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A Signaling Advertising Model Between an Intelligent Consumer and Two E-tailers

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Abstract Nowadays, by increasing sales forces' cost, trades shift more to e-business. In this paper, we present a signaling internet business model as a multi stage game. We consider two e-tailers and one intelligent consumer as players. The e-tailers can advertise or not, while, the consumer can search or not. The communication between one of the e-tailers and the consumer and also the interaction between the two e-tailers are considered as sequence at stages zero and one. We obtain Nash and Separating Equilibrium for each stage. Finally, Nash Equilibrium is obtained at stage two based on the historical impact of the players' actions. We show that in the signaling models when the game is not single shot, the good reputation is as important as advertising to signal about the product quality. In addition, searching and advertising costs have a great impact on the consumer and e-tailers' decisions.

Keywords: Advertising, B2C internet business models, Multi stage games, Reputation.

1. Introduction

With the rapid development of the Internet, many retailers as e-tailers have been using online technology to sell their products in e-business. There is no need to have physical place and this eliminates the sale's costs such as the sales force and the location's costs. Time and location independent business gives freedom to customers to shop in their own convenience without traveling. Consumers have the freedom to shop online without time limitation.

However, e-business is a threat to the e-tailers and the consumers. First, from the consumer point of view, there is no reliable tool to assess the products attributes and qualities since they cannot touch and feel the products. Second, the e-tailers have to pay more attention to effective ways for sale such as advertisements and since they cannot use their sales skills, the consumers can switch to another e-tailer easily without buying the product. Considering the effect of return on consumer's purchase intention could be considered as one of sales' skill (Pei et al., 2014).

One of the most inertial theories in the field of advertising refers to the signaling role of advertising that is based on Nelson's theory (Milgrom and Roberts, 1986; Nelson, 1974; Horstmann and MacDonald, 2003). The e-tailers should find a more effective way for signaling their consumers. These signals could be used to show the quality of the product and would be transmitted to the consumers by either the price or the advertising messages (Kirmani and Akshay, 2000; Linnemer, 2001). In addition, Mitra and Fay (2010) have proved that the reaction to the price signal is just a behavioral concept and cannot present solely the quality of the product. Nevertheless, the consumers' behavior are changed by increasing or decreasing of price

and the advertising cost (Esmaeili et al., 2009a; Esmaeili et al., 2009b). Sahuguet (2011) presents a direct relationship between the number of advertisement and the number of potential consumers. Moreover, Internet advertising campaigns has been considered by chance constrained optimization model regarding the uncertainty of the supply of Internet viewers (Deza et al., 2015). A significant shortcoming of all these models is that they assume that the customers have a static role.However, today customers can find out the product's attributes, qualities and prices through the Internet. Therefore, they are neither static nor naive anymore and cannot be deceived easily by advertisements.

Regardless the advertising budgeting and the marketing strategies, purchasing due to advertising leaves the consumer with a satisfaction or dissatisfaction (Beltran et al., 2013; Muzellec et al., 2015). One of the main reasons should be whether the advertisements are honest and they make a good reputation for the e-tailers. Or the advertisements are deceiving and consist of wrong information which is called noisiness of advertisements (Anand and Shachar, 2009). In other words, selling and buying makes a history on the e-tailer and the consumer's mind. However, most signaling models of advertising are presented for only one stage. A company decides to advertise or not and the customer chooses to buy the product or not and then the game is finished (Linnemer, 2001; Fluet and Garella, 2002; Horstmann and MacDonald, 2003; Anand and Shachar, 2007; Anand and Shachar, 2009). Neglecting the impact of history of advertising and purchasing on the consumer's and e-tailers' actions is another salient concern of signaling models of advertising. To our knowledge, trading has not been presented as the multi stage game in the literature.

Although e-business is the evolutionary part of the business world, most of the signaling models of advertising ignore e-business and present the traditional form of trading. Therefore, in this paper we are going to present a signaling internet business model as the multi stage game between two e-tailers and one intelligent consumer. The e-tailers present a product with two qualities- high and low- where this quality difference is not obvious. The e-tailers choose to advertise or not for selling durable products in order to maximize their profit. On the other hand, the consumer is assumed to be intelligent and curious about advertising signal which triggers him/her to search about the products qualities. Therefore, the consumer cannot be deceived or misperceived by the noisiness of advertisement. The consumer's utility is maximized by choosing the appropriate quality of the product. At stage zero, the communication between one of the e-tailers as a dynamic one and the consumer is considered to obtain Nash Equilibrium, while another e-tailer has no static action. At stage one; Separating Equilibrium is obtained for both e-tailers' interaction according to the nature of signaling games. Since our consumer is intelligent, the history of e-tailer's activities is magnified for the consumer at stage two. Therefore, based on the history, Nash Equilibrium is obtained at stage two by considering the interaction between the intelligent consumer and the two e-tailers. It is shown that in the multi stage game, the history of business's actions (reputation) is as important as advertisements to signal about the product quality. In addition, we also present that the optimal policy of the e-tailers and the consumer dependent upon advertising and searching costs.

The rest of the paper proceeds as followed. Section 2 describes notations and problem formulation. The e-tailers' and the consumer's models are presented in

Section 3. In Section 4 we discuss about multi stage game. Conclusion with some suggestion for further research is considered in Section 5.

2. Notation and Problem Formulation

This section introduces the notation and formulation of our model. Here, we state decision variables, parameters and assumptions underlying the model.

2.1. Parameters of the Model

P_i The price at which the e-tailer sells the product,
Q_i The type of product's quality in the market whether high or low $(i = H, L; Q_H > Q_L)$,
C_A The cost of advertising,
C_{Bi} The purchase cost based on the quality of product $(i = H, L)$,
C_S The cost of consumer's searching,
Π The e-tailer's profit,
U The consumer's utility,
F The consumer's fund.

2.2. Decision variables

B_{iE} The binary variable taking value 1 if the i e-tailer advertises and 0 otherwise,
B_C The binary variable taking value 1 if the consumer searches and 0 otherwise.

2.3. Assumptions

The proposed model is based on the following assumptions:

1. The e-tailers and the consumer in the market are risk neutral.
2. There is only one kind of product with high and low qualities that the quality difference is not obvious.
3. The consumer is intelligent and advertisements trigger's him/her to search for information about the product quality.
4. The consumer can afford to buy the product and the remained fund could not be saved for him/her.
5. The transaction continues periodically and histories of previous stages affect e-tailers' and consumer's behavior in the next stages.
6. The product is durable and the consumer buys only one unit of it in each stage.

2.4. Signaling games

Signaling games are a two-player game of incomplete information in which one player is informed and the other is not. The informed player's strategy is a type-contingent message and the uninformed player's strategy is a message-contingent action. The type of the equilibrium depends on the strategy chosen by the players. If they both choose the same strategy, the equilibrium is called Pooling Equilibrium. Otherwise a Separating Equilibrium is achieved.

Since the quality difference is not obvious for the consumer (Assumption 2), the presented model is the signaling game between the e-tailers and the consumer. In other words, the e-tailers are aware of the quality of the product while the consumer does not know about that. Therefore, e-tailers try to send signals to the consumer to help him/her guess the quality.

Such as each game, the signaling game has three specifications: the number of players, their strategies and their payoffs. The e-tailers and the consumer are the players of the game. In Section 4, their strategies and their payoffs are explained.

3. The e-tailers' and the consumer's model

In this section, the e-tailers and the consumer's models are presented.

3.1. The e-tailers' model

Assume a market in which there are two dynamic and static e-tailers. The static e-tailer is a potential competitor who does not take action in stage zero except being cautious about the dynamic e-tailer's actions. The dynamic e-tailer buys a product with high or low quality while the purchase costs are C_{BH} and C_{BL} in sequence ($C_{BH} > C_{BL}$) and prefers to sell both qualities at the same price indexed by P because of two reasons. The first reason is the monopolistic nature of the market(the static e-tailer has no action) and the second one is that the quality difference is not obvious. To maximize profit, the e-tailer decides to advertise or not to advertise. Therefore,

E-tailer's Profit= Selling price - Purchasing cost - Advertising Cost * E-tailer's binary variable

$$max\Pi(B_{iE}) = P - C_{Bi} - C_A B_e \tag{1}$$

Please note that if the dynamic e-tailer does not advertise, B_{iE}=0 and then the third part will be omitted.

3.2. The consumer's model

The consumer -as an intelligent one- has the ability to search about the products qualities. Since the consumer's fund is enough to afford purchasing the product and the remained fund could not be saved for the consumer (Assumption 4), we have considered a lost profit in the consumer model. The lost profit is the difference between the fund and the price ($F - P$). It happens when the consumer has bought the product and the remained fund could not be spent for another purchasing, therefore it is called lost profit. Therefore, the consumer's utility would be:

Consumer's Utility= Quality of the consumed product - Purchasing cost - Lost profit - Searching cost * Consumer's binary variable

$$\max U(B_C) = Q_i - P - (F - P) - C_S B_c \tag{2}$$

$$\max U(B_C) = Q_i - F - C_S B_c \tag{3}$$

Please note that the consumer can search through the internet and this reduces the cost of searching. In addition, if the consumer does not search, B_C=0 and then the third part will be omitted.

4. Multi stage game

In this section, we present the interaction between the e-tailers and the consumer. At stage zero, the communication between the dynamic e-tailer and the consumer is considered. In addition, the interactions between the e-tailers, the two e-tailers and the consumer are presented at stages one and two in sequence.

4.1. The stage zero

At stage zero, the interaction between the dynamic e-tailer (DE) and the consumer (C) is investigated. The static e-tailer chooses no action. However, the dynamic e-tailer's strategies (S_R) include advertise (A) or not to advertise (NA) for selling durable products under two qualities. The consumer's strategies (S_C) will also

be search (S) or not to search (NS). Therefore, the game models the situation as: S_C, S_R= {(S,A),(NS,A),(S,NA),(NS,NA)} The explanation of each situation in sequence is as below:

1. (S,A)= The dynamic e-tailer advertises and the consumer searches about the product. The dynamic e-tailer sells the high quality product because the consumer is aware of the differences in quality by searching. By considering advertising costs, the e-tailer's profit would be $\Pi(B_{DE}) = P - C_{BH} - C_A$ and the consumer's utility $U(B_C) = Q_H - F - C_S$,
2. (NS,A)= The dynamic e-tailer advertises and the consumer does not search. Since the consumer does not search, the seller can either sell the high or low quality product to the consumer with the same probability and therefore $\Pi(B_{DE}) = (\frac{1}{2}(P - C_{BH} - C_A) + \frac{1}{2}(P - C_{BL} - C_A)$ As the consumer does not search, he/she would not understand the differences in product quality. Therefore, the consumer may make a wrong purchasing decision and gains the utility $U(B_C) = \frac{1}{2}(Q_H - F) + \frac{1}{2}(Q_L - F)$,
3. (S,NA)= The dynamic e-tailer does not advertise and the consumer searches. As mentioned before, the advertising signals make the consumer aware of the product and trigger's him/her to search about the product. Therefore, when there is no advertising signal, there would be no decision to search,
4. (NS,NA)= The dynamic e-tailer does not advertise and the consumer does not search. In such a situation no trade takes place and the e-tailer's profit and the consumer's utility would be zero.

The players' payoffs for each situation are summarized in the following Table:

Table 1. The payoffs of the zero stage model

		DE	**DE**
		A	**NA**
C	**S**	$(Q_H - F - C_S, P - C_{BH} - C_A)$	-
C	**NS**	$(\frac{1}{2}(Q_H - F) + \frac{1}{2}(Q_L - F))$, $(\frac{1}{2}(P - C_{BH} - C_A) + \frac{1}{2}(P - C_{BL} - C_A)$	(0,0)

For the dynamic e-tailer, the best strategy that maximizes the e-tailer's profit is to advertise. In addition, by comparing two strategies of the consumer, we face with two optimal solutions. If $Q_H - 2C_S > Q_L$, the consumer chooses to search otherwise he/she does not search. It is obvious that the best strategy of consumer depends on the searching cost (C_S). If C_S is too high, it would be better for the consumer to buy the product without searching. However, as our model is in e-business, the search cost is really negligible according to the fast and easy access to the internet and the consumer should search to increase his/her utility. Therefore, situation (S,A) is the Nash equilibrium at the stage zero that makes sense. The dynamic e-tailer advertises and sells the high quality product and the consumer searches.

4.2. The stage one

The game is not over yet and it continues to the stage one. To enrich our model, we consider the static e-tailer breaks down the monopoly of the first e-tailer (the

dynamic e-tailer) and a signaling competition takes place between the two e-tailers. Regarding to the intelligent consumer, the history about the activities of the zero stage game is magnified which makes our proposed model more realistic. To our knowledge, the multi stages game with observed actions is ignored by most of the signaling models. Based on definition of the multi stage games with observed actions, in the stage one the players know the actions chosen at the stage zero. By entering the second e-tailer (the static e-tailer) as a competitor, the e-tailers do not want to destroy the consumer's trust with selling low quality products at the high price. Therefore, they need to sell the high and low quality product at P_H and P_L in sequence. In addition the second e-tailer (SE) has received the signals that the first e-tailer (FE) has sold the product with high quality to the consumer to make him/her well known. We have a set of pair strategies that the first component represents the quality of product and the second one represents advertising decision. The both e-tailers have the same strategies that include {(L,A),(L,NA),(H,A),(H,NA)}. In other words, both e-tailers can provide the product in either low quality (L) or high quality (H) while they advertise (A) or do not advertise (NA). The payoff of each player is shown in Table 2.

Table 2. The payoffs of the one stage model

		FE	**FE**	**FE**	**FE**
		(L,A)	**(L,NA)**	**(H,A)**	**(H,NA)**
SE	**(L,A)**	♣	♣	$(P_L - C_{BL} - C_A, P_H - C_{BH} - C_A)$	$(P_L - C_{BL} - C_A, P_H - C_{BH})$
SE	**(L,NA)**	♣	♣	$(\frac{1}{2}(P_L - C_{BL}), P_H - C_{BH} - C_A)$	$(\frac{1}{2}(P_L - C_{BL}), P_H - C_{BH})$
SE	**(H,A)**	♣	♣	✠	✠
SE	**(H,NA)**	♣	♣	✠	✠

It is obvious that zones ♣ will never been chosen by the first e-tailer because of his/her positive history. In fact he/she does not present the product with low quality because he/she does not want to destroy the consumer's trust and lose his/her loyal consumer. In addition, zones ✠ will never been chosen by the second e-tailer. The reason is if the consumer wants to pay the high price for the product with high quality, he/she will prefer to buy it from the first e-tailer (positive history of the first e-tailer). In other words, the second e-tailer cannot compete with the first e-tailer when they both behave the same. Therefore, in the Table 2, we discuss only about the zone which shows the pay offs:

1. {(H,A),(L,A)}: The first and second e-tailers sell high and low quality in sequence while both advertise.
2. {(H,NA),(L,A)}: The first e-tailer sells high quality without advertising activities. While the second e-tailer sells high quality with advertising.
3. {(H,A),(L,NA)}: The first e-tailer sells high quality with advertising. While the second e-tailer sells high quality without advertising.
4. {(H,NA),(L,NA)}: The first and second e-tailers sell high and low quality in sequence while they do not advertise.

Since the first e-tailer has his/her loyal consumer then he/she never chooses advertising strategy because of the advertising cost. Therefore, the first e-tailer presents high quality product without advertising to have a maximum profit (H,NA).

Moreover, the second e-tailer presents low quality product to obtain his/her market share among the consumer with low fund. Therefore, he/she needs to make the consumer aware of his/her product. Thus, on one hand if the second e-tailer does not advertise, with an equal probability the consumer buy or does not buy from him/her. On the other hand he/she faces with the advertising cost in using informative tools. If the advertising cost is too low ($P_L - C_{BL} > 2C_A$), there would be a Separating equilibrium in which the first e-tailer sells high quality product, does not advertise and benefits from the positive history of the stage zero while the second e-tailer sells low quality product and advertises. Therefore, the game's separating equilibrium would be {(H,NA),(L,A)}. In contrast, if $P_L - C_{BL} < 2C_A$, the strategy set {(H,NA), (L,NA)} would be the Pooling equilibrium. In other words, if advertising cost will be so high such that advertising would not be profitable for the second e-tailer, there would be a Pooling equilibrium in which both e-tailer choose the same message, and does not advertise. However, as our model reflects the e-business trade; the advertising cost is really negligible according to access to the inexpensive internet marketing tools such as e-mail marketing. Therefore, strategy set {(H,NA),(L,A)} would be the Separating equilibrium at stage one.

4.3. The stage two

In this section, we present signaling games between the e-tailers and the consumer. According to stage zero, the first e-tailer has sold high quality product to the intelligent consumer that brings him/her some sort of positive reputation for the next stages. On the other hand, in stage one the first and the second e-tailer decided to sell high and low quality product sequentially. As the consumer does not know which quality of the product the second e-tailer is going to sell, the second e-tailer prefers to advertise. Therefore, regarding to the mentioned history the first and second e-tailers ' strategies would be {(H,NA),(L,A)}. Moreover, the consumer has two strategies, search (S) or not search (NS). The players' payoffs for each situation are summarized in Table3.

Table 3. The payoffs of the two stage model

		FE	**SE**
		(H,NA)	**(L,A)**
C	**S**	$(Q_H - F - C_S, P_H - C_{BH})$	$(Q_L - F - C_S, P_L - C_{BL} - C_A)$
C	**NS**	$(\frac{1}{2}(Q_H - F) + \frac{1}{2}(Q_L - F), \frac{1}{2}(P_H - C_{BH}))$	$(\frac{1}{2}(Q_H - F) + \frac{1}{2}(Q_L - F), \frac{1}{2}(P_L - C_{BL} - C_A))$

1. ({NS,(H,NA)} and {NS,(L,A)})= If the consumer does not search, the situations {(H,NA) and (L,A)} for the first and second e-tailers should be considered simultaneously. In such a situation, the first e-tailer sells high quality without advertising and the second e-tailer sells low quality and advertises. As the consumer does not search, there is a probability that he/she makes a wrong purchasing decision and chooses the wrong e-tailer and gains $U(B_C) = \frac{1}{2}(Q_H - F) + \frac{1}{2}(Q_L - F)$. Therefore, the probability of the first e-tailer to sell the high quality product cuts in half and gains $\Pi(B_{FE}) = \frac{1}{2}(P_H - C_{BH})$

and also, the second e-tailer sells low quality product and gains $\Pi(B_{SE}) = \frac{1}{2}(P_L - C_{BL} - C_A)$,

2. ({S,(H,NA)} and {S,(L,A)})= If the consumer searches, the situations {(H,NA) and (L,A)} for the first and second e-tailers should be considered simultaneously. As the consumer searches, he/she with complete information chooses the product with high or low quality. If the consumer buys the high quality product from the first e-tailer, the first e-tailer gains $\Pi(B_{FE}) = P_H - C_{BH}$ and the consumer utility would be $U(B_C) = Q_H - F - C_S$ while the second e-tailer endures the advertising cost in addition to purchasing cost. Otherwise, the consumer buys the low quality product from the second e-tailer, the second e-tailer's profit is $\Pi(B_{SE}) = P_L - C_{BL} - C_A$, the consumer gains $U(B_C) = Q_L - F - C_S$ and the first e-tailer only sustains the purchasing cost.

Totally, the significant decrease in the e-tailers' utility and the consumer's profit that is because of not searching strategy of the consumer proves that it would be better for both sides of the trade that the consumer searches. Therefore, the Nash equilibrium depends on the consumer's taste in product quality. If the consumer needs a low quality product, the second e-tailer would be the best choice and the zone with strategy set {S,(L,A)} would be the Nash equilibrium. Otherwise, the consumer would buy the product from the first e-tailer and the Nash equilibrium would be strategy set {S,(H,NA)}. According to sections 4-1 and 4-2, if the searching or advertising cost is too high, the equilibrium would break down and the consumer and the second e-tailers would decide not to search and not to advertise strategies in sequence.

5. Conclusion

There are a number of industrial and government statistical reports that show that business on the Internet is speed up. Advertising and e-business are the concepts that have changed the world nowadays. In this paper we present a signaling internet business model as the multi stage game between two e-tailers and one intelligent consumer. The intelligent consumer has two strategies, search or not to search while the e-tailers choose advertise or not for selling durable products under two qualities. At stage zero, the communication between one of e-tailers and the consumer is considered to obtain Nash Equilibrium. In the stage one, Separating Equilibrium is obtained for both e-tailers' relation according to nature of signaling game. At stage two, the interaction between the intelligent consumer and the e-tailers is investigated to obtain Nash Equilibrium. It is shown in the multi stage game, the history of business's actions (reputation) would be as important as the advertising to signal quality. In addition, searching and advertising costs play a role key in the consumer and e-tailers' decisions that should be considered in the business world. In the presented model we shed light on the periodic nature of the business, the consumer awareness, and positive reputation which makes our model more real.

There are several ways of extending this model such as increasing the number of products and consumers. In addition, the noisiness of advertising is not investigated completely in the model. Whereas there is a new evolutionary trend in advertising such as hidden advertising in search engines and other sources of customer information. Also other kind of signaling games like cooperation between the players could be studied.

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