BERTRAND COMPETITION AND THE CHOICE OF INPUTS

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INTRODUCTION

Industrial organization economists are interested in firms' choices concerning the degree of product differentiation. Within a given market a high degree of product differentiation may result in positive economic profits and entry in a model of monopolistic competition. We can understand the word entry in two ways. One possibility is that firms not currently in the market begin producing products similar to those of existing firms. The second possibility is that firms in the market expand or alter their product lines to fill gaps in the product space. Firms engage in research and product development to fill gaps in the product space and establish quality or vertical differentiation. When one firm develops a superior product, i.e. a higher quality product, competitors face a tradeoff when mimicking the product improvement. Consumers' willingness to pay is higher for higher quality, and firms may be able to increase prices. Mimicking quality leads to a decrease in product differentiation and an increase in price competition. The final impact on prices and profits is not immediately clear.

Examples of product differentiation and product improvement are readily available in the carbonated beverage and snack food markets. Introduction of NutraSweet in diet soft drinks, and the development of Olestra for fat replacement are clear attempts at product improvement. If some brands adopt new inputs (e.g. ingredients for snack foods) while other do not this leads to an increase in product differentiation. It is unclear then whether or not all firms will adopt the higher quality input.

In this paper I provide some partial results aimed as answering the question of whether or not all downstream firms will adopt a new input from an upstream firm. I consider a downstream differentiated product duopoly. An upstream firm introduces an input, which, if used in production, increases the consumers' willingness to pay for the final product.

BASIC SETUP

I take as a benchmark some of the results of Singh and Vives (1984) who build on the differentiated duopoly market earlier proposed by Dixit (1979). Firms 1 and 2 (i and j) sell to a representative consumer with the following utility function,

$$U = \alpha_1 q_1 + \alpha_2 q_2 - (\beta_1 q_1^2 + 2\gamma q_1 q_2 + \beta_1 q_2^2)/2,$$

where α_i, β_i, $\beta_1\beta_2-\gamma^2$, and $\alpha_i\beta_j-\alpha_j\gamma^2$, are all positive. From the utility function we can find the direct demand function,

$q_i=a_i-b_ip_i+cp_j$,

where p_i and p_j are the respective prices and we define $a_i = \dfrac{\alpha_i\beta_j - \alpha_j\gamma}{\delta}$, $b_i = \beta_j/\delta$, and $c = \gamma/\delta$, where $\delta = \beta_1\beta_2 - \gamma^2$.

When price is the strategic variable firm i sets an equilibrium price of

$p_i^e = (2a_ib_j+a_jc+b_jcm_j+2b_ib_jm_i)/D$,

where $D=4b_1b_2 -c^2$ and m_i and m_j are the constant marginal costs. I assume that both firms have the same marginal cost, and I normalize this to zero. The equilibrium per firm quantity is,

$q_i^e=(2a_ib_j+a_jc+b_jcm_j+2b_ib_jm_i)b_i/D$.

The equilibrium profit for firm i is

$PROFIT=b_i(2a_ib_j+a_jc)^2/D^2$.

Now we can consider the impact of the introduction of an alternate input. Suppose an upstream firm develops a new input for production, which, when used alters the utility of the representative consumer. Specifically, a good made with the alternate input gives the consumer additional utility. If both firms adopt the new input the utility function is given by

$$U = A_1q_1 + A_2q_2 - (\beta_1q_1^2 + 2\gamma q_1q_2 + \beta_1q_2^2)/2,$$

and if only firm 1 adopts the new input the utility function is

$$U = A_1q_1 + \alpha_2q_2 - (\beta_1q_1^2 + 2\gamma q_1q_2 + \beta_1q_2^2)/2,$$

where $A_i > \alpha_i$. For notational convenience let $K_i=A_i-\alpha_i$. We want to consider whether both firms will choose to adopt the new input. Alternatively, if one firm adopts the new input the other firm may decide not to do so in order to take advantage of an increase in product differentiation that softens price competition.

CHOICE OF INPUT

Adopting the new input may appear at first glance to be a dominant strategy. However, if we assume that use of the new input results in higher marginal cost then it is unclear what either firm should do when its rival adopts the new input. I consider a special case where the firms are symmetric, i.e. $a_1=a_2=a$, and $b_i=b_j=b$. I also assume

that the marginal cost of production using the new input is m>0. We already have the benchmark where neither firm uses the new input; we need to consider three more cases.

First, if firm i does not adopt the new input while firm j does adopt the new input then profit to firm i will be

$PROFIT1 = b(2b(a-Kc)+(a+Kb)c+bcm)^2/D^2$.

Second, if firm i adopts the new input but firm j does not, the profit to firm i will be

$PROFIT2 =$
$(2b(a+Kb)+(a-Kc)c-2b^2m+mc^2)(2b^2(a+Kb)+(a-Kc)bc-2b^3m+bmc^2)/D^2$
$= b(2b(a+Kb)+(a-Kc)c-2b^2m+mc^2)^2/D^2$.

Lastly, if both firms adopt the new input then profit to each will be

$PROFIT3 = b(2ab+ac+2b^2(K-m)-c^2(K-m)+bc(m-K))^2/D^2$.

Comparing the terms we see that PROFIT2>PROFIT3>PROFIT>PROFIT1, when m<K. This implies that both firms have a dominant strategy to adopt the new input.

SUMMARY

This note provides some preliminary insights into the choice of adoption of a new input for duopolists in a differentiated goods market. I have only considered the most straightforward case where the firms are symmetric and shown that the firms' dominant strategy is to adopt the new input. An obvious extension is to consider the case where there are asymmetries between the firms, which is on the agenda for future research.

REFERENCES

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