

THE COMPARISON OF ENTRY DETERRENCE BETWEEN COURNOT AND BERTRAND COMPETITION

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We compare the incentive of an incumbent monopolist to deter the entry between Cournot and Bertrand competition in differentiated product markets. It is first shown that unless the products are perfect substitutes, the incumbent can block the entry more easily under Cournot competition than under Bertrand competition. For the entry deterrence, as long as the products are differentiated to some degree, like the blockaded entry, the incumbent would like to deter the entry more under Cournot competition than under Bertrand competition. However, if the product differentiation is quite small, the incumbent can deter the entry more easily under Bertrand competition than in the Cournot competition.

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I. INTRODUCTION

Since the pioneering works by Bain(1956), Modigliani(1958) and Sylos-Labini(1962), the incentive of an incumbent monopolist to deter the entry by a new firm has been one of the important research agenda in industrial organization literature. These papers assumed that under complete information, once the incumbent chose either quantity or price

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before the entry occurred, believing that what the incumbent chose would prevail after the entry, the potential entrant made an entry decision. Namely the incumbent was assumed to commit the quantity or price in advance. Early works have been extended in several directions. Since Milgrom & Roberts(1982) who analyzed the entry deterrence under incomplete information, a huge literature has appeared concerning the incentive of entry deterrence under incomplete information. Another direction where lots of researches were carried out was whether the incumbent could indeed commit the quantity or price in advance. There arose many controversies concerning whether the incumbent could have commitment power. In particular, since price is a strategic variable which can be changed easily, depending on whether entry occurs or not, the incumbent can charge a price different from the announced one. As a way to solve the commitment problem, it has been suggested in the literature that the incumbent can precommit the capacity before the entry occurs. Once the investment on the capacity is made, it has become a sunk cost so that it could play a role of commitment device in the view point of the incumbent.

Spence(1977) showed that in the homogeneous good market, under Cournot competition, by precommitting capacity, the incumbent could deter the entry. However, the equilibrium found in Spence was not subgame perfect Nash equilibrium. In other words, once entry occurred, the threat to expand the output up to the capacity was not a credible one. In the homogeneous good market, under Cournot competition, using the linear demand curve and constant marginal cost model, if the entrant should pay an entry cost k , Dixit(1979) characterized the ranges of k under which entry is blockaded, deterred and accommodated, respectively. The equilibrium considered in Dixit was Subgame perfect Nash equilibrium, but for the products were assumed to be strategic substitutes, excess capacity could not be explained as an equilibrium behavior. In another paper, Dixit(1980) analyzed a variant model of his previous paper. One of change was that he examined Bertrand competition. However, unlike his previous paper, he could not characterize the ranges of entry cost under which the blockaded entry, deterred entry or accommodated entry occurs, respectively. Bulow, Geanakoplos & Klemperer(1985)

examined the Cournot competition in a duopoly market. They showed that in equilibrium, the incumbent held excess capacity. This result was due to the fact that they assumed constant elasticity demand curve so that in a particular range, the products became strategic compliments.

Since the pioneering works by Cournot and Bertrand, Cournot competition and Bertrand competition have become the standard models for analyzing competition among firms in the oligopoly market. In the existing literature, the equilibria of Cournot competition and Bertrand competition were compared in both homogeneous good and differentiated good markets.¹ However, no attempt has been made to consider the way firm competes in the market affects the incentive of entry deterrence. The paper examines how the modes of competition change the incentive of deterring the entry.

The modes of competition will influence the incentive of the incumbent to deter the entry. The reason is that depending upon the modes of competition, the product can be either strategic substitutes or strategic complements. In Cournot competition, quantity becomes strategic substitute. On the contrary, in Bertrand competition, price becomes strategic complements. This means that in Cournot competition, when a firm increases its output, it reduces the profit of the other firm. In contrast, in Bertrand competition, when a firm raises its price, it will lead to the increase in the profit of the other firm. Furthermore, the incentive of the incumbent to deter the entry depends upon the degree of product differentiation. When the products are not sufficiently differentiated, it is harder for the incumbent to deter the entry under Cournot competition than in Bertrand competition.

The paper proceeds as follows. A model is presented in Section II. In Section III, the way how the modes of competition affect the incentive of the incumbent to deter the entry is analyzed. Conclusion follows in Section IV by summarizing the results and mentioning the future research agenda.

¹ For example, see Singh & Vives(1984), Cheng (1985), Vives(1985), Okuguchi(1987) for the differentiated product markets. See Dastidar(1997) for the homogeneous good market.

II. THE MODEL

Firm 1 (incumbent monopolist) and firm 2 (potential entrant) produce products 1 and 2, respectively. For simplicity, the marginal costs are assumed to be zero for each product. This implies that there exist no capacity constraints. Firm 1 is already in the market and produces good 1. On the contrary, if firm 2 enters the market, it should pay the entry cost denoted by $k (> 0)$.

Demand functions for each product can be derived from the utility maximization by a representative consumer whose utility function is assumed to take the following form:

$$U(q_1, q_2) = \alpha_1 q_1 + \alpha_2 q_2 - \frac{\beta_1 q_1^2 + 2\gamma q_1 q_2 + \beta_2 q_2^2}{2}.$$

In order to focus on the way how the modes of competition affect the incentive of the entry deterrence, we assume symmetry to the maximal extent. For simplicity, it is further assumed that $\alpha_1 = \alpha_2 = \alpha$, $\beta_1 = \beta_2 = 1$. Therefore, the final form of utility function is $U(q_1, q_2) = \alpha q_1 + \alpha q_2 - \frac{q_1^2 + 2\gamma q_1 q_2 + q_2^2}{2}$ with $\alpha > 0$. In order for the utility function to be strictly concave, it is assumed that $0 < \gamma < 1$. γ measures the degree of differentiation between two products. As γ becomes closer to 0, two products become more differentiated ones. If γ is closer to 1, they become close substitutes. In two extreme cases, with $\gamma = 0$, two products are independent, therefore, two markets become completely separated. There exists no interaction between the two markets. With $\gamma = 1$, two products become perfect substitutes. Demand functions for each product are derived from the following utility maximization problem:

$$\text{Max}_{q_1, q_2} \alpha q_1 + \alpha q_2 - \frac{q_1^2 + 2\gamma q_1 q_2 + q_2^2}{2} - (p_1 q_1 + p_2 q_2).$$

From the first order conditions, the following inverse demand functions

are derived:

$$p_1 = \alpha - q_1 - \gamma q_2, \quad p_2 = \alpha - q_2 - \gamma q_1 \quad (1)$$

Solving Equations in (1) for q_1 and q_2 in terms of p_1 and p_2 , we obtain the demand functions as follows:

$$p_1 = a - dp_1 - cp_2, \quad q_2 = a - dp_2 - cp_1 \quad (2)$$

where, with $\delta = 1 - \gamma^2$, $a = \alpha / (1 + \gamma)$, $b = 1 / \delta$, $c = \gamma / \delta$.

The game precedes in two steps. In the first stage, firm 1, the incumbent monopolist of product 1, chooses q_1 in Cournot competition, and p_1 in Bertrand competition. Firm 2, the potential entrant, upon seeing q_1 or p_1 (depending upon the modes of competition), it will decide whether to enter by paying the entry cost or not. If entry occurs, firm 2 chooses q_1 or p_1 (again, depending upon the modes of competition).²

III. EQUILIBRIUM ANALYSIS

III.1 Entry deterrence in Cournot competition

In this subsection, we first examine Cournot competition. For this, we calculate the monopoly quantity and profit of firm 1 when firm 2 does not enter the market. Since firm 2 does not exist in the market, q_2 equals 0. Therefore, in this case, the inverse demand function for firm 1 is $p_1 = \alpha - q_1$. Since marginal cost is assumed 0, firm 1's profit is $\pi_1 = (\alpha - q_1) \cdot q_1$. Then, it can be easily shown that the monopoly quantity is $q_1^M = \alpha / 2$, monopoly price is $p_1^M = \alpha / 2$, and the monopoly profit is $\pi_1^M = \alpha^2 / 4$.

² The paper assumes that the incumbent can commit quantity or prices in advance. We also analyzed the case where the incumbent can precommit through investment in capacity. This only complicates the whole analysis, but there is no qualitative differences in the final results. Therefore, the paper assumes that the incumbent can commit quantity or price in advance.

Next, we will calculate the best response function of firm 2 and its profit if entry occurs. With entry, the firm 2's inverse demand curve is $p_2 = \alpha - q_2 - \gamma q_1$, thereby, the profit is $\pi_2 = (\alpha - q_2 - \gamma q_1) \cdot q_2$. Differentiating π_2 with respect to q_2 , setting it to zero, and solving for q_2 , the best response of firm 2 against q_1 is obtained. Solving $\partial \pi_2 / \partial q_2 = \alpha - \gamma q_1 - 2q_2 = 0$ for q_2 , the best response function is $BR_2(q_1) = (\alpha - \gamma q_1) / 2$. Plugging this into the profit function, it will be the maximum profit which firm 2 can get after entry. Denoted by π_2^E , $\pi_2^E = (\alpha - \gamma q_1)^2 / 4$.

π_2^E is the gross profit before the entry cost is subtracted. Hence, if π_2^E does not exceed the entry cost, k , firm 2 will not enter. Solving $\pi_2^E = (\alpha - \gamma q_1)^2 / 4 = k$ for q_1 , we find the minimum value of q_1 which deters the entry. Let q_1^D be this value. Then, $q_1^D = (\alpha - 2\sqrt{k}) / \gamma$. Therefore, taking into the entry possibility, firm 2's best response is not to enter ($q_2 = 0$) when $q_1 \geq q_1^D$, and enter and choose $BR_2(q_1) = (\alpha - \gamma q_1) / 2$ when $q_1 < q_1^D$. Hence with $q_1 \geq q_1^D$, firm 1 can deter the entry. Being able to deter the entry does not necessarily mean that deterring entry is the best option for firm 1. It may be too costly to deter the entry. In this case, it pays for firm 1 to accommodate the entry. We now calculate the ranges of entry cost, k under which blockaded entry, deterred entry and accommodated entry occur, respectively.

Even though firm 1 chooses the monopoly quantity $q_1^M = \alpha / 2$, if the entry does not occur, the entry is said to be blockaded. The condition for blockaded entry is $q_1^M \geq q_1^D$. With $q_1^M = \alpha / 2$ and $q_1^D = (\alpha - 2\sqrt{k}) / \gamma$, the condition for $q_1^M \geq q_1^D$ is $\sqrt{k} \geq \alpha(2 - \gamma) / 4$.³ For the later comparison, let $CV_{BD}^C = \alpha(2 - \gamma) / 4$. The superscript C and the subscript BD refer to Cournot, blockade and deterrence, respectively.

We now consider the case of $\frac{\alpha}{4}(2 - \gamma) > \sqrt{k}$. In this case, since $q_1^M > q_1^D$ holds, if firm 1 chooses the monopoly quantity, firm 2 will enter by paying the entry cost, k . Firm 1 now faces two options. The first one is to choose q_1^D and deter the entry (entry deterrence). The second is to choose less than q_1^D and accommodate the entry so that firm

³ In the sequel, since \sqrt{k} rather than k is more convenient, every result is expressed in terms of \sqrt{k} .

1 behaves as a Stackelberg leader(entry accommodation).

When firm 1 accommodates the entry, the quantity chosen by firm 1, denoted by q_1^A is the one which maximizes firm 1's profit, taking into account firm 2's best response. When entry occurs, firm 1's profit is $\pi_1 = [\alpha - q_1 - \gamma(\frac{\alpha - \gamma q_1}{2})] \cdot q_1$. Differentiating π_1 with respect to q_1 and solving for q_1 by setting it to 0, q_1^A is given by $q_1^A = \frac{2\alpha - \alpha\gamma}{2(2 - \gamma^2)}$. With accommodated entry, firm 1's profit is $\pi_{1C}^A = \frac{\alpha^2(2 - \gamma)^2}{8(2 - \gamma^2)}$. If firm 1 deters the entry by choosing $q_1 = q_1^D$, firm 1's profit, denoted by π_{1C}^D , is given as follows:

$$\pi_{1C}^D = (\alpha - q_1^D) \cdot q_1^D = \frac{(\alpha - 2\sqrt{k})\{\alpha(\gamma - 1) + 2\sqrt{k}\}}{\gamma^2}.$$

The range of \sqrt{k} over which $\pi_{1C}^A \leq \pi_{1C}^D$ holds is as follows:

$$\sqrt{k} \geq \frac{\alpha(2 - \gamma)}{4} - \frac{\sqrt{2\alpha\gamma}\sqrt{\gamma(4 - 3\gamma)(2 - \gamma^2)}}{8(2 - \gamma^2)}.$$

For the comparison in the sequel, let CV_{DA}^C be the critical value of \sqrt{k} such that $\pi_{1C}^A = \pi_{1C}^D$ holds. Then, $CV_{DA}^C \geq \frac{\alpha(2 - \gamma)}{4} - \frac{\sqrt{2\alpha\gamma}\sqrt{\gamma(4 - 3\gamma)(2 - \gamma^2)}}{8(2 - \gamma^2)}$. The subscript DA refers to deterrence and accommodation.

Proposition 1 summarizes the result in Cournot competition.

Proposition 1. In Cournot competition, when $\sqrt{k} \geq CV_{BD}^C \equiv \alpha(2 - \gamma)/4$, entry is blockaded. When $CV_{DA}^C \leq \sqrt{k} < CV_{BD}^C$, entry is deterred. When $\sqrt{k} < CV_{DA}^C$, entry is accommodated, where CV_{BD}^C and CV_{DA}^C were

defined above.

III.2 Entry deterrence in Bertrand competition

In this subsection, we analyze the Bertrand competition. When firms compete with price, demand functions are more convenient than inverse demand functions. As we calculated the entry deterring quantity (q_1^D) in Cournot competition, we will find the entry deterring price in Bertrand competition. Unlike Cournot competition, however, in Bertrand competition, two products are strategic complements. Therefore, with Bertrand competition, when firm 1 charges a price less than or equal to the entry deterring price, entry is deterred. The reason for this is that an increase in price of one product leads to the increase in profit of the other product.

We first calculate the monopoly price of firm 1. Demand functions for both firms are given in Equation (2), $q_1 = a - bp_1 + cp_2$, $q_2 = a - bp_2 + cp_1$. Since firm 1 is a monopoly, $q_2 = a - bp_2 + cp_1 = 0$ should hold. By substituting $p_2 = (a + cp_1)/b$ into $q_1 = a - bp_1 + cp_2$, the demand function for firm 1 is $q_1 = \alpha - p_1$. This demand function is the same as in Cournot competition. Therefore, the monopoly price and profits are $p_1^M = \alpha/2$ and $\pi_1^M = \alpha^2/4$, respectively.

We now consider the post-entry best response and profit of firm 2. After the entry, since firm 2's demand function is $q_2 = a - bp_2 + cp_1$, the profit is $\pi_2 = (a - bp_2 + cp_1) \cdot p_2$. Differentiating π_2 with respect to p_2 and solving for p_2 by setting it to 0, the best response of firm 2 against p_1 is obtained as follows, $BR_2(p_1) = (a + cp_1)/2b$. Plugging this into the profit function, the post-entry profit of firm 2 is $\pi_2^E = (a + cp_1)^2/4b$.

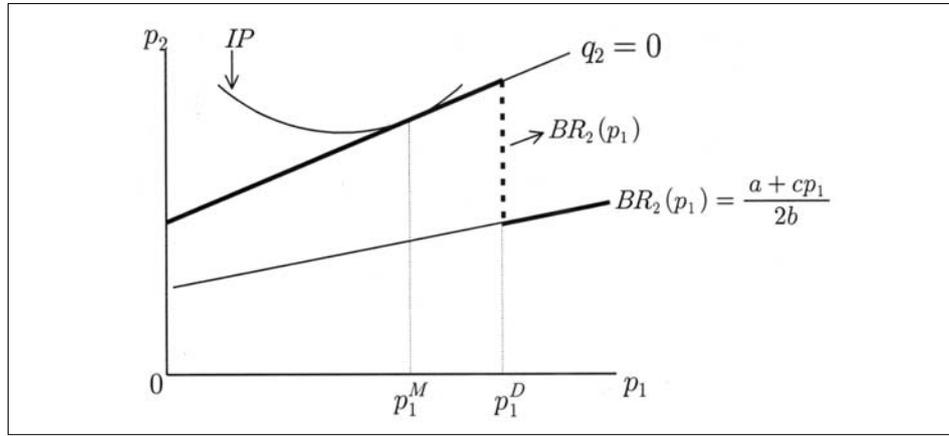
π_2^E is the profit before the entry cost is subtracted. Unless π_2^E exceeds the entry cost, k , firm 2 does not enter the market. Solving $\pi_2^E = (a + cp_1)^2/4b = k$ for p_1 , the entry deterring price, denoted by p_1^D is obtained as follows, $p_1^D = (2\sqrt{bk} - a)/c$. Therefore, taking into the account entry possibility, firm 2's best response is not to enter ($q_2 = 0$) when $p_1 \leq p_1^D$, and enter and choose $BR_2(p_1) = (a + cp_1)/2b$ when $p_1 > p_1^D$. Hence with $p_1 \leq p_1^D$, firm 1 can deter the entry.

The blockaded entry occurs when $p_1^M \leq p_1^D$ holds. With $p_1^M = \alpha/2$

and $p_1^D = (2\sqrt{bk} - a)/c$, $p_1^M \leq p_1^D$ holds when $\sqrt{k} \geq \alpha(2-\gamma)/4\sqrt{(1-\gamma^2)}$ holds. For the comparison in the sequel, let $CV_{BD}^B = \alpha(2-\gamma)/4\sqrt{(1-\gamma^2)}$.

The superscript *B* and the subscript *BD* refers to Bertrand, blockade and deterrence, respectively. Figure 1 shows the blocked entry in Bertrand competition.

[Figure 1] Blockaded entry in Bertrand Competition



In Figure 1, $q_2 = a + cp_1 - dp_2 = 0$ shows the combination of p_1 and p_2 when entry does not occur. *IP* refers to firm 1's isoprofit line. Firm 1's isoprofit line has zero slope when it intersects with its best response function. Furthermore, when p_2 increases, firm 1's profit also increases. $BR_2(p_1) = (a + cp_1)/2b$ is the best response function of firm 2. With $p_1 \leq p_1^D$, firm 2's best response is not to enter. With $p_1 > p_1^D$, firm 2 indeed enters. Therefore, with possibility of entry being taken into account, firm 2's best response function is a bold line in Figure 1. In case of blocked entry, firm 1's isoprofit line is tangent to firm 2's best response function in the region of $p_1^M \leq p_1^D$. Hence, although firm 1 charges the monopoly price, with $p_1^M \leq p_1^D$, entry is automatically blocked.

If $\sqrt{k} < CV_{BD}^B = \alpha(2-\gamma)/4\sqrt{(1-\gamma^2)}$ holds so that $p_1^M > p_1^D$, when firm 1 charges the monopoly price, firm 2 has an incentive to enter. In this case, like in Cournot competition, firm 1 decides whether to deter the

entry or accommodated entry. Firm 1 can deter the entry by choosing p_1^D , or accommodate entry by choosing a higher price than p_1^D and behaves like a Stackelberg leader.

With accommodated entry, p_1^A is the price which maximizes firm 1's profit, taking into account firm 2's best response. When entry is accommodated, firm 1's profit is $\pi_1 = [a - dp_1 - c(\frac{a - cp_1}{2b})] \cdot p_1$.

Differentiating π_1 with respect to p_1 and solving for p_1 by setting it to 0, p_1^A is equal to $\frac{2ab - ac}{4b^2 - 2c^2}$. Plugging $p_1^A = \frac{2ab - ac}{4b^2 - 2c^2}$ into the profit function, firm 1's profit denoted by π_{1B}^A is equal to $\pi_{1B}^A = \frac{\alpha^2(2 - \gamma)^2(1 - \gamma)}{8(1 + \gamma)(2 - \gamma^2)}$. If firm 1 deters the entry by choosing $p_1 = p_1^D$, firm 1's profit denoted by π_{1B}^D is as follows;

$$\begin{aligned} \pi_{1B}^D &= (\alpha - p_1^D) \cdot p_1^D \\ &= \frac{(1 - \gamma) \{ -\alpha^2 - 4(1 + \gamma)k + 2\alpha(2 + \gamma - \gamma^2) \sqrt{\frac{k}{(1 - \gamma^2)}} \}}{\gamma^2}. \end{aligned}$$

The range of \sqrt{k} where $\pi_{1B}^A \leq \pi_{1B}^D$ holds is as follows:

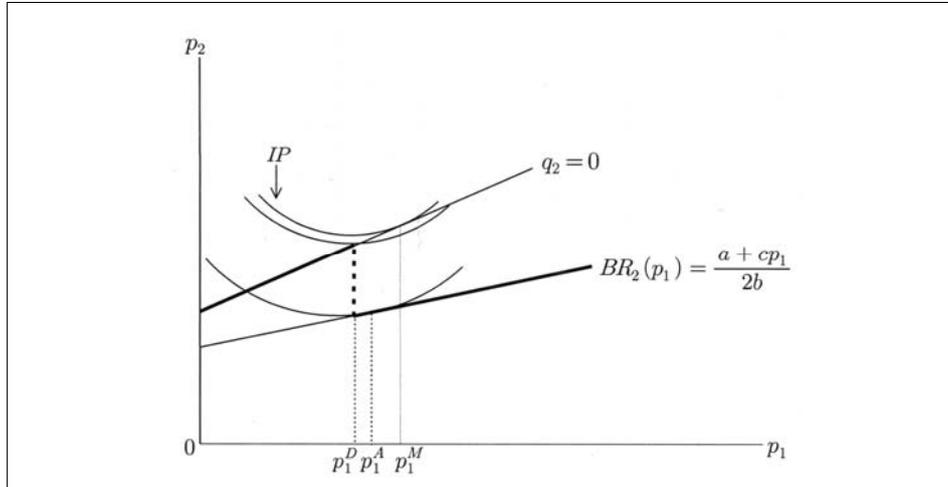
$$\sqrt{k} \geq \frac{\alpha(2 - \gamma)}{4\sqrt{(1 - \gamma^2)}} - \frac{\sqrt{2}\alpha\gamma\sqrt{\gamma(1 + \gamma)(2 - \gamma^2)(4 + \gamma - \gamma^2)}}{8(2 - \gamma^2)\sqrt{(1 - \gamma^2)(1 + \gamma)}}.$$

For the comparison in the sequel, let CV_{DA}^B be the critical value of \sqrt{k} such that $\pi_{1B}^A = \pi_{1B}^D$ holds. Then, CV_{DA}^B is as follows:

$$CV_{DA}^B = \frac{\alpha(2 - \gamma)}{4\sqrt{(1 - \gamma^2)}} - \frac{\sqrt{2}\alpha\gamma\sqrt{\gamma(1 + \gamma)(2 - \gamma^2)(4 + \gamma - \gamma^2)}}{8(2 - \gamma^2)\sqrt{(1 - \gamma^2)(1 + \gamma)}}.$$

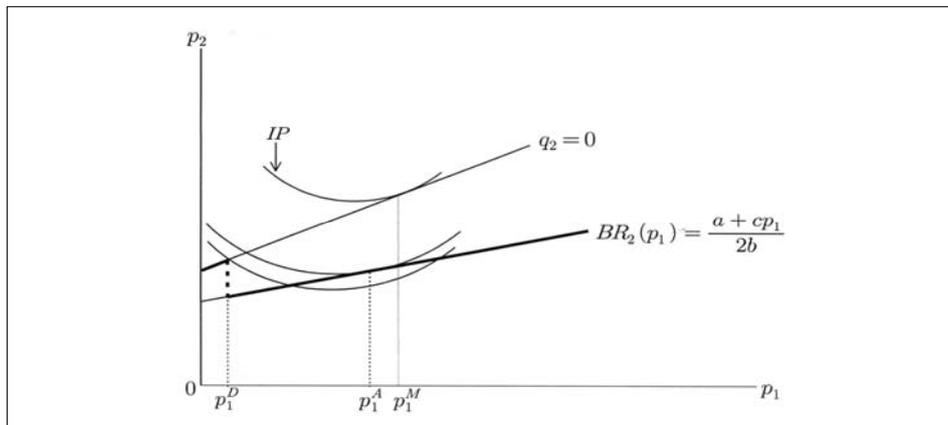
Hence, with $\sqrt{k} \geq CV_{DA}^B$, the entry is deterred. This is shown in Figure 2.

[Figure 2] deterred entry in Bertrand competition



With $\sqrt{k} > CV_{DA}^B$, the entry is accommodated. This is shown in Figure 3.

[Figure 3] accommodated entry in Bertrand competition



Proposition 2 summarizes the result in Bertrand competition.

Proposition 2. In Bertrand competition, when $\sqrt{k} \geq CV_{BD}^B \equiv \alpha(2-\gamma)/4\sqrt{(1-\gamma^2)}$, entry is blockaded. When $CV_{DA}^B \leq \sqrt{k} < CV_{BD}^B$, entry is deterred. When $\sqrt{k} < CV_{DA}^B$, entry is accommodated, where CV_{BD}^B and CV_{DA}^B were defined above.

III.3 The Comparison between Cournot and Bertrand competition

We first compare the blockaded entry. For Cournot and Bertrand competition, the critical values are $CV_{BD}^C \equiv \alpha(2-\gamma)/4$ and $CV_{BD}^B \equiv \alpha(2-\gamma)/4\sqrt{1-\gamma^2}$, respectively. With the assumption of $0 < \gamma < 1$, $\frac{1}{1-\gamma^2}$ is greater than 1. Therefore, $CV_{BD}^B > CV_{BD}^C$ holds. Namely, it is easier to blockade the entry in Cournot competition than in Bertrand competition. The reason is as follows. When firm 1 chooses the monopoly price in Bertrand competition, the residual demand for firm 2 is larger than that when firm 1 chooses the monopoly quantity in Cournot competition. In Cournot competition, firm 2's inverse demand function is $p_2 = \alpha - q_2 - \gamma q_1$. Plugging firm 1's monopoly quantity $q_1^M = \alpha/2$ and solving for q_2 in terms of p_2 gives the firm 2's demand function, $q_2 = \alpha(2-\gamma)/2 - p_2$. In contrast, in Bertrand competition, firm 2's demand function is $q_2 = a - dp_2 + cp_1$, where with $\delta = 1 - \gamma^2$, $a = \alpha(1-\gamma)/\delta$, $b = 1/\delta$, $c = \gamma/\delta$. Plugging $p_1^M = \alpha/2$, $a = \alpha(1-\gamma)/\delta$, $b = 1/\delta$, $c = \gamma/\delta$, and rearranging the equation, firm 2's demand function in Bertrand competition is $q_2 = \{\alpha(2-\gamma)/2 - p_2\}/(1-\gamma^2)$. With $0 < \gamma < 1$, when firm 1 behaves as a monopolist, firm 2's demand function is larger in Bertrand competition than in Cournot competition. Although firm 1 behaves as a monopolist, since, depending upon the modes of competition, firm 2 faces a different incentive, the demand functions are not identical in both cases. Since demand is larger in Bertrand competition than in Cournot competition, firm 2 can reap larger profit in Bertrand competition. This means that for blockaded entry, the entry cost should be larger in Bertrand competition than in Cournot competition.

Proposition 3. With $0 < \gamma < 1$, $CV_{BD}^B > CV_{BD}^C$ holds. Therefore, it is easier to blockade the entry in Cournot competition than in Bertrand competition.

We now consider the case where blockaded entry does not occur. For

this, we compare two critical values, $CV_{DA}^C = \frac{\alpha(2-\gamma)}{4} - \frac{\sqrt{2\alpha\gamma}\sqrt{\gamma(4-3\gamma)(2-\gamma^2)}}{8(2-\gamma^2)}$ and $CV_{DA}^B = \frac{\alpha(2-\gamma)}{4\sqrt{(1-\gamma^2)}} - \frac{\sqrt{2\alpha\gamma}\sqrt{\gamma(1+\gamma)(2-\gamma^2)(4+\gamma-\gamma^2)}}{8(2-\gamma^2)\sqrt{(1-\gamma^2)}(1+\gamma)}$. Since both CV_{DA}^C and CV_{DA}^B contain

α , it is convenient to compare CV_{DA}^C/α and CV_{DA}^B/α . Both CV_{DA}^C/α and CV_{DA}^B/α are functions of γ only. First of all, when γ equals 0, both CV_{DA}^C and CV_{DA}^B equal $\alpha/2$. With $\gamma=0$, products 1 and 2 are completely independent ones so that there exists no strategic interaction at all. Hence in entry decision, in both Cournot and Bertrand competition, firm 2 simply compares the post-entry monopoly profit $\alpha^2/4$ and the entry cost, k . Whenever the former exceeds the latter, entry occurs regardless of firm 1's choice. Therefore, with $\gamma=0$ it is not surprising that CV_{DA}^C and CV_{DA}^B are identical and equal to $\alpha/2$. With $0 < \gamma < 1$, both CV_{DA}^C and CV_{DA}^B are very complicated functions of γ . With a very lengthy and tedious calculation, it can be shown that both CV_{DA}^C and CV_{DA}^B are decreasing in γ and they intersect with each other only once in $0 < \gamma < 1$. For the purpose of comparison, it is better to draw CV_{DA}^C/α and CV_{DA}^B/α over the range of $0 < \gamma < 1$. Using Mathematica, the picture is as follows:

[Figure 4] Comparison of CV_{DA}^C/α and CV_{DA}^B/α

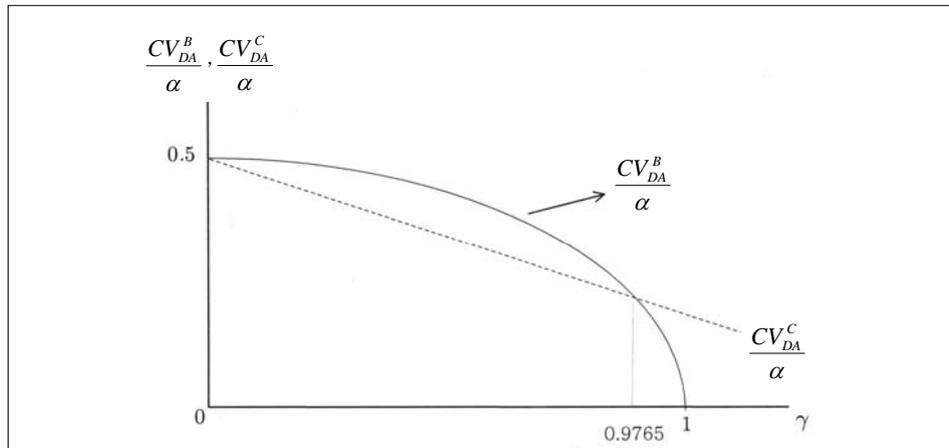


Figure 4 shows that $CV_{DA}^C/\alpha = CV_{DA}^B/\alpha$ holds at $\gamma \approx 0.9765$. This critical value of γ is denoted by γ^* . With $\gamma < \gamma^*$, $CV_{DA}^C/\alpha < CV_{DA}^B/\alpha$ holds so that like in blockaded entry, it is easier to deter the entry in Cournot competition than in Bertrand competition. With $\gamma > \gamma^*$, however, since $CV_{DA}^C/\alpha > CV_{DA}^B/\alpha$ holds so that entry deterrence becomes easier in Bertrand competition than in Cournot competition. The intuition behind this result is as follows. As γ is closer to 1, the degree of product differentiation becomes smaller. In the extreme case of $\gamma=1$, two products become the homogeneous product. In homogeneous good market with constant marginal costs, the equilibrium price in Bertrand competition is the same as the marginal costs, which implies that post-entry profit is zero for firm 2. Therefore, as long as the entry cost is positive, firm 2 never enters the market in Bertrand competition. In Cournot competition, however, the post-entry profit is larger than 0. Hence, even though the entry cost is positive, as long as it is less than the post-entry profit, the entry occurs in Cournot competition. Therefore, when γ is sufficiently close to 1 ($\gamma > \gamma^*$), firm 1 can deter the entry more easily in Bertrand competition than in Cournot competition. In the opposite case ($\gamma < \gamma^*$) where two products are differentiated to some degree, like blockaded entry, since prices are strategic substitutes, it is in potential entrant's interest to compete with price. Hence, with some degree of product differentiation, it is easier to deter the entry in Cournot competition than in Bertrand competition.

Proposition 4. When two products are sufficiently close substitutes, it is easier to deter entry in Bertrand competition. However, two products are differentiated to some degree, it is easier to deter the entry in Cournot competition.

IV. CONCLUSION

We investigate the way how the modes of competition affect the incentive of entry deterrence in a differentiated product market. It is first shown that it is always easier to blockade the entry in Cournot competition. On the contrary, in case of entry deterrence, it depends upon the degree of differentiation between two products. As long as two

products are differentiated to some degree, like blockaded entry, it is easier to deter the entry in Cournot competition. However, when two products are very close substitutes, it is easier to deter the entry in Bertrand competition. This result may have some implication for firm's strategy choice. First, the degree of product differentiation is given in our model. But if it is a choice variable, the mode of competition will affect the level of product differentiation chosen by the incumbent firm for the purpose of entry deterrence. Second, the type of strategy (-quantity or price-) is given in our model. If it is again a choice variable, given the degree of product differentiation, the incumbent firm has preference of one strategy over another so that it will choose the preferred one.

In the paper, this result was derived from the linear demand and constant marginal cost case. It will be an interesting future research agenda to examine whether the same result holds under general demand and cost functions. Also to extend the model into the one with incomplete information will be another interesting subject in future research.

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