Market Structure: a Theoretical Approach to Effects of Advertising on Products Price and Quality

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Abstract-This study investigates the effects of advertising on price and quality of products in monopoly and duopoly markets. We examine, by a diagrammatical approach, the state of profitability in a firm both before and after advertising being implemented. Our results show that advertising is directly related to the price and profitability in a monopoly market; however, in the context of a duopoly market, the relationship is uncertain. Our findings also suggest that quality tends to be higher when the price is higher and vice versa. This conclusion holds true for the monopoly market and for the duopoly market.
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I. I. INTRODUCTION

A few topics in economics have given rise to passionate debates. The role of advertising in competition and in a monopoly context as well as its effects on company's profitability, prices and product quality is one of them. When it comes to analyzing this issue, we first need to define what we mean by a monopoly market, a duopoly market, and advertising.

A monopoly market or a pure monopoly is characterized as:

1. A single firm being the sole of some given product,
2. Lack of close substitutes for the product,
3. Many buyers.

The objective of a monopolist is to maximize profit; the demand curve of it is the market demand curve, whose slope leans downward to the right. The profit maximizing output of the monopolist is the level where marginal cost equals marginal revenue. However, as marginal revenue is less than price, the equilibrium output (OQm in Figure 1) has the important attribute that price exceeds marginal cost. The gap in between represents the existence of a positive profit, shown as the shaded area in Figure 1.
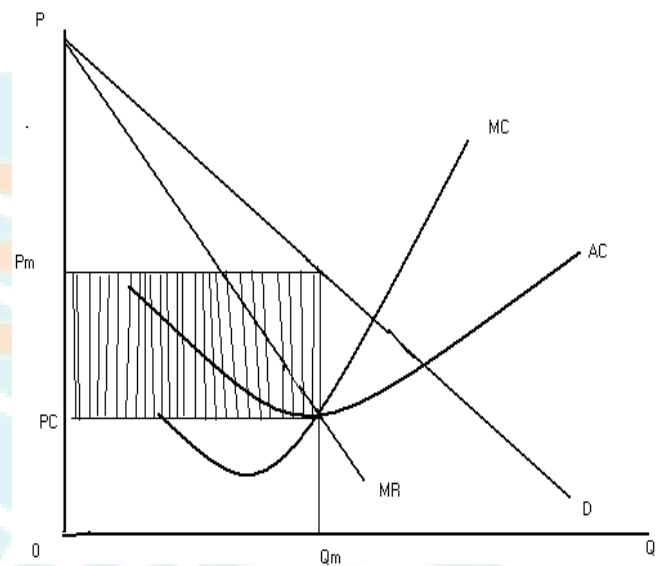

Figure 1: The monopoly market without advertising

The condemnation of the monopoly, owing to its miss-allocation of resources, calls for a more competitive market such as duopoly. In a duopoly market, we assume two firms, who produce and sell two homogenous products for the same price. Since the market is shared by two, any course of action benefiting one firm will be harmful to the other; hence action taken by one rival will have its counterpart in a maneuver by the other. The competitors may spend their life-time trying to "second-guess" each other.

We also assume that each firm maximizes its own profit as indicated below:

$$\frac{d\pi}{dQ_1} = \frac{\delta TR_1}{\delta Q_1} + \frac{\delta TR_1}{\delta Q_2} * \frac{dQ_2}{dQ_1} - \frac{dTC_1}{dQ_1} = 0 \quad (1)$$

$$\frac{d\pi_2}{dQ_2} = \frac{\delta TR_2}{\delta Q_1} * \frac{dQ_1}{dQ_2} + \frac{\delta TR_2}{\delta Q_2} - \frac{dTC_2}{dQ_2} = 0 \quad (2)$$

We are able to solve (1) and (2) to get the output Q1 and Q2, if we know dq1/dq2 and dq2/dq1. These derivatives are called conjectural variations. Some further behavioral assumptions need to be made with respect to their values

to obtain a determinate equilibrium. After reviewing the definition of the two markets, we need to determine what is advertising and the types of advertising.

Some economists believe advertising is the "mass paid communication, the ultimate purpose of which is to import information, develop attitudes and induce action beneficial to the producer." Others, including Kaldor (1950, 1951) and Stiglitz (1968), hold the opinion that advertising has two distinct roles: to provide information and to act as a competitive tool, meaning that advertising is to provide information concerning prices and qualities of goods and services available in the market. In the same vein, Shy (1995) defined advertising as a form of providing information about price, quality, and location of goods and services. Advertising differs from other forms of information channel in two respects. First, the selling party transmits product information. Second, the purchasing party does not always have to pay to receive this information (or pay just a little in terms of the value of time spent on watching TV advertisement or on sorting out relevant advertising in a Sunday newspaper).

In general, one can say that the critical role of advertising is to persuade consumers to purchase goods in question rather than to provide genuine information as to its value. In this sense, advertising helps consumers to differentia products of one firm from those of its competitors'; it is a method, therefore, of reducing scope and effectiveness of price competition by attaching a strong element of 'goodwill' to each firm. Telser (1964), Nelson (1970,1974) and Demsetz (1979) proposed that advertising served as a tool to transmit information from producers to consumers about differentiated brands, which reduces consumers' information search cost. Advertising therefore informs consumers about products and product attributes. When consumers become more price-sensitive, price is then determined by quality. All these theories imply that advertising aims to increase profits of companies. Hence, it calls for substantial investment by individuals, firms and government. It has been estimated that developed countries spend more than two percent of their gross national product (GNP) on advertising (Schmalense, 1972, 1986). The advertising expense of a firm is normally measured as a percentage of dollar sales, which varies drastically across products and industries. Capturing the effects of advertising on an entity's profitability in monopoly and duopoly markets becomes intricate when firms operate as duopolists. Our primary task is to analyze the effects of advertising on the monopoly and duopoly markets. Specifically, we intend to find out whether it increases or decreases the profitability. The objectives of this study are:

1. To examine the effects of advertising on profitability, price and quality of products with particular interest in monopoly and Duopoly markets
2. To study the extent to which advertising affects these variables (calibration) in the two forms of markets and
3. To make recommendations to issues associated with the effects of advertising on monopoly and duopoly markets.

The following hypothesis will be tested in our analysis:

H1-Advertising facilitates a firm to be more profitable in a monopoly market than it does to a company operating in a duopoly market.

H2- Price is more sensitive to advertising in the context of a monopoly market.

H3-Advertising and quality are directly related to market structure.

II. II. Literature Review and Research Model

III. 1. Literature Review

Two competing theories have been identified, one of which is the "market power" school of thought. It argues advertising reduces price elasticity and so it shrinks advertiser's market power and alleviates competition (Comanor and Wilson 1979). Ornstein (1977) complements this viewpoint by identifying brand loyalty as the intermediary variable which helps to explain how advertising lowers price elasticity. The alternative theory, the "advertising as information" school, holds that advertising enhances price elasticity by exposing consumers to an increased number of alternatives (Nelson 1974, 1975). For this reason, advertising boosts competition. The information school of thought was led by Stigler and Stiglitz (1968, 1968) of the University of Chicago.

The mechanism underlying both theories is the impact of advertising on price elasticity of demand. Gatignon (1984) found that advertising increased price sensitivity at the firm and the industry level. In the opposite, Benham (1972), whose study results were confirmed by Kwoka in 1984 and Hass-Wilson in 1986, suggested that advertising decreased price sensitivity at both levels while controlling for quality. This study was conveyed in eye glasses markets. In the same vein, investigation concerning the effects of advertising on monopoly on one hand and on duopoly on the other has been conducted by many

Page 6

researchers among whom are Kaldor (1950,-1951, p.14), Dorfman (1954) and Steiner (1954). According to Bierman and Fernandez (1998, p.11), Nicholson (1995, p.679) and Waldman and Jensen (1997, p324), the duopoly market tends to diminish prices and the follow-on profitability in the non-cooperative case; for recent examples, see Bierman and Fernandez (1998, P.11), Nicholson (1995, p.679) and Waldman and Jensen (1997, p324). Devine and Marion (1979) demonstrated the negative correlation between mean and variance of prices and advertising. Both theories are subject to test by estimating sales response functions in different markets and then measuring the impact of advertising on price elasticity (Comanor and Wilson 1979).

With respect to the advertising-quality relationship, preliminary research on the issue indicates that advertising expenditures and quality enhancement generally are not correlated. However, perceived quality appears to be positively correlated with advertising spending, especially for frequently purchased goods (Moorthy and Zhoo 1994). Advertising can convey quality information if information about a firm's sunk costs is indeed integrated into advertising expenditure. (Kihlstrom and Riordan 1984) Extensive literature in information economics proposes that price and advertising will function as credible signals as long as sellers do not profit to convey false market signals, for example, charging high prices for low quality. However, very few studies have tested directly impacts of advertising on price and quality of products both in monopoly and in duopoly market, which could be explained by the difficulty associated with modeling the issue. Eskin (1975) and Baron(1977) report negative interactions between advertising and price in an analysis of variance of field market test data . To enrich literature on this particular issue, we believe that innovative approaches have to be applied to the study.

A. 2. Research Model

1) 2. a. Model Description

This model takes a similar form of the Dorfman-Steiner Model to explain the effects of advertising on monopoly and duopoly markets. We modify the model by using the first part of the original Model to enlighten the price effects of advertising, and using the second part of the Model to describe quality effects of advertising in two forms of market. To get a more concrete understanding of the problem, we will use a simple calibration (numerical) to describe the effects of possible changes in price in relation to the profitability of a firm before and after advertising. We assume a small closed economy where one firm operates as a monopoly. Cost of this monopolist can

be kept secret, although the firms are requested by Anti-trust law to disclose fixed cost as long as they are in some sort of competition. The firm imports or produces products and sells finished goods to the population. Quantity sold is given by OQ_1 at the monopoly price P_1. Attributed to its monopoly position, the firm makes a monopoly profit, indicated as the shaded area in Figure1. As new entrants are unpreventable, the firm decides to invest in advertising to maintain significant profits before any new entrant steps in. This shifts its demand curve to the right and consequently having increased its profit. The high profit to be earned in a monopoly market is tempting to outsiders. A second firm, let's say firm2, will enter the market and now two firms operate as duopolists.

2) 2. b. Model when the Firm is a Monopoly

Let the demand function of the monopoly be given as:
$$Q = Q(AD, P) \quad (3)$$
And let the cost function is given by:
$$C = C(Q) \quad (4)$$
P= price
Q = quantity
AD = advertisement outlay
T = total advertisement cost
The profit function by definition is given by:
$$\pi = P*Q(AD, P) - C - AD*T \quad (5)$$
The objective of the monopoly firm is to maximize its profit by means of advertising and to select the appropriate values of P and AD.
Let's find the first order condition (F.O.C), with respect to price.

$$\frac{\delta \pi}{\delta P} = Q(AD, P) - \frac{\delta C}{\delta P} = 0 \quad (6)$$

$$\frac{\delta \pi}{\delta P} = Q(AD, P) + P\frac{\delta Q}{\delta F} - \frac{\delta C}{\delta P} = 0 \quad (7)$$

Then we multiply the last term of (5) by $\dfrac{\delta Q}{\delta Q}$ and rearrange.

$$\frac{\delta \pi}{\delta p} = (P - C')\frac{\delta Q}{\delta P} = -Q(AD, P) \quad (8)$$

Now we divide both sides by P and rearrange them.

$$\frac{\delta \pi}{\delta P} = \frac{(P - C')}{P}\frac{\delta Q}{\delta P} = \frac{-Q}{F} \quad (9)$$

$$\frac{\delta \pi}{\delta P} = \frac{(P - C')}{P} = \frac{-Q(AD, P)*\delta P}{\delta Q * P} = -\frac{1}{\varepsilon} \quad 10)$$

C' is the marginal cost (MC), denoted as $\dfrac{\delta C}{\delta Q}$.

Let's find the (F.O.C) with respect to advertisement.

$$\frac{\delta\pi}{\delta AD} = P\frac{\delta Q}{\delta AD} - \frac{\delta C}{\delta Q}*\frac{\delta Q}{\delta AD} - T = 0 \quad (11)$$

$$\frac{\delta\pi}{\delta AD} = (P - \frac{\delta C}{\delta Q})\frac{\delta Q}{\delta AD} = T \quad (12)$$

Now we divide both sides by AD/P and rearrange them.

$$\frac{\delta\pi}{\delta AD} = \frac{(P-C')}{P}\frac{\delta Q}{\delta AD}*\frac{AD}{Q} = \frac{AD*T}{QP} \quad (13)$$

$$\frac{\delta\pi}{\delta AD} = \frac{E_A}{\varepsilon_P} = \frac{AD*T}{QP} \quad (14)$$

Equation (14) is the reduced form of the well-known Dorfman-Steiner condition, which converses that the ratio of advertising and price elasticity must be equal to the ratio of advertising and sales.

3) 2. c. Model for the Duopoly Market
4) Assumptions

1. There are two firms in the market.
2. Each firm produces or sales slightly differentiated products.
3. The two firms enjoy some limited product differentiation, market power and / or other advantage that gives them realistic pricing options. In other words, there is some variation in prices which may result in higher or lower sales volume within the operating range of the company.
4. Advertisement effects are equal across firms in the cooperative case and different in the non-cooperative one.

Now we assume that a second firm is attracted by the tremendous profit made by the monopoly and decides to enter the market. We have now two firms competing in the same market. The question now is to detect the advertising effects on profitability, price and quality for each firm. Thus, the demand curve of one firm will have to include the reaction of its rival. Let

$$Q = Q(AD, \overline{AD}, P)$$
$$(15)$$
$$C = C(AD, \overline{AD}, P)$$
$$(16)$$

$\overline{AD}$ represents advertising spending.

$$\pi = PQ(AD, \overline{AD}, P) - C(Q(AD, \overline{AD}, P)) - AD*T$$
$$(17)$$

Effects of advertising on the duopoly profitability will be:

$$\frac{\delta\pi}{\delta AD} = P(\frac{\delta Q}{\delta AD} + \frac{\delta Q}{\delta \overline{AD}}*\frac{\delta \overline{AD}}{\delta AD}) - \frac{\delta C}{\delta Q}(\frac{\delta Q}{\delta A} - \frac{\delta Q}{\delta \overline{AD}}*\frac{\delta \overline{AD}}{\delta AD}) - T = 0$$
$$(18)$$

$$\frac{\delta\pi}{\delta AD} = (P - \frac{\delta C}{\delta Q})(\frac{\delta Q}{\delta AD} + \frac{\delta Q}{\delta \overline{AD}}*\frac{\delta \overline{AD}}{\delta AD}) - T = 0 \quad (19)$$

We know that

$$E_{AD} = \frac{\delta Q}{\delta AD}*\frac{AD}{Q} \quad \text{And} \quad E_{\overline{AD}} = \frac{\delta Q}{\delta \overline{AD}}*\frac{\overline{AD}}{Q}$$
$$(20)$$

$$\frac{\delta\pi}{\delta AD} = (\frac{P-C'}{P})(\frac{\delta Q}{\delta AD} + \frac{\delta Q}{\delta \overline{AD}}*\frac{\delta \overline{AD}}{\delta AD}) = \frac{T}{P} \quad (21)$$

Let us multiply both sides by AD/Q and rearrange (19) the equation as:

$$(\frac{P-C}{P})(\frac{\delta Q}{\delta AD}*\frac{AD}{Q}) + (\frac{\delta Q}{\delta \overline{AD}}*\frac{\overline{AD}}{Q}*\frac{\overline{\delta AD}}{\delta AD}*\frac{AD}{\overline{AD}})) = \frac{ADT}{PQ}$$
$$(22)$$

$$\frac{\delta\pi}{\delta AD} = \frac{-1}{\varepsilon_p}(E_{AD} + E_{\overline{AD}}*E_{AD,\overline{AD}}) = \frac{AD*T}{PQ}$$
$$(23)$$

Where, $E_{AD,\overline{AD}}$ is the elasticity in response to competitor firm's advertising expenditure with respect to its own spending.

5) Diagrammatical Analysis when the Firm is a Monopoly

Since advertising increases the total cost of producing and distributing a particular product, total revenue needs to be higher to cover the extra advertising outflow. However, average price per unit of sold did not to be increased in order to satisfy this condition. As long as quantity sold increases, an increase in total revenue can be achieved without raising selling price. Yet, the fact that increased output incurs more production costs has to be taken into account.
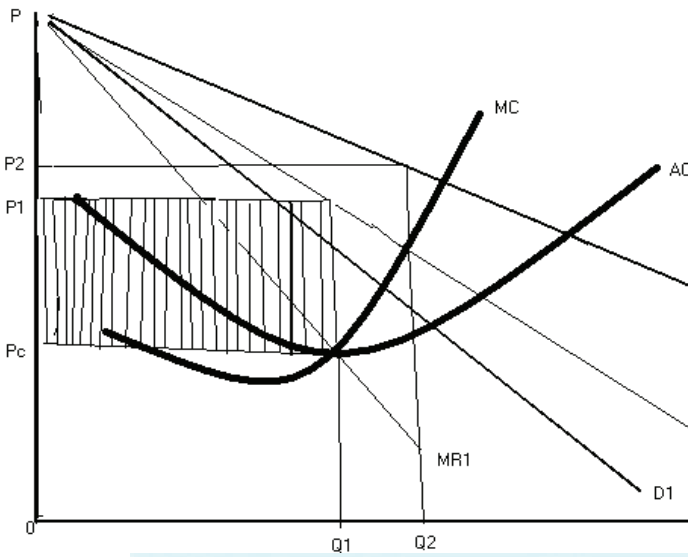
Figure1: Effect of price and quantity increase.

Q1 is the monopoly quantity before advertising.

Q2 is the monopoly quantity after advertising.

MR1 is the marginal revenue of the monopoly before advertising

MR2 is the marginal revenue of the monopoly after advertising.

AC is the total average cost of the monopoly

P1 is the monopoly price before advertising

P2 is the monopoly price after advertising.

Assuming production cost is constant regardless of production quantity, total unit cost of product must increase with an increase in advertising.

In Figure 2.1, (OQ1*PcP1) is the monopoly profit before advertising. (Pc-P2)(0-Q2) is the monopoly profit after advertising. Excess profit resulted from advertising is the difference between post-advertising profit and prior-advertising profit. (see details in numerical calibration)
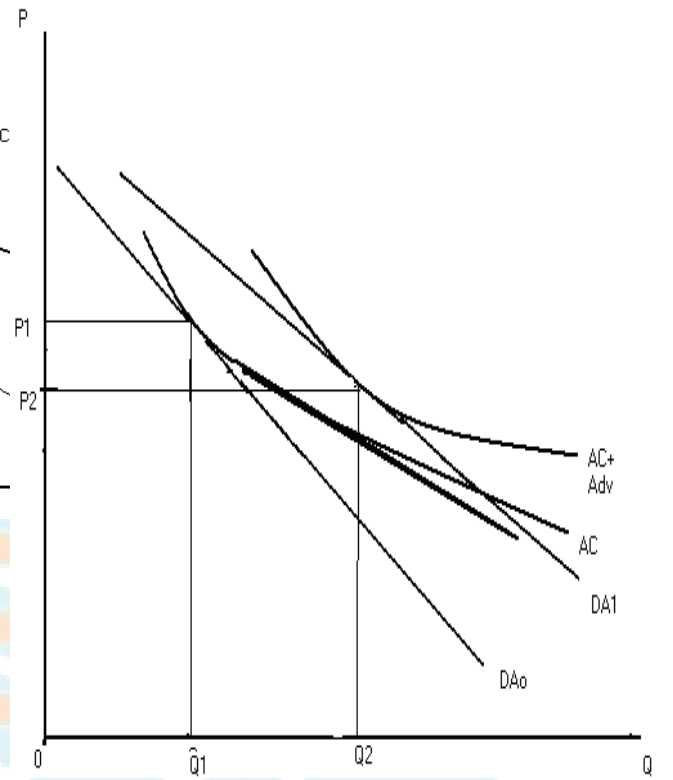

Figure 2: Effect of price decrease or Necessary condition for price decrease

Q_1 and P_1 are identified as the monopolist quantity and price, respectively. Q_2 and P_2 are denoted as the quantity and price after advertising. MR1 (DA_0) and MR_2 (DA_1) are defined to be marginal revenue before and after advertising. The rectangular area (P_1 Q_1) represents the profit before advertising; the rectangular area (P_2 Q_2) is the profit after advertising.

6) Diagrammatical Analysis when the Firms are Duopolists

Figure 3 shows the advertising response of the rivalry firm in relation to its own advertising spending (the advertising reaction functions). Two firms are labeled as firm1 and firm2; RF_1 (ZCV) gives the profit –maximizing level of advertising for the firm, given particular levels of advertising by its rival, and vice versa for RF_2(ZCV). We know that profit is decreasing along the reaction functions as it moves away from the axes, which is not surprising given equilibrium prices and marginal costs. The figure identifies multiple equilibrium. The non-cooperative equilibrium (NC) is given by the intersection of the reaction functions. The leadership by the firm resulting in Stakelberg equilibrium at point SCC' is the contract curve of Pareto-optimal maximum profit point. If the duopolists

have positive conjectural variations, the reaction functions shift to RF$_2$ (CV) and RF$_1$ (CV). The intersection of these reaction functions gives a new non-cooperative equilibrium at a higher profit level than NC. This situation can be interpreted as one of tacit collusion between the firms.
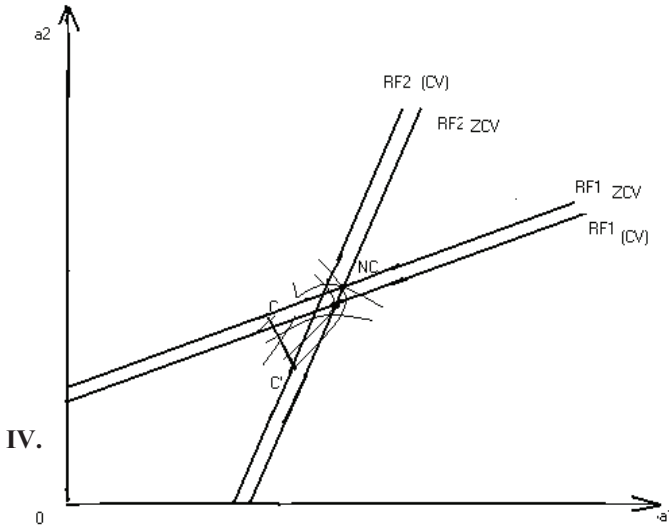

Figure 3: Advertising reaction to price change in a duopoly market.

V.

VI. III. EFFECTS OF ADVERTISING ON PRICE AND QUALITY OF PRODUCTS

The effects of advertising on price and quality are directly related to the effects of advertising on profitability. When advertising increases prices, profits will also increase and vice versa when it decreases prices. However, we need to recognize that the consequences vary depending on the structure of the market, i.e. monopoly or duopoly. We aim to study its effects on these two markets.

A. 1. Advertising and Price in Monopoly Market

As it has been mentioned earlier, advertising is a strategy influencing the shape or position of the demand curve for a firm's product. This implies that demand may change at different price level even without a change in the physical characteristics of a product. To realize the ultimate profit-maximizing objective, a firm has to compare the maximum profit (total revenue minus production and advertising cost) to each pair of demand and cost curve.

Effects of advertising on price in a monopoly market are two folded: Advertising either increases the price or decreases it. Expectedly, following up advertising, a firm will increase its production quantity as a result of the excess demand. However, advertising is costly; to cover the advertising cost, it has to raise the price at the same time to maximize profit as shown on the diagrams (figure 1 and 2.).

If advertising is to lower selling price, it has to increase the quantity sold and either unit profits must be reduced or unit production cost must decline with increases in output, as shown by Figure 2. The problem now is to figure out whether the post-advertising profit is greater than initial profit without advertising. The calibration will help to clarify the issue later on. A preceding test regarding the introduction of a toy advertisement on television reveals a sharp price reduction following advertising. Generally speaking, local advertising leads to higher price sensitivity among existing consumers, which will result in a lower optimal price level for the firm. (Dorfman and Steiner, 1954) For instance, advertising may introduce consumers to outlets which were not aware of previously. In addition, advertising may bring in new consumers who are more price-sensitive than retained customers. In this case, the optimal price level will decrease.

It is noteworthy that the statement advertising reduces prices is invalid unless the aforementioned conditions are satisfied. Thus, the presence of an increase in demand and its resulting scale economies do not guarantee that advertising will lower prices. How can we explain that high advertising intensity is directly related to reducing prices without market concentration?

B. 2. Advertising and Price in Duopoly Market

We recall that one of the well-known approaches to analyze the impact of advertising on profitability of a firm is the prisoner's dilemma game. It is simply assumed that the corresponding numerical 2*2 profit (payoff) matrix is such that for any firm the profit is higher if neither of them does advertising.

In the duopoly case, we have to distinguish between the non-cooperative case and the cooperative case.

In the non-cooperative case, any decision taken by one firm in order to increase its profitability will generate retaliation by the other firm, which will return the demand level to the original state.

In this case, advertising will simply raise the price of the product in question at the expenses of consumers .Both firms will make a higher profit because of the tacit collusion between them.

In the cooperative case, both firms will act accordingly to spend as much or as little in advertising and impose a collusion price to consumers. This price may be higher than the initial one; if so, the duopolists will realize a

"super profit". Alternatively, this price could be lower than the original one, if they perceive consumers may be influenced by price difference. In this situation, profits will not change much (see the calibration).In fact; the cooperative case is similar to the monopoly situation where consumers follow the "dictat" of the firm.

4. dvertising and Quality in Both Markets

By quality, we refer to all aspects of a product, including service specified out in a sale contract, which also influences the demand curve. The essential difference between advertising and changes in quality is that the latter incorporated into variable costs. Each conceivable quality corresponds with a definite average cost curve; however, it is still possible that several different qualities share the same average cost curve. Milgrom and Roberts (1986) provide a signaling model of advertising of a newly exposed good. In a duopoly market, consumers are willing to pay more for a product they believe to be of high quality because such a product is perceived to be more satisfactory. This, to some extent, creates opportunities for a firm to produce a low-quality good to imitate the high-quality producer. The firm who produces high quality products, therefore, has an interest in setting an initial price-advertising combination that could make the low-quality producer unprofitable. Being alerted by advertising, consumers are confined of the high quality of the product and are willing to pay more for it than would otherwise be the case.

Advertising can convey quality information if information about a firm's sunk costs is incorporated into advertising expenditures (Kihlstrom and Riordan 1984). A large volume of literature in information economics is there suggesting that price and advertising will function as credible signals only if sellers do not convey false market signal. Assuming a firm produces a differentiated product whose quality can be measured, and whose rate of sales per unit of time (q), is a continuous and differentiable function of price (p) and quality index (x). We write as its demand function.

$$q = f(p,x) \qquad (31)$$

The average cost of production, c, is a function of q and x

$$C=C (q, x) \qquad (32)$$

The effects on profit of arbitrarily small changes in price and quality precisely offset the effects on sales.

$$qdp - qdc = -q\left[\frac{\frac{\delta f}{\delta x}}{\frac{\delta f}{\delta p}} + \frac{\delta c}{\delta x}\right]dx$$

(33)

The condition for profit maximization is when the quality in parenthesis is zero, or

$$-\frac{\delta f}{\delta p} = \frac{\frac{\delta f}{\delta x}}{\frac{\delta c}{\delta x}}$$

(34)

This is the condition sought. The left hand side of this equation is the slope of an ordinary demand curve. The right hand side essentially measures the rate at which sales increase in response to an increase in average cost incurred in order to achieve an increase in quality. The value on the right hand side of equation (25) is greater than it is on the left. This indicates that an increase in quality would increase demand more than enough to compensate for the loss of sales, which could result from an increase in price just enough to cover the increase in cost. Under such a circumstance, quality should be increased.

Thus, the ordinary quality level in any market depends on the relative magnitudes of two market characteristics and one technical feature of a product. Quality tends to be higher, is the existence of the following three conditions: the greater the sensitivity of consumers to quality variation is(measured by df/dx),the lower the sensitivity of consumers price Δy^0 appears to be(measured by $\frac{\delta f}{\delta p}$), and the lower the effect on average costs of quality changes turns out to be(measured by $\frac{\delta c}{\delta x}$).These three determinants interact with one another to realize the general level of quality.

VII. IV- CONCLUSION AND RECOMMENDATIONS

Much attention has recently been paid to the empirical analysis of an individual market, rather than to the broad sweep of industries. This study shows that various schools

of thought all agree that advertising is directly related to a monopoly market. The effects of advertising on the profitability of a firm by increasing price and quantity are beneficial to the seller, although a monopoly position is not welcomed by consumers. Advertising also proves to have a direct effect on quality of products. This point is supported by a positive relationship between the amount of advertising spent and the quality of a product perceived by consumers. However, in a duopoly market, as most other authors have noted, it is very difficult to capture the effects of advertising on price, and its related profitability. This is due to the sensitivity of customers to even the slightest price change when there is more than one firm operating in the market. Finally, we also notice that advertising is directly related to the quality of products, which is one of the major findings of all those who have examined the issue.

For further studies, we suggest that emphasis be placed on the overall model to evaluate the effects of advertising on profitability (price and quality of products) in an oligopoly market. This will generalize the case studied above.

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