

# Advance Competition Strategy and Consumer Behavior Analysis

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**Abstract**—This paper analyzes the rules and conditions of advance and spot competition equilibrium. Then it focuses on how consumer's behavior effects the optimal decisions in the mix competition equilibrium. Further, it finds out that how different type of consumer behavior choose in different situations, such as, if consumer's difference becomes high, firm's optimal advance price increases but its optimal total revenue decrease, which means that neither consumers nor firms would like to this situation etc.

**Keywords**—Advance competition; Strategy; Consumer behavior; Analysis

## I. INTRODUCTION

Nowadays, due to more intense market competition, kinds of new retailing strategies have come out in the whole world, especially in China. Advance selling strategy has become common in online markets, such as Taobao, Jingdong, and many other wechat business. On the other hand, diversified marketing tools have been integrated into advance selling both online and offline market and make the competition more intense and complicated. In this paper, it focuses on some problems as follows:

- If consumer's advance demand utility and spot demand utility vary widely, what will happen when the mix competition equilibrium realize?
- When this mix competition equilibrium happens, if consumer's homogeneity is high, what will happen when some other variables change? Further, if both high consumer's homogeneity and that "consumer's advance demand utility and spot demand utility vary widely" exist at the same time, what it can conclude? etc.

Xie and Shugan (2001) has proven that monopolies can earn more profits by advance-selling than by selling exclusively on the spot. Later in 2005 they continued to assume that the firms sell either in advance or on the spot but not in both periods, which means that consumers are not forward looking. However, this paper allows firms to sell in both periods, and it assume that consumers are forward looking. Therefore, competitiveness in the spot period will reduce spot period prices and influence firms' advance revenues. Further, the diversified marketing tools will influence firm's spot prices and revenues too.

When customers make an order in advance, most of them are uninformed, and they are willing to pay at most their expected value for the product or service. Later, when consumers purchase on the spot, their exact values for the product are usually different across consumers. Someone value the product more than others, and no consumer would like to pay more than his realized value.

## II. ADVANCE COMPETITION MODEL

### A. Basic Model

At advance period, consumer's expected value is  $V$ , where  $V \in \{v_L, v_H\}$ ,  $v_H \geq v_L > 0$ , and the expected value of consumer's preferred product is  $E[V] = \frac{1}{2}(v_L + v_H)$ , here

$\beta = \frac{v_L}{v_H}$  which means that the value of  $v_L$  relative to  $v_H$ .

The spot price is  $v_H = \frac{2E(V)}{\beta + 1} \left( \beta = \frac{v_L}{v_H} \in \left(0, \frac{1}{2}\right) \right)$  without

marketing tools, and it assumes that  $\beta = \frac{v_L}{v_H} \in \left(0, \frac{1}{2}\right)$ ,

which means  $v_H \geq 2v_L$ . On the other hand, it defines  $\alpha$  as the probability that a customer attaches for preferring firm 1 in the advance period after processing his information, therefore  $(1 - \alpha)$  is the probability that the same consumer would like to prefer firm 2. here, assume that  $\alpha$  is a uniform random variable, i.e.  $\alpha \sim U\left[\frac{1-\delta}{2}, \frac{1+\delta}{2}\right]$  where  $\delta \in [0, 1]$  means the

range of the distribution above. As  $\delta$  increases, consumers become more heterogeneous about their knowledge which helps consumers better evaluate their eventual preference, before making their advance period purchasing decisions

Consumer's individual rationality constraint (IR) about preferring firm 1 is,  $\alpha_1 E[V] - p_1 \geq 0$  which means

$\alpha_1 \geq \frac{p_1}{E[V]}$ . Consumer's incentive compatibility constraint

(IC) about preferring firm 1 is,  $\alpha_1 E[V] - p_1 \geq (1 - \alpha_1) E[V] - p_2$  which means

$\alpha_1 \geq \frac{1}{2} \left( 1 + \frac{p_1 - p_2}{E[V]} \right)$  . It can conclude that  $\alpha_1 \geq \max \left\{ \frac{p_1}{E[V]}, \frac{1}{2} \left( 1 + \frac{p_1 - p_2}{E[V]} \right) \right\}$  . If  $\frac{1}{2} \left( 1 + \frac{p_1 - p_2}{E[V]} \right) \geq \frac{p_1}{E[V]}$  , which means that  $p_1 + p_2 \leq E[V]$  . On the other hand, if  $p_1 + p_2 > E[V]$  , which means that  $\frac{1}{2} \left( 1 + \frac{p_1 - p_2}{E[V]} \right) < \frac{p_1}{E[V]}$  .

Similarly, consumer's individual rationality constraint about preferring firm 2 is,  $(1 - \alpha_2)E[V] - p_2 \geq 0$  which means  $\alpha_2 \leq 1 - \frac{p_2}{E[V]}$  . Consumer's incentive compatibility constraint about preferring firm 2 is,  $(1 - \alpha_2)E[V] - p_2 \geq \alpha_2 E[V] - p_1$  which means  $\alpha_2 \leq \frac{1}{2} \left( 1 + \frac{p_1 - p_2}{E[V]} \right)$  . So it can conclude that  $\alpha_2 \leq \min \left\{ 1 - \frac{p_2}{E[V]}, \frac{1}{2} \left( 1 + \frac{p_1 - p_2}{E[V]} \right) \right\}$  . If  $\frac{1}{2} \left( 1 + \frac{p_1 - p_2}{E[V]} \right) \leq 1 - \frac{p_2}{E[V]}$  , it can find  $p_1 + p_2 \leq E[V]$  . On the other hand, if  $p_1 + p_2 > E[V]$  , it can find that  $\frac{1}{2} \left( 1 + \frac{p_1 - p_2}{E[V]} \right) > 1 - \frac{p_2}{E[V]}$  . Assume  $\hat{\alpha} = \frac{1}{2} \left( 1 + \frac{p_1 - p_2}{E[V]} \right)$  ,  $\underline{\alpha} = 1 - \frac{p_2}{E[V]}$  ,  $\bar{\alpha} = \frac{p_1}{E[V]}$  , it can conclude from the analysis above some conclusions as follows:

If  $p_1 + p_2 \leq E[V]$  , all consumers purchase in advance from either firm 1 or firm 2 (Figure 1), and none of them would like to buy from spot market. All consumers with  $\alpha \geq \hat{\alpha}$  buy from firm 1 in advance and all consumers with  $\alpha \leq \hat{\alpha}$  buy from firm 2 in advance.

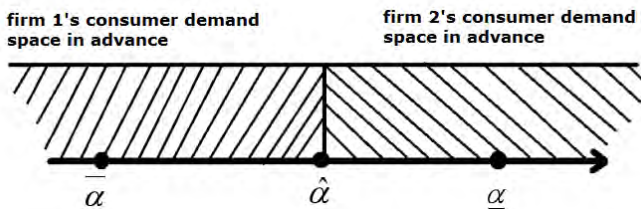


Fig. 1 Consumer's demand space with  $p_1 + p_2 \leq E[V]$

If  $p_1 + p_2 > E[V]$  , all consumers are divided three types (Figure 2): consumers with  $\alpha \geq \alpha$  buy from firm 1 in advance and consumers with  $\alpha \leq \bar{\alpha}$  buy from firm 2 in

advance. However, consumers with  $\bar{\alpha} \leq \alpha \leq \alpha$  would like to wait until spot market opens.

If  $p_1 + p_2 \leq E[V]$  , consumer's advance demand is  $F(\hat{\alpha}(p_1, p_2))$  from firm 2 and consumer's advance demand is  $\bar{F}(\hat{\alpha}(p_1, p_2)) = 1 - F(\hat{\alpha}(p_1, p_2))$  from firm 1. where  $F(\bullet)$  is the cdf of  $\alpha$  . If  $p_1 + p_2 > E[V]$  , consumer's advance demand is  $\bar{F}(\bar{\alpha}(p_1))$  from firm 1 and consumer's advance demand is  $F(\underline{\alpha}(p_2))$  from firm 2. And, those consumers who give up advance demand and buy from spot market's realized spot value is  $V = v_H$  which occurs with probability 0.5. The spot market demand from firm 1 is  $D_1^s = \int_{\bar{\alpha}}^{\alpha} \frac{\alpha}{2} dF\alpha$  , and the spot market demand from firm 2 is  $D_2^s = \int_{\bar{\alpha}}^{\alpha} \frac{1 - \alpha}{2} dF\alpha$  .

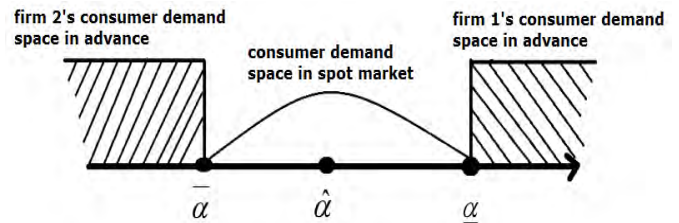


Fig. 2 Consumer's demand space with  $p_1 + p_2 > E[V]$

In figure 1, all of consumers' demand is in the range of  $(\alpha_1, \alpha_2)$  , and the revenue of firm 1 is

$$\Pi_1(p_1; p_2) = p_1 \times \frac{1}{\delta} \times \left( \frac{1 + \delta}{2} - \hat{\alpha} \right) = \frac{p_1}{2\delta} \left( \delta - \frac{p_1 - p_2}{E(V)} \right);$$

the revenue of firm 2 is

$$\Pi_2(p_1; p_2) = p_2 \times \frac{1}{\delta} \times \left( \hat{\alpha} - \frac{1 - \delta}{2} \right) = \frac{p_2}{2\delta} \left( \delta - \frac{p_2 - p_1}{E(V)} \right).$$

In figure 2, all of consumers' demand is in the range of  $(\alpha_1, \alpha_2, \alpha_s)$  , and the revenue of firm 1 is

$$\Pi_1(p_1; p_2) = p_1 \times \frac{1}{\delta} \times \left( \frac{1 + \delta}{2} - \frac{p_1}{E(V)} \right) + \frac{2E(V)}{\beta + 1} D_1^s;$$

the revenue of firm 2 is

$$\Pi_2(p_1; p_2) = p_2 \times \frac{1}{\delta} \times \left( \frac{1 + \delta}{2} - \frac{p_2}{E(V)} \right) + \frac{2E(V)}{\beta + 1} D_2^s$$

### B. Advance Competition Equilibrium

Firstly, in the range of  $(\alpha_1, \alpha_2)$  (which means the area that all consumers buy from advance market), firm 1 and firm 2 join in advance competition which means that

$$p_1 + p_2 \leq E[V], \text{ and firm 1's profit function is}$$

$$\Pi_{11} = \frac{p_1}{2\delta} \left( \delta - \frac{p_1 - p_2}{E(V)} \right), \text{ firm 2's profit function is}$$

$$\Pi_{21} = \frac{p_2}{2\delta} \left( \delta - \frac{p_2 - p_1}{E(V)} \right). \text{ By derivation it finds}$$

that  $p_{11}^* = p_{21}^* = \delta E[V]$ , and two firms realize maximal revenues.

Secondly, in the range of  $(\alpha_1, \alpha_2, \alpha_s)$  (which means the area that some consumers buy from advance market, the others buy from spot market), firm 1 and firm 2 join in both advance competition and spot market, which means that

$$p_1 + p_2 \geq E[V], \text{ and firm 1's profit function is}$$

$$\Pi_{12}(p_1; p_2) = p_1 \times \frac{1}{\delta} \times \left( \frac{1+\delta}{2} - \frac{p_1}{E(V)} \right) + \frac{2E(V)}{\beta+1} \int_{\frac{1-p_2}{E(V)}}^{\frac{p_1}{E(V)}} \alpha dF\alpha.$$

By derivation it finds that  $p_{12}^* = p_{22}^* = \frac{(1+\delta)(\beta+1)E(V)}{2(2\beta+1)}$ . In

Cachon, G. P. & Feldman, P. (2017) it has given the detailed analysis, and the conclusion is as follows in Theorem 1.

#### Theorem 1 In the range of

$$0 < \delta \leq \frac{5+10\beta+\beta^2-2\sqrt{1+\beta-3\beta^2-\beta^3+2\beta^4}}{7+18\beta+7\beta^2}, \text{ the}$$

advance competition equilibrium realizes at the point of

$p_{11}^* = p_{21}^* = \delta E[V]$ , and all firms joins in advance competition, none of them would like to compete in spot market; in the range of

$$\frac{5+10\beta+\beta^2-2\sqrt{1+\beta-3\beta^2-\beta^3+2\beta^4}}{7+18\beta+7\beta^2} < \delta \leq \frac{1}{2}, \text{ firms}$$

would compete in both advance competition and spot market, and the competition equilibrium realizes at the

point of  $p_{12}^* = p_{22}^* = \frac{(1+\delta)(\beta+1)E(V)}{2(2\beta+1)}$ ; Further, in the

$$\text{range of } \left[ \delta_2(\beta), \frac{5+10\beta+\beta^2-2\sqrt{1+\beta-3\beta^2-\beta^3+2\beta^4}}{7+18\beta+7\beta^2} \right],$$

both of the two competition equilibrium exist. Besides, in

the range of  $\delta < \frac{1+2\beta-\beta^2}{(1+\beta)^2}$  both of the firms will

compete only on spot market.

### III. CONSUMER'S BEHAVIOR ANALYSIS AND CONCLUSIONS

#### A. Parameter analysis

What this paper cares about mostly is that, how consumer's behavior and marketing tools effect advance competition. From theorem 1 it can get figure 5 as follows:

In figure 3, curve① refers to  $\delta = \frac{2\beta+1}{\beta+1} - 1$  which comes

from  $p_1 + p_2 \geq E[V]$ ; curve② refers to  $\delta = \delta_2(\beta)$  which comes from Cachon, G. P. & Feldman, P. (2017)'s conclusion; curve③ refers to

$$\delta = \frac{5+10\beta+\beta^2-2\sqrt{1+\beta-3\beta^2-\beta^3+2\beta^4}}{7+18\beta+7\beta^2}; \text{ and}$$

curve④ refers to  $\delta < \frac{1+2\beta-\beta^2}{(1+\beta)^2}$ . It can conclude that:

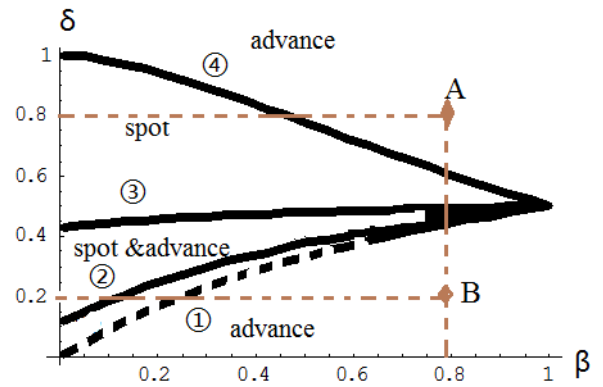


Fig.3 Areas in the  $(\delta, \beta)$  parameter space for which kind of competition is better for two firms

Firstly, the more smaller of the parameter  $\beta$ , the more lower of advance utility, and the more higher of spot utility. All of these mean that as the parameter  $\beta$  increases, consumer's behavior choice becomes more single, and firms could make better predict about consumer's behavior.

Secondly, if  $\beta = 0.8$  in Figure 3, both of point A and point B refers to durable consumer goods industry such as rice, toilet paper, grain and oil, etc. All of these industries produce basic needs in our life, which means  $v_H$  is close to  $v_L$ , that is

$\beta > \frac{1}{2}$ . At this time, if consumers are highly homogeneous

which refers to point B, such as  $\delta = 0.2$  &  $\beta = 0.8$ , if the advance price decreases a little, consumer's behavior would be very sensitive to it, and advance demand will be strong; if consumers are highly heterogeneous, which refers to point A, such as  $\delta = 0.8$  &  $\beta = 0.8$ , consumer's behavior would also be very sensitive to advance price.

Usually, durable consumer goods industries are very mature, they have stable and strong demand quantity, and their profit margins are not too high. So the gap between advance price and spot price is not too big, which is in accordance with the reality.

Thirdly, at the point of  $\beta = 0.1$  &  $\delta = 0.2$ , consumers are highly homogeneous, advance and spot competition happens together; at the point of  $\beta = 0.2$  &  $\delta = 0.8$ , consumers are highly heterogeneous, only spot competition happens at this time.

Fourthly, if  $\delta = 0$ , the equilibrium price is  $p_1^* = p_2^* = 0$ , which means that all consumers will buy from advance market, and both of the firms' revenues are close to zero.

Finally, kinds of promotion tools on both advance and spot market make consumer's repeat purchase behaviors increase, such as cups, slippers, even mobile phones, etc. All of that promote the total consumer demands in some way, and make price become more cheaper, or push product's quality become better, due to the more violent competition.

**B. Price and Revenue analysis**

It assumes that  $E[V] = 500$ , the advance price's curve in both advance and spot equilibrium in figure 6, and the optimal revenue's curve is in figure 5.

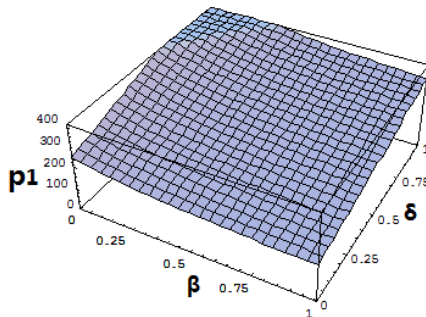


Fig. 4 Firm 1's optimal advance price's curve

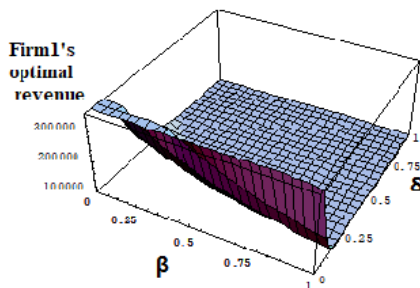


Fig. 5 Firm 1's optimal total revenue's curve

As the parameter  $\beta$  increases, firm 1's optimal advance price decreases slowly; and it increases significantly as the parameter  $\delta$  increases. However, firm 1's optimal total revenue decreases as the parameter  $\beta$  increasing, and the same rule happens as the parameter  $\delta$  increases. So if consumer's advance demand utility and spot demand utility vary widely ( $\beta$  is small), both firm 1's optimal advance price and optimal total revenue are high. If consumer's difference becomes high ( $\delta$  is getting bigger), firm 1's optimal advance price increases but its optimal total revenue decrease, which means that neither consumers nor firms would like to this situation.

This paper's future research orientation will focus on how marketing tools affect the mix competition equilibrium, etc.

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