentioned, the possibility of positive output by the entrant reduces the price of the product, which induces the incumbent to produce more than its monopoly output under entry. Since, this effect prevails irrespective of the number of entrants, entry under Stackelberg competition increases welfare for any arbitrary number of entrants by inducing the incumbent to produce more under entry than under no entry. As an example, let us consider entry of n firms, where each entrant faces the marginal cost c. If the inverse demand function is $p = a - bq$, we find that the output of the incumbent under entry is $\frac{a - c_i + n(c - c_i)}{2b}$, where c_i is the marginal cost of the incumbent. Since, $n = 0$ corresponds to the case of no entry, it is immediate that the incumbent's output is higher under entry than under no entry if $c > c_i$ and the outputs of the entrants are positive.

3. Conclusion

Assuming Cournot competition, Klemperer (1988) shows that entry reduces welfare in the absence of scale economies if the entrant is sufficiently cost inefficient than the incumbent. In a free entry model, this research has been extended by Ghosh and Saha (2007) to show excessive entry in the absence of scale economies.

However, either the incumbency advantage or the cost efficiency may allow the incumbent firm to behave like a Stackelberg leader in the product market. We show that if the incumbent behaves like a Stackelberg leader, entry can increase welfare for any cost asymmetries between the firms. Hence, entry should be more encouraged in industries with dominant firms.

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