E-Commerce Pricing Strategies under Costs Structures Different with Traditional Retailers

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Abstract: With the rapid development of internet, e-commerce has experienced great progress during the last decades. It has been proved that e-commerce is different with traditional retailers in both its sale channels and cost structure. Faced with the same demand, there exists competition between e-commerce and traditional commerce. The main concern of this thesis is to show how the completion influences the price strategies. It is found by a two-stage game model that the share of the population with internet access has influence on the competition behavior, which conforms to the reality.

Keywords: electronic commerce; retailer; costs; pricing strategy; game theory

1 Introduction

With the rapid development of internet, e-commerce has experienced great progress during the last decades. We know that e-commerce is different with traditional retailers in both its sale channel and costs, so it is of great value to study the completion between traditional retailers and e-commerce retailers, especially through a theoretical framework.

Recent research in electronic commerce conducted can be divided into empirical research and theoretical analysis. Previous empirical researches have focused on the comparison of price of the same products between traditional and e-commerce, which has yielded conflicting results. For example, J.P. Bailey compared the prices for books, CDs, and software sold in conventional offline and on the Internet channels in 1996 and 1997. He found higher prices in online channels for each product category.[1] But F. Ancarani and S. Venkatesh found that the prices of books and CDs in Italy were lower at e-commerce retailers than at traditional retailers by about 4-6%.[2] Clay et al., however, did not find any significant differences in the two channels for books, noting that the unit prices in online and physical bookstores during the week of April 19, 1999 were the same.[3] Theoretical research has tried to construct a model to explain why the conflicting results exists. Balasubramanian showed a strategic analysis of competition between a traditional store and a e-commerce store focusing on the role of information and market coverage,[4] while Bakos and Harrington analyzed the relation between search costs and product price in electronic marketplaces through a circular city model.[5,6] Se-Hak Chu tried to use a game theory to analyze illustrate the pricing strategies.[7]

Our research work is based on Se-Hak Chu's initial model which has give us good understanding the pricing difference. It is discovered that some assumptions of Se-Hak Chu's do not conform to realities, which cannot be neglected. For example, he didn't consider different costs between traditional retailers and e-commerce retailers, which really exists and is very essential.[8] We believe the costs structure of retailers will influenced their pricing strategies. So we construct a two-stage game model in consideration of different cost structures to illustrate that pricing difference. In the first stage, the two retailers set prices, and then, consumers choose the best way to buy the products, through e-commerce retailer or traditional retailer.

2 Model

2.1 Hypothesis

The hypothesis of our model include assumptions that describe the market, retailers and consumers, many of which are the same to Se-Hak Chu's model[7], except for the cost structure.

1) About market

We propose that the market locates at a linear city of length $\bar{s}$ where there is only one traditional retailer (denoted by t in the following article) at the end of the city.

At the same time, we assume that there is also only one pure e-commerce retailer (denoted by e in the following article) that sells the same goods with the traditional retailer without physical location.

The market is composed of consumers that distributed uniformly along the city, which means that at each location, the quantity of consumers is the same. Meanwhile we propose that a fraction of consumers at each location point, m, have access to the Internet, while others, $1-m$, do not have access to the Internet.

The above assumptions conform to those of Se-Hak Chu's model. [7]

2) About the two retailers

As is mentioned above, there is only one traditional

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retailer and e-commerce retailer. We assume that the two retailers have the profit functions as follows:

$$\begin{cases}\Pi_t(P_t,P_e)=(P_t-c_t)D_t-C_t\\ \Pi_e(P_t,P_e)=(P_e-c_e)D_e-C_e\end{cases} \quad (1)$$

In Equation (1), P_t and P_e are the prices charged by traditional retailer and e-commerce retailer respectively; D_t and D_e are the demand of the tow retailers'; c_t and c_e are their variable costs, while C_t and C_e are the retailers' fixed cost.

Let $\Delta c = c_t - c_e$, which represents the difference of the variable costs. From these assumptions, we can know that Equation (1) suggests that the profits of retailers are the difference between sales and costs, which is different from Se-Hak Chu's model. [7]

And finally, we believe the behavior of retailers is to maximize their profits, which is a general assumption for economic analysis.

3) About the consumers

Each consumer's utility function is as follows:

$$U=\begin{cases}V-P_t-ts & \text{if he buys from the offline firm}\\ V-P_e-a & \text{if he buys from the online firm}\\ 0 & \text{if he dose not buy}\end{cases} \quad (2)$$

Here, V is the valuation each consumer has on the goods, which is same no matter he choose where to buy the good.

At the same time, t represents the transportation cost per unit of length; s is the distance between consumers and traditional retailer, that is, his location; a represents the search costs and other costs related to quality uncertainty.

It is believed that consumers will act to maximize their utility.

Of course, the consumer will buy the goods only if $U>0$, and we assume the city is so long that some consumers opt not to buy the good. These assumptions can be expressed as follows:

$$\begin{cases}P_t \le P_e + a\\ V-P_e-a \ge 0\\ \bar{s} \ge (V-P_t)/t\end{cases} \quad (3)$$

The former two conditions not satisfied means that the consumer won't buy the goods because it cannot bring any utility to the consumer. The last condition means that the city is so long that some consumers opt not to buy the goods. These three conditions are very natural to our analysis and it will be shown Equation (3) will be very useful in our following proof.

We can see that the assumptions concerning the consumers are the same to those of Se-Hak Chu's model.[7]

2.2 Model

Now, we will set up our model under the assumptions given above, including the purchasing choices of consumers, market demand of two retailers, and their equilibrium prices and equilibrium profits.

1) The purchasing choice of consumers

As there are only two retailers in the market and we assume consumers will act to maximize their utility, so each consumer will compare the utility of the two channels and decide how to buy. Fig.1 depicts the utility comparison for each consumer at different location.

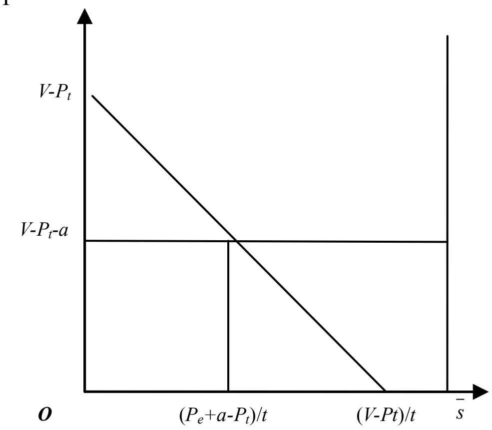

Figure 1 the utility of consumers at different location

According to Figure 1, we can get the purchasing choice for each consumer at different location illustrated by in Table.1.

Table.1 the choice of consumers at different location

location	Internet accessible	Internet in-accessible
$[0,\frac{P_e+a-P_t}{t}]$	Traditional	Traditional
$[\frac{P_e+a-P_t}{t},\frac{V-P_t}{t}]$	Electronic	Traditional
$[\frac{V-P_t}{t},\bar{s}]$	Electronic	No shopping

2) The market demand of retailers

According to the choice of consumers at different location and the distribution of consumers who can access to Internet, we will get the demand functions of traditional retailer and e-commerce retailer as follows:

$$\begin{cases}D_t=\dfrac{m(P_e+a-P_t)}{t}+\dfrac{(1-m)(V-P_t)}{t}\\ D_e=m\left(\bar{s}-\dfrac{P_e+a-P_t}{t}\right)\end{cases} \quad (4)$$

3) The equilibrium prices and profits of retailers

Given the profit functions Equation (1) and the demand functions Equation (4) the profit functions are as follows:

$$\begin{cases}\Pi_t(P_t,P_e)=(P_t-c_t)D_t-C_t\\ =(P_t-c_t)\left[\dfrac{m(P_e+a-P_t)}{t}+\dfrac{(1-m)(V-P_t)}{t}\right]-C_t\\ \Pi_e(P_t,P_e)=(P_e-c_e)D_e-C_e\\ \qquad =(P_e-c_e)\left[m\left(\bar{s}-\dfrac{P_e+a-P_t}{t}\right)\right]-C_e\end{cases} \quad (5)$$

As the assumption of retailers' will maximize their profits, we can determine the first derivative condition of Equation (5) on m ($d\Pi/dP=0$). Then we get the equilibrium prices functions of both traditional retailer and e-commerce retailer as follows:

$$\begin{cases} P_t^* = \dfrac{2(2-m)c_t + mc_e}{4-m} + \dfrac{[m+2(1-m)k_t]X}{4-m} \\ P_e^* + a = \dfrac{c_t + (3-m)c_e}{4-m} + \dfrac{[2+(1-m)k_e]X}{4-m} \end{cases} \quad (6)$$

Here, we let $X = t\bar{s} + a$ present transaction costs of traditional retailer and e-commerce retailer. Also we define $k_t = (V-c_t)/X$ and $k_e = (V-c_e)/X$. In other words, k_t represents the traditional retailer's ratio of valuation relative to transaction and k_e is the e-commerce retailer's ratio of valuation relative to transaction.

Equation (4) to Equation (6) constitutes our basic model.

3. Conclusions

In this part we will discuss the influence of Internet penetration (m) on equilibrium prices and equilibrium profits. At the same time, we will discuss two extreme cases, when no people can access the Internet (denoted by $m=0$), and when all people can access the Internet (denoted by $m=1$), to show the equilibrium prices and profits.

1) Equilibrium prices

We determine the first derivation of Equation (6) on m. And on the condition of Equation (3), we can prove $dP_t^*/dm \le 0$ and $d(P_e^*+a)/dm \le 0$. These equations indicate that as more consumers have access to the Internet, both the traditional and e-commerce prices drop. That is to say, as more consumers access the Internet, the traditional retailer faces more competition from the e-commerce retailer and is forced to lower its price, which, in turn, puts downward pressure on the e-commerce retailer's price.

We also find variable costs will affect the retailers' prices and we divide this problem into two cases. One is when $c_t - c_e \le X$ and the other is when $c_t - c_e > X$.

When $c_t - c_e \le X$, it can be proved that there exists a critical point, m^* which divides the line into two parts. And when $m \le m^*$, $P_e^* \le P_t^*$, otherwise $P_e^* > P_t^*$, which has been depicted in Figure 2.

Figure 2 shows that when the difference between traditional retailer's variable costs and e-commerce retailer's variable costs is less than or equal to transaction costs, as the online market matures, the price of the e-commerce retailer tends to be higher than that of a traditional retailer. This conclusion is the same to Se-Hak Chu's model. [7]

In the other case, while $c_t - c_e > X$, we can prove no matter how high the Internet penetration is, $P_e^* \le P_t^*$. This conclusion can be depicted in Figure 3.

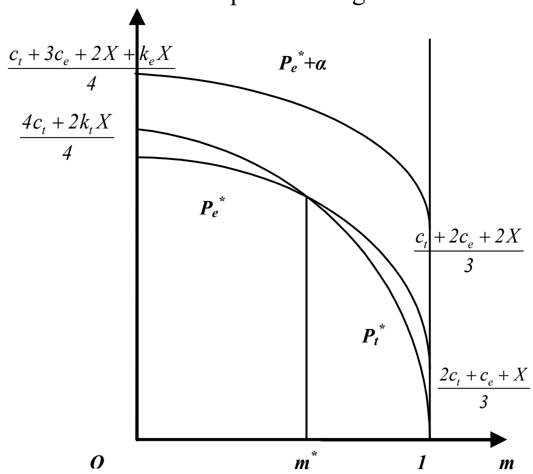

Fig.2. The influence of *m* equilibrium prices （ $c_t - c_e \le X$ ）

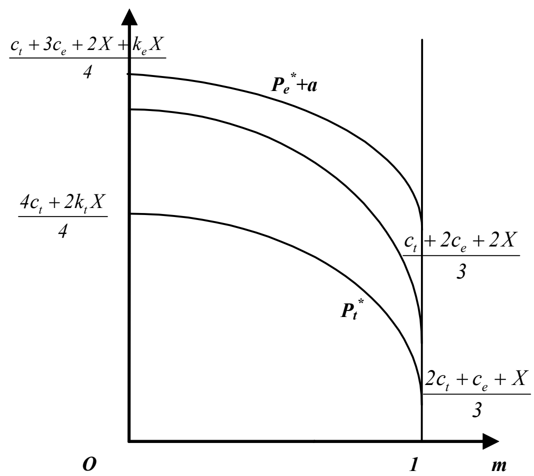

Figure 3. The influence of *m* equilibrium prices ($c_t - c_e > X$)

Figure 3 states that while the difference between traditional retailer's variable costs and e-commerce retailer's variable costs is more than transaction costs, the price of traditional retailer is always higher than e-commerce retailer.

2) Equilibrium profits

We determine the first derivation of Equation (5) on m. And on the condition of Equation (3), we can prove $d\Pi_t/dm \le 0$, which implies that the Internet may lead traditional retailer's welfare to decline. That is to say, with more and more people can access the Internet and purchase goods through e-commerce channel, the profit of traditional retailers will go down.

But we cannot prove the Internet access has the same influence on e-commerce retailer's profit, it seems like that the Internet has different influence on different level. We can prove that there exists $\tilde{m}$, while $m \le \tilde{m}$, $d\Pi_e/dm \le 0$, otherwise $d\Pi_e/dm > 0$. This

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conclusion can be depicted in Figure 4.

Figure 4 implies that while Internet penetration is less than or equal to $\tilde{m}$, e-commerce retailer's profits are positively correlated with *m*, and While Internet penetration is bigger than $\tilde{m}$, e-commerce retailer's profits are negative correlated with *m*. One possible reason might be the different cost structure. As can be seen in reality, e-commerce might experience a long period to be accepted by the consumers and also their suppliers, so the Internet access may have different influence at different period. Obviously this is a more real scenario.

It is worth mentioning that these two conclusions are different with those of Se-Hak Chu's model.[7],

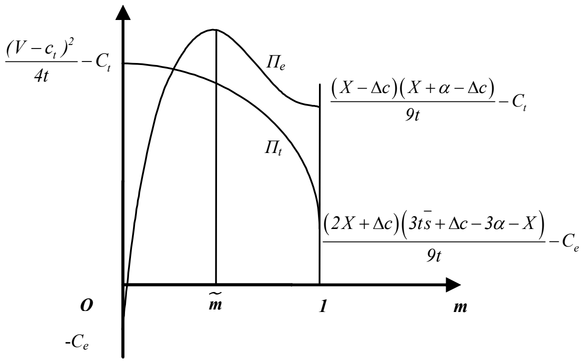

Figure 4. The influence of *m* on profits

while we believe this is more realistic.

3) Two extreme cases

Finally, let us discuss two extreme cases that are when nobody can access to the Internet and all the people can access to the Internet. Here we still emphasize on the equilibrium prices and profits.

If nobody can access to the Internet (that is, *m=0*), according to Equation (5), substituting *m* with 0, we will get Equation (7), which state the equilibrium profits for both the two retailers:

$$\begin{cases}\Pi_t(P_t,P_e)=(P_t-c_t)D_t-C_t=(V-c_t)^2/4t-C_t \\ \Pi_e(P_t,P_e)=(P_e-c_e)D_e-C_e=-C_e\end{cases} \quad (7)$$

This implies that while no one can access to the Internet e-commerce retailer's profit is negative, from which we can see that e-commerce retailer will not compete with traditional retailer unless there is enough people that can access the Internet.

In another extreme case, that is, while everyone access to the Internet, according to Equation (6), substituting *m* with 1, which state the equilibrium prices for both the two retailers:

$$\begin{cases}P_t^*(m=1)=(2c_t+c_e+X)/3 \\ P_e^*(m=1)=(c_t+2c_e+2X)/3\end{cases} \quad (8)$$

And we will get $P_e^*-P_t^*=(X-\Delta c)/3$, this equation states when everybody can access to the Internet, whose price is higher depends on the transaction costs and the difference between traditional retailer's variable costs and e-commerce retailer's variable costs.

According Equation (5) the profits of sellers can expressed as Equation (9), which means while all the people access the Internet, traditional retailer may exist in the market or withdraw from the market. And it depends on the costs' structure and size of traditional retailer. And there is a critical quantity, when Internet penetration is more than it, traditional retailer will withdraw. Market will become monopolistic where only e-commerce retailer exists.

$$\begin{cases}\Pi_t(P_t,P_e)=(P_t-c_t)D_t-C_t \\ \quad =(X-\Delta c)(X+a-\Delta c)/9t-C_t \\ \Pi_e(P_t,P_e)=(P_e-c_e)D_e-C_e \\ =(2X+\Delta c)(3t\bar{s}+\Delta c-3a-X)/9t-C_e\end{cases} \quad (9)$$

4. Summary

In this paper, we have analyzed different costs of retailer and extend the initial model of Se-Hak Chu. Though our model is more complicated than the initial one, we think our assumption is more close to reality. Compared with Se-Hak Chu' model, we have got the same conclusions of the influence of Internet on profit, but the conclusions of the influence on price are different. However, our study still has some limitations, such as this model may only apply to 'search goods'. Thus we anticipate establishing a model that can be applied to 'experience goods'.

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