# PERCEIVED RISK IN ONLINE SHOPPING, INFORMATIVE ADVERTISING AND PRICE COMPETITION: SOME THEORETICAL UNDERSTANDINGS

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**ABSTRACT**

This paper presents a theoretical model to understand the effects of perceived risk of buyers on the strategic behaviors of an "online firm" (a firm that sells its product using visual shops) and an "offline firm" (a firm that sells its product using a brick and mortar shop). Perceived risk is assumed to be associated only with the demand of product of the "online firm", as a buyer cannot evaluate "non-digital" attributes of the product at the time of shopping. Our model is built in a duopoly set up, where two firms with different sets of strategies involve in price competition and the "online firm" sends advertisement signals to minimize the risk perception among buyers.. We have also taken into account the role of transport cost which the "offline firm" tries to minimize by choosing an optimal location. Our model shows that an increase of number of advertisement or transport cost persuades buyers to shift from offline shopping to online shopping. Welfare analysis of the model shows that profit maximizing level of advertising is smaller than the socially optimal level in the presence of perceived risk among buyers.

**Key Words:** Perceived risk, Online market, Informative advertising, Transport cost and Social welfare.

**JEL Classification:** D81, L81, M37, D6, D43.

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## 1. INTRODUCTION AND BRIEF LITERATURE REVIEW

In the modern era of technology, increasing number of buyers are buying products from online market. With the development of Internet many retailers also have changed their business models by extending their bricks and mortar shops to the virtual shops. However, many buyers are skeptical or suspicious about the functional mechanism of electronic commerce, its intransparent processes and effects, and the quality of many products that are offered. It is generally seen that in a traditional retail environment, buyers perceive more risks in online shopping and this perception greatly influence their purchasing decision. An important reason why general buyers are reluctant to shop online is because of fundamental lack of faith or trust between businesses and buyers. In essence, buyers simply do not trust most web providers enough to engage with them. Trust is not only a short term issue but probably the most significant long term barrier for realizing the potential for e-commerce to buyers.

In the theory of consumer behavior, the central problem is choice and since the outcome of any choice is realized in future only, risk or uncertainty is inherently associated with it. Since risk is often perceived to be painful and in that it may produce anxiety, perception of risk is one pivotal aspect of consumer behavior (Taylor, 1974). Perceived risk can be defined as the nature and amount of risk perceived by a consumer in contemplating a purchase decision (Cox and Rich, 1964). There are two aspects of risk associated with any choice situation— uncertainty about the outcome and uncertainty about the consequences. In a choice situation risk can be interpreted in terms of possible psychological/social loss or in terms of functional/economical loss or both (Taylor, 1974). Though economic cost of a bad decision is the most commonly discussed element of risk, it is not the only one and may not be considered to the most important one. Roselius (1971) expresses the view that consumers often face the dilemma of willingness to buy the product, and yet they hesitate to purchase because it involves taking the risk of incurring some types of loss. He adds that to reduce risk buyers may shift from one type of perceived loss to another where he has more tolerance. Thus, perceived risk is associated with choice decision of consumers in many cases. In case of online shopping, the buyer for example, may know that she can return a purchase which proves to be unsatisfactory and consequently may not perceive any risk or financial loss. Nevertheless, she may perceive substantial risk of time loss (having to return the purchase, delay in obtaining a needed item); ego loss and frustration (dissatisfaction resulting from making a poor purchase); and of not achieving her buying goals.

Advertising, which is a common strategy taken by firms to differentiate their own product from that of others, can convey information about the product to buyers or persuade them to buy the same. An important role of informative advertising is to assure buyers about the quality of the product. When firms know that buyers consider purchasing of their product to be risky, they try to sends advertising signals to increase their product demand by assuring buyers about their product quality and promising compensation if any loss occurs during transaction. Moving internet users or online buyers to the "purchase click" is proving to be difficult in the presence of perceived risk and thus online retailers find it increasingly important to represent themselves to the buyers to increase the public awareness of the firm and its products by informative advertising. In environments where the quality of the products is unobservable by consumers before they purchase the good, a substantial amount of advertising is observed. Even though it is not very clear whether the majority of advertising provides direct or indirect information about the quality of the products, the Industrial Organization literature has considered most of these advertising expenditures as directly uninformative. The underlying idea has formerly been proposed by Nelson (1974). Nelson's ideas have more formally been developed by Milgrom and Roberts (1986) and Kihlstrom and Riordan (1984).

In economic analysis, the very idea of advertising has been introduced by Marshal (1890, 1919), and then gathered momentum with Chamberlin's (1933) integration of selling costs into economic theory. Advertising can play a constructive role by conveying information to consumers or making them aware of the existence and location of products, or conveying (pre-purchase) information concerning the functions and qualities of the products (Marshal, 1890, 1919). When Marshal fails to integrate advertising with economic theory, in his theory of monopolistic competition, Chamberlin (1933) embraces this integration. Braithwaite (1928) contributes significantly toward the conceptual formulation of persuasive advertising. He extends the view that a consumer's demand for the advertised product can be shifted out and her pre advertising preference can be distorted with advertising. Kaldor (1950) further advances the persuasive view of advertising by distinguishing between the direct and indirect effects of advertising. The informative view of advertising is relatively new; whose foundation is laid by economists like Ozga (1960) and Stigler (1961).

Effects of advertising can be distinguished between direct effects such as effects on sales, brand loyalty and market-share stability, and on economies of scale and indirect effects such as on concentration, profit, entry, price and quality. Many empirical studies review the relationship between sales and advertising[3]. Most of the studies suggest that a firm's current advertising is associated with an increase in its sales, though this effect is short lived. On the other hand, among the indirect effects of advertising, price and profits have achieved a special place in the literature. Comanor and Wilson (1967, 1974) are among the first to show the positive relationship between advertising and profitability. There are many other empirical studies with the same conclusion. At the same time, the effects of advertising on price are conflicting in nature and thus the overall relationship cannot be deduced only through theoretical understandings (Chamberlin, 1933). However, empirical literature also fails to establish any unique relationship between the two.

Since advertisement by nature is endogenous, its relationship with any other variable should be interpreted with a great care. Given the effects of advertising on other endogenous variables, it is important to choose the optimal number of advertising for a firm. Thus, another group of economists tried to check whether advertising is socially optimal or not. Dixit and Norman (1978) are the first to establish a rigorous methodology. By defining social welfare as the sum of consumer's surplus and profits they show that profit maximizing level of advertising is excessive. However, they are criticized by Fisher and McGowan (1979) for including advertisement in the utility function. Becker (1977) and Nichols (1985) however show that firms in a competitive market buy the socially optimal level of advertising. Butters (1977), in a theoretical model with a set of very restrictive assumptions, show that firms do advertise optimally. However, Stegeman (1991) argues that there is no obvious reason to believe that firms in Butters's model choose socially optimal level of advertising. Others have recognized presence of externalities in search models and argued that undercutting externalities tends to cause excess advertising (Grossman and Shapiro, 1984).

Given this backdrop, the present study tries to understand the role of informative advertisement in mitigating perceived risk of consumers who are purchasing from a firm selling through internet (an online firm) rather than from a firm selling through traditional shop based retail market ( an offline firm). In a duopoly setup where firms simultaneously compete in prices the study endogenously determines the level of informative advertising u undertaken by the online firm. Interestingly, in this framework the study observes a counterintuitive result that that the level of advertisement chosen by the online firm is below the socially optimal level.

[3] See for example Nelson (1974), Lambin (1976), Ashley et al (1980), Boyd and Seldon (1990), Seldon and Doroodian (1989), Thomas (1989), Kwoka (1993), Landes and Rosenfield (1994), Thomas (1999) etc.

Our paper is divided in five sections. We start with a brief introduction and review of literature. In section 2 we have demonstrated a theoretical model and its comparative and welfare analyses are done in section 3 and 4 respectively. Section 5 ends the paper with a brief conclusion or summary of the study.

## 2. A MODEL OF INFORMATIVE ADVERTISING IN THE PRESENCE OF PERCEIVED RISK

In this section we present a model of informative advertising in a duopoly market where one firm is having a brick-mortar shop and henceforth will be referred as the offline firm and the other firm sells its product through internet and will be refereed as the online firm. It is further assumed that the firms sell homogeneous product that is there does not exist any quality difference in the product sold by them.

### 2.1 DESCRIPTION OF THE MODEL

***Market Structure and Consumer Preference***

We assume that the online and the offline firms are selling to N number of consumers. The maximum willingness to pay for a unit of a product for each consumer is "$v$", i.e. each consumer uses only one unit of the product and attaches a gross value of "$v$" to it. This gross value or willingness to pay does not change across consumers and firms as products are homogenous in nature. Now a consumer can buy a product either from the "online firm" or from the "offline firm" but not from both. Purchase decision of a consumer depends on many factors such as transport cost (in case of offline firm), perceived risk (in case of online firm) and off course relative prices of two firms.

***Transport cost in case of offline shopping***

If a consumer purchases a product from the "offline firm", she certainly bears a transport cost of "$\tau$". For a consumer who purchases a product from the "offline firm" at price $P_{off}$ , the consumer surplus is $(v - \tau - P_{off})$. The consumer purchases the product if and only if the product gives her a positive surplus.

***Perceived risk in case of online shopping***

We have already discussed different types of risk associated with online shopping. If a product is purchased from the "online firm", a risk is borne by the consumer and let $\theta$ be the dollar value of the risk or more precisely loss of product value due to presence of risk in transaction. Since $\theta$ depends on consumers' perception, it is unobservable to the "online firm"[4]. Thus, $\theta$ is a random variable and is assumed to be uniformly distributed[5] with maximum value $\bar{\theta}$ and minimum value 0. If the price of the product is $P_{on}$, the consumer surplus then is $(v - \theta - P_{on})$.

***The production technology***

Since each firm produces and/or sells the same product, the production technology does not differ across firms. For the sake of simplicity we are ignoring existence of any fixed cost[6]. Production is assumed to be subject to constant returns to scale with a marginal cost of $c > 0$.

***Information structure***

Here we assume that the existence of the "offline firm" is a common knowledge among buyers. Consumers know that the product is available at the "bricks and mortar shop". On the contrary, "online firm" supplies product specific information. Here we employ an information technology similar to that in Butters (1977). The "online firm" sends advertisement to apprise consumers about its existence and the characteristics and price of the product[7]. Apart from informing consumers about the product and price, informative advertisement in our model plays an important role. Since consumers attach risk with online shopping, one main objective of advertisement by the "online firm" is to minimize the risk perception. With different promotional strategies "online firm" is seen to assure its buyers about the quality of its products and also promises to compensate for any type of losses (if occurred) with different schemes such as "money back", "replacement guarantee" etc.

***Advertising technology***

Advertisings messages are produced by the "online firm" itself. A fraction of total population, $\lambda$, can be targeted for advertisement. However, we consider a no targeting assumption and thus $\lambda$ can be interpreted as the probability of receiving an advertisement by a

[4] Only the "online firms" bother about $\theta$ as a purchase of product from the "offline firm" is assumed to be risk free.
[5]Consumers are heterogeneous to the "online firm" as well as to the "offline firm". To the "offline firm" they are heterogeneous with respect to their position or location. On the other hand, to the "online firm" consumers are heterogeneous with respect their perceived risk or $\theta$. Since consumers are assumed to be uniformly distributed along the line, to maintain consistency we have to assume that $\theta$ too is uniformly distributed.
[6] The Nash equilibrium solution does not change even if we consider a fixed cost.
[7] For a detail note on different purposes of informative advertising see Grossman and Shapiro (1984).

consumer. The total cost of advertisement in the furtherance of simplicity is assumed to be constant, say $C_A$. Instead of a constant advertising cost, however, one may consider a concave type of cost function such as $C_A = \frac{\lambda^2}{2}$; with $C_{A_\lambda} > 0$ and $C_{A_{\lambda\lambda}} > 0$. This is noteworthy that assumption of constant advertisement cost does not change Nash equilibrium (NE) of the model; it only changes the optimum number of advertisement. Therefore in our model the NE solution is indifferent to the type of advertisement cost function but the optimum number of advertisement by the profit maximizing "online firm".

### 2.2 Consumers Demand

We have already mentioned that if a consumer purchases a product from the "offline firm" at a price $P_{off}$ per unit, then the consumer surplus she enjoys is $(v - \tau - P_{off})$. On the other hand, if consumer purchases the same product from the "online firm" the consumer surplus becomes $(v - \theta - P_{on})$. Then the consumer is said to be indifferent if and only if $(v - \tau - P_{off}) = (v - \theta - P_{on})$, i.e. $\hat{\theta} = (P_{off} - P_{on} + \tau)$. We call this $\hat{\theta}$ the critical value of $\theta$, based on which a consumer takes her purchase decision. Interpretation of $\hat{\theta}$ has special implication here in our model. If a consumer buys a product from the "offline firm" and if $P_{off} > P_{on}$, she forgoes the discount offered by the "online firm"; and also bears an extra transport cost of amount $\tau$. Thus, $\hat{\theta}$ can be alternatively interpreted as the opportunity cost of buying a product from the "offline firm". Then a consumer prefers to buy the product from the "offline firm" if she thinks that the expected loss due to presence of risk in online shopping is greater than the opportunity cost. Thus we assume that she buys the product from the "offline firm" if $\theta > \hat{\theta}$, and the "online firm" if $\theta \leq \hat{\theta}$.

### 2.3 Sequence of the Game

The entire model is structured in the form of a sequential game. At the first stage of the game the online firm decides optimum number of advertisement to be sent to the consumers. At the next stage of the game the firms simultaneously choose their prices. Next the consumers who have received the advertisement signal chooses between the "online firm" and the "offline firm" and those who have not received any advertisement purchase from the offline form. Since it is a sequential move game, following the standard practice we shall solve it using backward induction technique to derive the sub game perfect NE.

### 3.4 Equilibrium in the Model

***Equilibrium concept***

The market equilibrium studied in our model, is a non-cooperative NE in prices, P and advertising intensities, $\lambda$. Here we use the classical model of price competition introduced by Bertrand (1883) considering advertising as a strategic variable. Here we follow the systematic method of finding the NE by constructing the players' best response functions. So long as these functions may be computed, the method straightforwardly leads to the set of NE. In Bertrand model, we first find out a NE and then argue that no other pair of prices is a NE.

***Equilibrium analysis***

We now compute the equilibrium with a fixed number of firms since there is no scope for entry and exit. Before the calculation of equilibrium the necessary first step is to define demand functions for the two firms. Demand for each firm is a function of prices, P and advertising intensities, $\lambda$. Symbolically, $x = x(P, \lambda)$. Now, the "online firm" sends $\lambda N$ number of advertisement signals to buyers. In other words, $\lambda N$ is the fraction of population that receives an advertisement signal. Then the fraction of population $(1 - \lambda)N$ does not receive any advertisement and end up buying the product from the "offline firm". As we have mentioned before, the fraction of population receives advertisement, $\lambda N$, buys from the "online firm" if and only if $\theta \leq \hat{\theta}$. Otherwise they prefer to buy from the "offline firm" even after receiving an advertisement signal from the "online firm". Thus the demand function for the "online firm" can be defined as

$$x_{on}(P, \lambda) = \lambda N \, Prob(\theta < \hat{\theta}) \tag{1}$$

Similarly for the "offline firm" the demand function can be written as

$$x_{off}(P, \lambda) = \lambda N \, Prob(\theta > \hat{\theta}) + (1 - \lambda)N \tag{2}$$

Interestingly, if $\theta > \hat{\theta}$ for all consumers, then the "offline firm" can successfully capture the entire market.

Since $\theta$ is a random variable, for profit maximization we consider expected demand functions instead of actual demand functions. Demand functions for two firms are given as follows

$$\pi_{on} = \lambda N \, Prob(\theta < \hat{\theta})(P_{on} - c) - C_A \tag{3}$$

$$\pi_{off} = \lambda N \, Prob(\theta > \hat{\theta})(P_{off} - c) + (1 - \lambda)N(P_{off} - c) \quad (4)$$

Substituting distribution functions of θ the two profit function can be simplified as

$$\pi_{on} = \frac{\lambda N \hat{\theta}}{\bar{\theta}}(P_{on} - c) - C_A \quad (3a)$$

$$\pi_{off} = \frac{\lambda N}{\bar{\theta}}(\bar{\theta} - \hat{\theta})(P_{off} - c) + (1 - \lambda)N(P_{off} - c) \quad (4a)$$

Substituting the value of $\hat{\theta}$, the two profit function can be further simplified as

$$\pi_{on} = \frac{\lambda N}{\bar{\theta}}(P_{off} - P_{on} + \tau)(P_{on} - c) - C_A \quad (3b)$$

$$\pi_{off} = \frac{\lambda N}{\bar{\theta}}(\bar{\theta} - P_{off} + P_{on} - \tau)(P_{off} - c) + (1 - \lambda)N(P_{off} - c) \quad (4b)$$

Now, differentiating (3b) with respect to $P_{on}$, and (3b) with respect to $P_{off}$ we get two first order conditions (FOCs)[8] and by rearranging them we derive two price reaction functions as follows

$$P_{on} = \frac{1}{2}(P_{off} + c + \tau) \quad (5)$$

$$P_{off} = \frac{1}{2}\left(P_{on} + c + \frac{\bar{\theta}}{\lambda} - \tau\right) \quad (6)$$

Solving (5) and (6) simultaneously we derive the NE in prices.

$$P_{on} = \frac{1}{3}\left(\frac{\bar{\theta}}{\lambda}\right) + \frac{\tau}{3} + c \quad (7)$$

$$P_{off} = \frac{2}{3}\left(\frac{\bar{\theta}}{\lambda}\right) - \frac{\tau}{3} + c \quad (8)$$

In figure 1 below two reaction functions and the NE is shown. The NE clearly differs from the classical Bertrand model. In case of traditional Bertrand NE prices are the same; but here two prices differ significantly. Again in our model each price is higher than the marginal cost although in the Bertrand equilibrium prices are found to be equal with the marginal cost. However, if we ignore the perceived risk (i.e. $\bar{\theta} = 0$) and the transport cost (i.e. $\tau = 0$), we go back to the traditional Bertrand equilibrium. The sole reason behind these departures from conventional Bertrand equilibrium is the different strategic behavior of two firms.

[8] For FOCs and SOCs see Appendix 1.

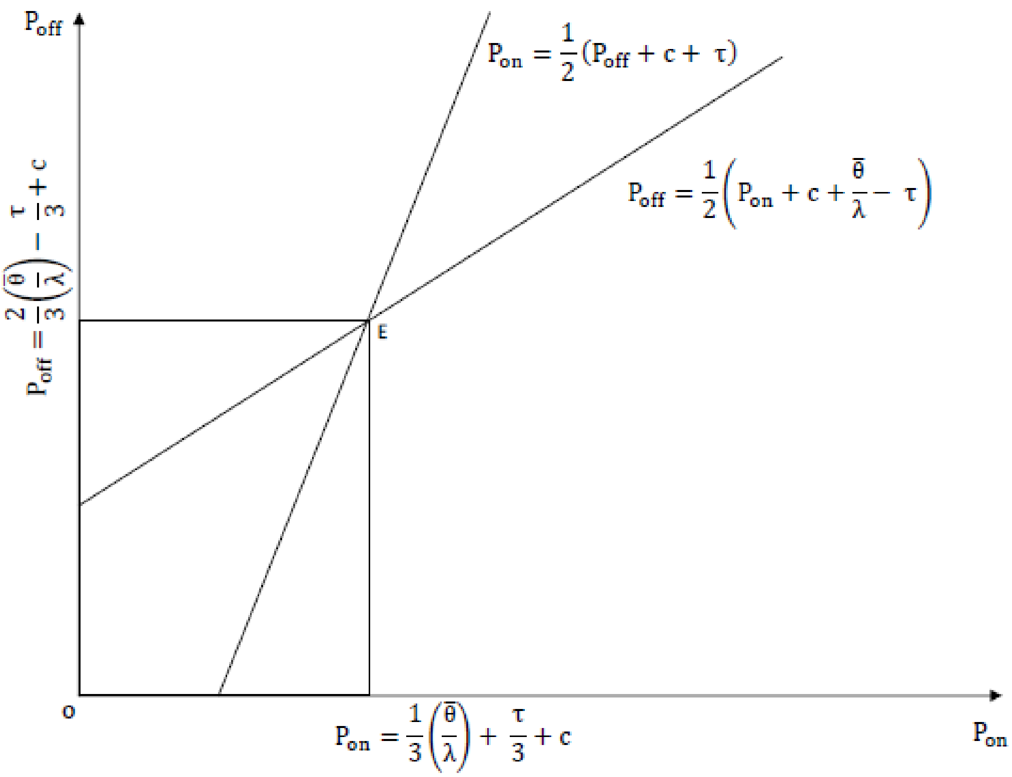


Figure 1: Price reaction functions and equilibrium

Now, given the two prices in (7) and (8), we can calculate the optimum value of $\hat{\theta}$ as

$$\hat{\theta}^* = \frac{1}{3}\left(\frac{\bar{\theta}}{\lambda}\right) + \frac{\tau}{3} \qquad (9)$$

Given equilibrium prices and the optimum value of $\hat{\theta}$, we can find out optimum level of profit for two firms.

$$\pi^*_{on} = \frac{\lambda N}{\bar{\theta}}\left\{\frac{1}{3}\left(\frac{\bar{\theta}}{\lambda}\right) + \frac{\tau}{3}\right\}^2 - C_A \qquad (10)$$

$$\pi^*_{off} = \frac{\lambda N}{\bar{\theta}}\left\{\frac{2}{3}\left(\frac{\bar{\theta}}{\lambda}\right) + \frac{\tau}{3}\right\}^2 \qquad (11)$$

**Proposition 1: For a small transport cost, the "offline firm" charges a higher price**[9]

Let $\hat{\theta}^* > \tau$, i.e. transport cost is smaller than the optimal loss due to presence of risk in online shopping. Then we can show that $P_{off} > P_{on}$. Interpretation of this lemma is straight forward. The "offline firm" has a fixed demand so long as $\lambda < 1$. If a typical buyer receives an advertisement, she compares the expected loss due to risk in online shopping with average transport cost. If $\hat{\theta}$ is sufficiently large, that is the perceived risk in online shopping overweighs the average transport cost, then the demand for the "offline firm" increases and that of the "online firm" decreases. This certainly allows the "offline firm" to charge a higher price. However, this conjecture crucially depends on the number of advertisement sent by the "online firm". Later on we shall show that if the "online firm" chooses profit maximizing level of advertising, then it can charge a higher price than the "offline firm"[10].

## 4. Comparative Statics

From (9) we can obtain expected demand functions for the "online firm" and the "offline firm" as follows:

$$x^*_{on}(\tau,\lambda) = \frac{\lambda N\hat{\theta}^*}{\bar{\theta}} = \frac{N}{3} + \frac{\lambda N\tau}{3\bar{\theta}} \tag{12}$$

$$x^*_{off}(\tau,\lambda) = \frac{\lambda N}{\bar{\theta}}\left(\bar{\theta} - \hat{\theta}^*\right) = \frac{2N}{3} - \frac{\lambda N\tau}{3\bar{\theta}} \tag{13}$$

Differentiating (12) and (13) with respect to λ, we get

$$\frac{\delta x^*_{on}(\tau,\lambda)}{\delta\lambda} = \frac{N\tau}{3\bar{\theta}} \tag{14}$$

$$\frac{\delta x^*_{off}(\tau,\lambda)}{\delta\lambda} = -\frac{N\tau}{3\bar{\theta}} \tag{15}$$

If the "online firm" sends one more advertisement, then the expected demand for the "online firm" (the "offline firm") increases (decreases) by the amount $\frac{N\tau}{3\bar{\theta}}$. The amount of change depends upon three parameters, namely N, i.e. the size of the population or market,τ, i.e. the average transport cost, and $\bar{\theta}$, i.e. the maximum risk perception by the consumer. Higher the transport cost more is the change in favour of the "online firm". On the contrary, higher the $\bar{\theta}$, less is the change in favour of the "online firm".

[9] Proof of this proposition is given in the Appendix 2.
[10] See proposition 1a.

Again, differentiating (12) and (13) with respect to τ, we get

$$\frac{\delta x^*_{on}(\tau,\lambda)}{\delta\lambda} = \frac{N\lambda}{3\bar{\theta}} \tag{16}$$

$$\frac{\delta x^*_{off}(\tau,\lambda)}{\delta\lambda} = -\frac{N\lambda}{3\bar{\theta}} \tag{17}$$

So, increase in transaction cost by one unit reduces (increases) demand for product of the "offline firm" (the "online firm") by the amount $\frac{N\lambda}{3\bar{\theta}}$ . It is noteworthy that in the first case though the "offline firm" does not send any advertise signals to buyers, its demand reduces when the "online firm" increases number of advertisement. It is a type of negative externality that works due to constant demand or size of the market. Similarly, due to increase in transport cost affects demand of the "offline firm" as a negative externality and that of the "online firm" as a positive externality.

## 5. WELFARE ANALYSIS

In this part of our model, we investigate the nature of the biases that arises in the market equilibrium relative to the outcome that would be socially optimal. Here we compare the level of advertising that obtains in the market to the level that maximizes social welfare. Grossman and Shapiro (1984) has shown that profit maximizing level of advertising intensity for a firm always exceeds welfare maximizing level of the same. Here we check the consistency of such a result. To do so, we have first derived the profit maximizing level of advertisement intensity for the "online firm". The optimum profit for the "online firm" is

$$\pi^*_{on} = \frac{\lambda N}{\bar{\theta}}\left\{\frac{1}{3}\left(\frac{\bar{\theta}}{\lambda}\right) + \frac{\tau}{3}\right\}^2 - C_A$$

Differentiating with respect to λ and setting the FOC equal to zero gives us

$$\frac{\delta\pi^*_{on}}{\delta\lambda} = \frac{N}{9\bar{\theta}}\left\{\left(\frac{\bar{\theta}}{\lambda}\right) + \tau\right\}^2 - \frac{2N}{9\lambda}\left\{\left(\frac{\bar{\theta}}{\lambda}\right) + \tau\right\} = 0$$

Solving for λ we get

$$\lambda^M = \frac{\bar{\theta}}{\tau}\text{, given } N \neq 0\text{, and } \tau \neq 0 \tag{18}$$

where $\lambda^M$ is the profit maximizing level of advertising intensity for the "online firm". Interestingly, it is the ratio of maximum perceived risk to the transport cost. This result has two important implications. Firstly, if the risk perception increases among buyers then the "online firm" sends more advertisement to increase its demand. This explains the main objective of advertisement by the "online firm" and also justifies our assumption about the objective of advertisement. Secondly, if transport cost increases then the "online firm" enjoys a positive externality and reduces the number of advertisement as advertisement is costly.

**Proposition 1a: If the "online firm" practices profit maximizing level of advertising, then it can charge a higher price[11].**

From (18) we have $\lambda^M = \frac{\bar{\theta}}{\tau}$, then we have $\hat{\theta}^* < \tau$ and thus $P_{on} > P_{off}$. Intuitively if the "online firm" takes an aggressive strategy then certainly it is possible to capture the lion share of the market, as we know that for the "online firm" demand increases with increase in advertising intensity. This also creates a negative externality for the "offline firm" and thus makes the "online firm" capable of charging a relatively higher price.

Let us now derive the socially optimal level of advertisement. Following Grossman and Shapiro (1984), we define the welfare standard as the consumer surplus plus profits, or gross benefits to consumers less production and marketing costs. The aggregate gross consumer surplus is given by

$$CS = \frac{\lambda N v \hat{\theta}}{\bar{\theta}} - \frac{\lambda^2 N \hat{\theta}^2}{2\bar{\theta}} - \frac{\lambda N P_{on} \hat{\theta}}{\bar{\theta}} + \frac{\lambda N}{\bar{\theta}}(v - P_{off} - \tau)(\bar{\theta} - \hat{\theta}) + (v - P_{off} - \tau)(1 - \lambda) \quad (19)$$

Then the welfare standard is given by

$$W = CS + \pi_{on} + \pi_{off}$$

$$= \frac{\lambda N v \hat{\theta}}{\bar{\theta}} - \frac{\lambda^2 N \hat{\theta}^2}{2\bar{\theta}} + \frac{\lambda N}{\bar{\theta}}(v - \tau) + N(1 - \lambda)(v - \tau) - N.c - C_A \quad (20)$$

Substituting the value of optimal $\hat{\theta}$, we get

$$W = \frac{Nv}{3}\left(1 + \frac{\lambda\tau}{\bar{\theta}}\right) - \frac{N}{2\bar{\theta}}\left\{\frac{1}{3}(\bar{\theta} + \lambda\tau)\right\}^2 + \frac{\lambda N}{\bar{\theta}}(v - \tau) + N(1 - \lambda)(v - \tau) - N.c - C_A \quad (20a)$$

Then differentiating W with respect to λ and setting FOC equal to zero, we obtain the socially optimal level of advertising intensity, given by

$$\lambda^W = \frac{(3v - \bar{\theta})}{\tau} + \frac{9}{\tau^2}(1 - \bar{\theta})(v - \tau) \quad (21)$$

[11] Proof is shown in Appendix 3

It is needless to say that both $\lambda^M$ and $\lambda^W$ are positive and $\lambda^M$ is less than $\lambda^W$. This clearly contradicts the result of Grossman and Shapiro (1984). According to them the profit maximizing level of advertising exceeds social optimal level as the private benefits from advertising always exceeds social benefits. However, in our model since the objective of advertising has changed from informing buyers about the product characteristics to convincing them about firm's product authenticity. The objective of the social planner is to increase consumers' welfare by reducing the risk and thus she prefers to send maximum possible advertisement. But equation 7 and 8 show that if online firm raises advertisement, the offline firm retaliates by reducing its price and as a result the online form has to follow and has to reduce its price to attract consumers. This may actually reduce the level of profit. As a result, the online firm's profit maximizing advertisement level is moderate and below the socially optimal level.

## 6. CONCLUSION

Our theoretical model contributes to the literature in many different ways. Firstly, this model introduces consumers' perceived risk in the process of optimization and firms' price determination. We have shown that in a duopoly setup presence of perceived risk significantly affects the prices and profits of firms. Secondly, to reduce risk among consumers when "online firms" use informative advertising, it helps them to increase their demand and in some cases they may charge a relatively higher price compared to firms operating though their bricks and mortar shops. The "offline firms" face location problem in the presence of transport cost and a high transport cost may compel consumers to shift from "offline firms" to the "online firms". So we have also found presence of positive and negative externalities in demand. When high perceived risk among consumers create positive demand externalities for the "offline firms", high transport cost does the same for the "online firms". On the contrary, if the "online firms" send advertisement aggressively to reduce consternation among consumers about possible losses in online shopping, it may create negative demand externality for "offline firms". However, when we compare the profit maximizing level of advertising of the "online firm" to the socially optimal level, we find that former is lesser. This is possible because the presence of perceived risk compel the social planner to convey more information to buyers.

**APPENDICES**

***Appendix 1: FOC and SOC of profit maximization***

From (3b) and (4b) we have the profit functions of the two firms as

$$\pi_{on} = \frac{\lambda N}{\bar{\theta}}(P_{off} - P_{on} + \tau)(P_{on} - c) - C_A$$

$$\pi_{off} = \frac{\lambda N}{\bar{\theta}}(\bar{\theta} - P_{off} + P_{on} - \tau)(P_{off} - c) + (1 - \lambda)N(P_{off} - c)$$

Differentiating $\pi_{on}$ with respect to $P_{on}$ and $\pi_{off}$ with respect to $P_{off}$, and setting derivatives equal to 0 gives us two FOCs as follows:

$$\frac{\delta\pi_{on}}{\delta P_{on}} = -\frac{2\lambda N}{\bar{\theta}}(P_{on} - c) + \frac{\lambda N}{\bar{\theta}}(P_{off} - c) + \frac{\lambda N\tau}{\bar{\theta}} = 0$$

$$\frac{\delta\pi_{off}}{\delta P_{off}} = \frac{\lambda N}{\bar{\theta}}(P_{on} - c) - \frac{2\lambda N}{\bar{\theta}}(P_{off} - c) + \frac{\lambda N(\tau + \bar{\theta})}{\bar{\theta}} + (1 - \lambda)N = 0$$

Then the SOCs can be found from second order partials as follows:

$$\frac{\delta^2\pi_{on}}{\delta P_{on}^2} = -\frac{2\lambda N}{\bar{\theta}} < 0;\ \frac{\delta^2\pi_{off}}{\delta P_{off}^2} = -\frac{2\lambda N}{\bar{\theta}} < 0;\ \text{and}\ \frac{\delta^2\pi_{on}}{\delta P_{on}\delta P_{off}} = \frac{\delta^2\pi_{off}}{\delta P_{off}\delta P_{on}} = \frac{\lambda N}{\bar{\theta}} > 0$$

Thus

$$\frac{\delta^2\pi_{on}}{\delta P_{on}^2}.\frac{\delta^2\pi_{off}}{\delta P_{off}^2} - \left(\frac{\delta^2\pi_{on}}{\delta P_{on}\delta P_{off}}\right)^2 = \frac{3\lambda^2N^2}{\bar{\theta}^2} > 0$$

***Appendix 2: Proof of proposition 1***

Let $\hat{\theta}^* > \tau$

Substituting, the value of $\hat{\theta}^*$, we have

$$\frac{1}{3}\left(\frac{\bar{\theta}}{\lambda}\right) + \frac{\tau}{3} > \tau$$

Or, $\frac{1}{3}\left(\frac{\bar{\theta}}{\lambda}\right) - \frac{2\tau}{3} > 0$

Or, $\frac{2}{3}\left(\frac{\bar{\theta}}{\lambda}\right) - \frac{\tau}{3} - \frac{1}{3}\left(\frac{\bar{\theta}}{\lambda}\right) - \frac{\tau}{3} > 0$

Or, $P_{off} - P_{on} > 0$

Thus, $P_{off} > P_{on}$.

***Appendix 3: Proof of proposition 1a***

If the "online firm" practices profit maximizing level of advertising, then

$$\lambda = \frac{\bar{\theta}}{\tau}$$

and thus, $$\hat{\theta}^* = \frac{1}{3}\left(\frac{\bar{\theta}}{\lambda}\right) + \frac{\tau}{3} = \frac{2\tau}{3}$$

Then we have, $\hat{\theta}^* < \tau$ and hence $P_{off} < P_{on}$.

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