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Mohd, Irfan

Indian Institute of Technology Kanpur

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Mohd Irfan*
Indian Institute of Technology Kanpur
irfan@iitk.ac.in

Abstract

This paper proposes a two-stage game theoretic model in which the discretionary power of executives acts as an implicit defense against hostile takeovers. Following managerial enterprise models, this paper analyzes the effects of target's executives' discretionary power over R&D and advertising in defeating hostile takeover attempts. It is shown that in vertically differentiated industries, in equilibrium, target's executive keep low level of R&D and advertising to make their firm an unattractive target for hostile takeovers. The model reveals that the executives are influenced by their self-interest of monetary and non-monetary benefits and this self-interest behavior makes the industry less differentiated. Additionally, the firm's takeover (hostile or friendly) is endogenously determined by the executives.

Keywords: Executives Discretion, Hostile Takeovers, Vertical Differentiation, R&D, Advertising
JEL Classification: D03, G34, L6, L15

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* **Correspondence:** PhD Student (Economics), Department of Humanities and Social Sciences, Indian Institute of Technology Kanpur, UP (India). Phone No: +919935829507.

1. Introduction

Hostile takeover of firms are not new in corporate world, in UK during the period 1991-97, hostile takeover bids covers around 16.5% of total bids for public companies (Deakin, Hobbs and Singer, 2001).The unprecedented economic recession which began in the first quarter of 2001 raises the number of such takeovers. Value of these takeovers in US was around $95 billion in 2001 which is more than double the value in 2000, and almost $15 billion more than in 1988 (Thorton,2002).The crises had motivated the industry leaders to acquire their rivals as a corporate growth strategy. Firms' having adequate cash reserves or borrowing capability initiated the forcibly acquisition of others at discounted prices. As a consequence, distressed firms' became more vulnerable to hostile takeovers attempts. However, favorable conditions were restored in 2004 the hostile takeover attempts didn't take off. In year 2006, more than 100 hostile transactions, valued at over $520 billion, were announced around the world (Ruud, Näs, and Tortorici, 2007).Indeed, the picture of hostile takeovers is more or less similar in other countries too.

Hostile takeovers are public offer of specific price, usually a substantial premium over the prevailing market price of stocks. It allows the bidders to seek control directly from the shareholders by going 'over-the-heads' of target's executive team. In contrast to friendly takeovers, where the bidder's proposal receives a positive reaction from the target's executive team because it need to be approved by executives, hostile bids are unsolicited offers that challenge the strategic direction and leadership of the company (Pearce II and Robinson, 2004).On the consequence side, successful hostile takeover replaces the target' executive team by a new and efficient team [Franks and Mayer (1987), Krug (2003)].

The executive's legal obligation is to get a good deal for shareholders, which often means supporting the hostile takeovers. However, executives' self-interest is to save his job and non-monetary benefits (i.e. number of staff, security, power, status & prestige) which he often looses after his firm's hostile takeover. A target's executive faces the dilemma of choosing between self-interest or shareholders interest in hostile takeovers attempts. If the incentives are not perfectly aligned with those of shareholders, they would be tempted to oppose the hostile takeover attempts. According to Jensen and Mechkling (1976), in such situations where his self-

interest is more influencing then shareholder's interest, executive will follow his self-interest. Defeating the hostile takeovers attempts also opens the option for friendly takeover where they apparently retain their job, non-monetary benefits and get a share in firm's ownership (stock).Aveni and Kenser (1993) examined that in friendly takeovers executives cooperate with the bidder for their job, non-monetary benefits and share in ownership.

Target's executives have access to a variety of explicit defensive tactics to defeat hostile takeovers (Gaugan,2007).The array includes charter amendment, poison pills golden parachute, litigation, green mail and standstill agreements and many more(Pearce II and Robinson,2004). Although these defenses are effective in delaying the hostile takeovers but they are rarely enough to keep the target away from the fear of hostile takeover attempts. Bidder's motivation for attempting the hostile takeover is backed by higher profit earnings by expanding the product breadth and customer base. Similarly, the motivation for accepting the hostile takeover by target's share holders is to get a higher premium over the market prices of stock. Therefore, if the gains from the hostile takeover are less for the bidder he will give up his attempt or if the premiums are lower target's shareholders will be reluctant to accept the hostile takeover offer.

This relationship (takeover gains/premiums with hostile takeovers) is the subject matter of this paper. More specifically, the purpose is to explore how executives are exploiting it to fulfill their self-interest. A two stage game theoretic model is constructed to show that when firms are competing in vertically differentiated industries, target's executives use their discretionary power over R&D and advertising to lower the gains and premiums accrue to bidders and target's shareholders, respectively. As a result, they defeat the hostile takeover attempt of their firm. Additionally, this behavior will make the industry less differentiated and the choice of takeover (hostile or friendly) becomes an endogenous decision. The rest of the paper is organized as follows: Section 2 is devoted for the review of related literature, followed by the description of model in section 3 and finally we conclude in the last section.

2. Related Literature

The area of hostile takeovers has been extensively explored in past years. Researchers have developed a number of arguments for such activity including the existence of synergy or economies of scale and disciplining the executives. The synergy motive occurs because of

economic gains that result by merging the resources of two firms. Berkowitch and Narayan(1993) examine the synergy motives of takeovers using 330 hostile takeovers made during 1963-1988 and found that there is a positive correlation between takeover target and total gains. On the disciplinary role of takeovers, Grossman and Hart (1980) argued that when a firm's environment changes, the relationship between shareholders and executives becomes obsolete. Executives get the opportunity to transfer some value to themselves. Hence, takeovers improve efficiency of executives by enabling a third party (bidder) to take control of the firm. According to Manne (1965), a takeover provides assurance of competitive efficiency among executives and thus saves the interests of scattered shareholders. Morck et. al. (1989) in their analysis of 425 public trades firms found that hostile takeover attempts are motivated by the gains associated with disciplining poorly performing executives. Samuelson (1970) in his seminal work mentioned that takeovers are nature's method of eliminating deadwood in firm's survival struggle.

In the contrast of executive replacement hypothesis, considerable attention has devoted to the study of opposition by target's executives to takeover attempts. Easterbrook and Fischel (1981) in their analysis find that executives resist hostile takeover attempt to preserve their firm's independence and thus preserve their salaries and status. In light of own self-interest and shareholders interest in hostile takeover attempts, executive faces a dilemma of accepting or resisting the takeover. Jensen (1988), in his work argued that executive always follows their self interest. Additionally, executive's self interest is not only limited to monetary benefit like salary and share in profits but also non-monetary benefits. Williamson (1963) stated that executive's utility function includes the monetary benefits and non-monetary benefits, non-monetary or private benefits are material satisfaction and include number of staff, security, power, status, prestige and professional excellence. *"with the expansion of staff, the expansion of physical plant and equipment provides general opportunities for managerial satisfaction"* Williamson (1963).

The evidence suggests that these benefits are lost by target's executives after hostile takeovers because they are replaced by new and efficient team. For example, Franks and Mayer (1996) examine 33 successful hostile takeovers in the United Kingdom that were first announced during 1985 and 1986.They find that hostile takeovers are associated with high executive

turnover,90% executives resigned after successful hostile takeover. Similarly, Krug(2003) in his research found that on average, about a quarter of the executives in acquired top management teams leave within the first year, additional 15% depart in the second year, roughly double the normal turnover rate. From this perspective, executive may prevent hostile takeover that would be profitable for shareholders if he expects to lose some of his rents and perquisites (Schnitzer, 1996).

Executive have several defenses against hostile takeovers like poison pills, corporate charter amendments ,golden parachutes, litigation, greenmail, standstill agreements and capital structure changes(for details see Gaugan,2007). PearceII and Robinson (2004) reviewed the effects of these defenses and concluded that only poison pills and litigation are likely to increase the shareholders wealth, effects of others are negative or negligible. However, all these defenses are confined to maximizing the shareholders interest and assume that executives are performing for the best of their shareholders. Jensen (1986) criticizes this assumption unrealistic and stated that executives always follow their self-interest rather than shareholders. Jarell also argued that these are explicit defenses and most of them are ineffective in eliminating the firm's chances of takeover, these measures can only delay the takeover attempts and nothing else. Therefore, executives are motivated to look for some other defenses which are implicit in nature and more effective.

Marris (1963), in his model of managerial enterprise affirmed that managers have discretionary power over R&D and advertising expenditures along with the prices to maximize their firm's rate of growth. R&D allows a firm to improve the quality (Deroian and Gannon, 2006) by real change while advertising improves the quality imaginary, by changing the consumer preferences between the available brands (Bloch and Manceau, 1999). Additionally, in vertically differentiated industries, product differentiation is established through R&D or advertising activities (Motta, 1993).Therefore, we can say that in vertically differentiated industries, executives might use this discretionary power to defeat their firm's hostile takeover attempt. Although available literature had extensively explored various defenses against hostile takeovers, but neglected the role of executive's discretionary power over R&D and advertising. Harris and Raviv (1987) examined the effect of issuing high amount of debt in deterring the

takeover raid. Similarly , implementing the management buyout is another example of saving the self-interest of target's executive team (Shleifer and Vishney,1987) In contrast, this paper proposes a two-stage game theoretic model of executive discretion over R&D advertising in making the takeover type an endogenous decision (decided by the executives).

3. The Model

It is necessary to remark that this paper is mainly interested in the effects of executive's discretion (R&D and advertising) in defeating hostile takeover attempts. We considered a two stage game in which it is assumed that, a priori, executives have discretionary power in choosing the quality of their products. They do it by adopting a level of R&D or advertising intensity and each firm knows its rival's product quality. In the first stage, executives behave non-cooperatively and choose the quality of their products. This establishes a level of quality (product) differentiation between their products. And in the second stage, given this level of quality differential, one of the firms decides to takeover his rival. Further, assume that the first takeover attempt is always hostile takeover and the failure in hostile takeover attempt will open other takeover option i.e. friendly takeover or no takeover. We will solve this game by the method of backward induction to find the equilibrium level of quality differential that minimizes the possibility of hostile takeover with minimum loss to executives.

To develop the model we have followed some interesting aspects of the income and quality purchase models of Gabszewicz and Thisse(1979) and Shaked and Sutton(1982)[1].To describe the model simply, suppose we have an industry with N number of firms, competing in qualities or more specifically the industry is vertically differentiated(differentiate their products in terms of quality). To avoid the complexities associated with cost it is assumed that the cost of production is zero. On demand side, consumers are heterogeneous i.e. different in their income level or willingness to pay, identified by their income θ and they are uniformly distributed along the space [0, 1].Each consumer has its unique place in this space according to his income. Consumers may purchase either single unit of the product from one of the firms or none at all if

[1] Brief explanation is given in "The Theory of Industrial Organization" Jean Tirole (1989),The MIT press, page 296

prices are too high. The utility function for a consumer with $\theta \in [0,1]$ is $U(\theta) = \theta s - p$ when he consumes a product of quality s at price p with given income θ.

As a matter of fact, in differentiated product markets, there are always some consumers who are located at the extremes in the space [0, 1] see in figure 1.1. More specifically, because of the budget constraint or elite mindset they don't have any incentive to tradeoff between income and quality. In other words, their elasticity of substitution between income and quality is either zero or infinite. These consumers are located at left (right) extreme part of the space and served by the firms producing products with inferior (elite) quality. Consumers whose income is less than $\underline{\theta}$ have the elasticity equal to infinite and income more than $\overline{\theta}$ have elasticity equal to zero. Between these two extremes, remaining market $\overline{\theta} - \underline{\theta}$, where $\overline{\theta} > 2\underline{\theta}$ is covered by the n number of firms, competing in qualities.

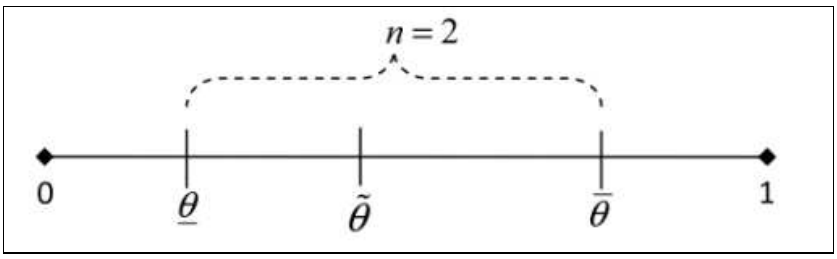

Figure 1.1: Distribution of consumers

For simplicity, assume that there are only two firms $Firm_1$ and $Firm_2$ producing distinct, substitute goods in space $[\overline{\theta} - \underline{\theta}]$. Firms are producing their products with a quality and price combination of (s_1, p_1) and (s_2, p_2) respectively where $\boldsymbol{s}$ is the quality index, $s_1 < s_2$ and $(s_1, s_2) \in [0,1]$ .There would be a consumer, who is indifferent between the products of firms, we denote this marginal consumer by its place in $\overline{\theta} - \underline{\theta}$ space by $\tilde{\theta}$. This marginal consumer have the respective utility functions $U(\tilde{\theta}) = \tilde{\theta} s_1 - p_1$ and $U(\tilde{\theta}) = \tilde{\theta} s_2 - p_2$ for both the products at given prices, quality and income. By definition he satisfies $\tilde{\theta} s_1 - p_1 = \tilde{\theta} s_2 - p_2$ and solving the equality of these utility functions, income of this marginal consumer is:

$$\tilde{\theta} = \frac{p_2 - p_1}{s_2 - s_1} \qquad (1)$$

Clearly, consumers having income $\theta < (>)\tilde{\theta}$ will buy from $Firm_1$ ($Firm_2$). Let, $\varepsilon \equiv s_2 - s_1$, which is a measure of quality differential between the firms products, a large ε indicates a large amount of differential. Any increase in quality due to the increase in R&D or advertising by $Firm_1$ (keeping s2 fixed) will decrease the ε.Thus, makes his product a close substitute of $Firm_2$'s product i.e. low differentiation .However, increase in R&D or advertising by $Firm_2$ (keeping s1 fixed) will increase the ε and consequently makes his product more unique i.e. high differentiation. Accordingly, with covered market assumption, the demand enjoyed by $Firm_1$ and $Firm_2$ are $\tilde{\theta} - \underline{\theta}$ and $\bar{\theta} - \tilde{\theta}$ respectively and their profits functions are $\prod_1 = p_1(\tilde{\theta} - \underline{\theta})$ and $\prod_2 = p_2(\bar{\theta} - \tilde{\theta})$.Then under Bertrand competition, profit maximization under non-cooperative behavior yields the following profits as a function of ε (derivations are given in appendix A.1).

$$\prod_1(\varepsilon) = \frac{1}{9}(\bar{\theta} - 2\underline{\theta})^2 \varepsilon \quad \text{and} \quad \prod_2(\varepsilon) = \frac{1}{9}(2\bar{\theta} - \underline{\theta})^2 \varepsilon \qquad (2)$$

3.1 Solution of stage II

Now let's go to our takeover game, backward induction method implies that first we should consider the second stage of this game. With the given level of quality differential ε, bidder firm decides whether to attempt the hostile takeover or not. We solve this stage to find that at what level of ε the target's hostile takeover is possible. Let us assume that $Firm_2$ is interested in the hostile takeover of $Firm_1$, other way can also be possible. If the hostile takeover is not a possibility, then either $Firm_1$ will remain in operation or will initiate friendly takeover led by its executives. In friendly takeovers executives cooperate with the bidder for their job, non-monetary benefits and share in ownership (Aveni and Kenser, 1993).Hence, friendly or no takeover option will fulfill the executive's self-interests.

After the successful hostile takeover of $Firm_1$, the profit level of $Firm_2$ would be $\prod_m(\varepsilon)=\frac{1}{4}\bar{\theta}^2 s_2$ because now he is enjoying the monopoly in the space $\left[\bar{\theta}-\underline{\theta}\right]$ (see appendix A.2).The maximization problem is conceptually equivalent to the problem of a monopolist producing two different qualities (Hackner,1994).In result, he produces only one product with quality s_2. The net gain of $Firm_2$ from this hostile takeover is the difference between the monopoly and the non-cooperative profits:

$$G(\varepsilon)=\frac{1}{4}\bar{\theta}^2 s_2-\frac{1}{9}(2\bar{\theta}-\underline{\theta})^2\varepsilon \qquad (3)$$

Higher gains would allow $Firm_2$ to offer a higher premium to the shareholders of $Firm_1$, in excess of their stock prices. Getting higher prices on their stock would encourage the shareholders of $Firm_1$ to sell their stocks to $Firm_2$.Thus, enhances the target's possibility of hostile takeover.

Proposition I: *Takeover gains* $G(\varepsilon)$ *are a function of quality differential* ε *and there is a critical limit for hostile takeover, beyond this it is unprofitable to takeover the target.*

Proof : Hostile takeover of $Firm_1$ by $Firm_2$ is only possible when the gains of $Firm_2$ from this takeover is at least greater than zero, $G(\varepsilon)>0$.Hence, for the critical limit of quality differential ε which determines hostile takeover of $Firm_1$, we should solve the following inequality.

$$\frac{1}{4}\bar{\theta}^2 s_2-\frac{1}{9}(2\bar{\theta}-\underline{\theta})^2\varepsilon \;>\; 0 \qquad (4)$$

Therefore, the critical level ε_c is equal to $\frac{9}{4}\left[\frac{\bar{\theta}^2 s_2}{(2\bar{\theta}-\underline{\theta})^2}\right]$ (details are given in appendix A.3). $Firm_2$ will attempt the hostile takeover of $Firm_1$ only when the given level of quality differential ε is less than the critical level ($\varepsilon<\varepsilon_c$) as shown in figure 1.2.

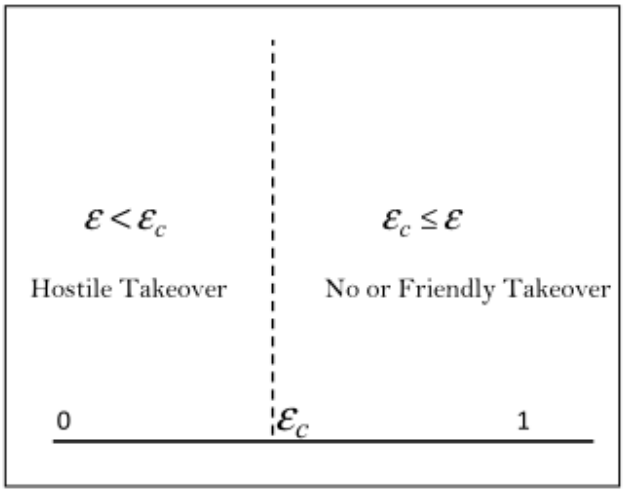

Figure 1.2: Hostile takeover as a function of ε

3.2 Solution of stage I

Since we got the possibility of firm's hostile takeover (from stage II) in terms of quality differential ε, we now move to the first stage of this game, in which the executives of $Firm_1$ have a significant role to play. Here executives' problem is to set of the level of quality differential which maximizes his self-interest. We assume that all executives have a homogenous utility function, to simplify the analysis further assume that there is only one executive in $Firm_1$. The utility function of this executive is $U(\varepsilon) = S + \psi \prod_1(\varepsilon) + B(1-\varepsilon^2)$ and it is characterized as a function of monetary benefits (fixed salary (S), fixed percentage (ψ) in firm's profits) and non-monetary benefits B attained by them [ψ & B >0].Accordingly, for the optimal level of quality differential ε_U he would maximize his utility function given in the below equation:

$$\max_{\varepsilon} \; S + \psi \prod_1(\varepsilon) + B(1-\varepsilon^2) \qquad (5)$$

Solving the optimization problem in equation (5) gives the utility maximizing level of quality differential $\varepsilon_U = \frac{1}{18}\left[\frac{\psi}{B}(\bar{\theta} - 2\underline{\theta})^2\right]$ (derivation is given in appendix A.4).This is the first best choice that the executive would like to maintain in the industry (see in figure 1.3).

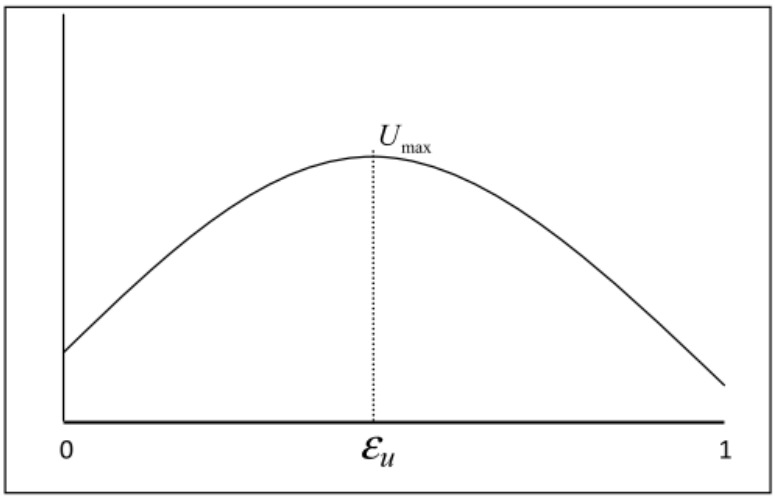

Figure 1.3: Utility maximizing level of $\mathcal{E}$

Proposition II: *The utility maximizing choice of quality differential $\mathcal{E}_U$ is inversely related with the non-monetary benefits of executives. Any change in the non-monetary benefit (B) will change the choice of $\mathcal{E}_U$.*

Proof: The first derivative of the optimal choice $\mathcal{E}_U = \frac{1}{18}\left[\frac{\psi}{B}(\bar{\theta} - 2\underline{\theta})^2\right]$ w.r.t $\mathcal{E}$ is $-\frac{\psi}{18}\left(\frac{\bar{\theta} - 2\underline{\theta}}{B}\right)^2$. The negative slope confirms that the utility maximizing quality differential choice $\mathcal{E}_U$ is a decreasing function of B. This implies that any change in non-monetary benefits will motivate the executives to distort their optimal level of quality differential ($\mathcal{E}_U$).

Figure 1.4 illustrates the equilibrium quality differential ($\mathcal{E}_E$) of this two stage game. From the second stage of this game we derived the $Firm_1$'s critical limit of being hostile takeover by $Firm_2$, and the first stage focuses on the utility maximizing choice of quality differential. Executive's objective is not limited in maximizing his utility function but also rule out his firm's possibility of takeover. He can retain his job and enjoy other benefits only when his firm either implements friendly takeover or remain in industry. Therefore, the equilibrium choice of quality

differential is influenced by the firm's possibility of hostile takeover. The following proposition describes the outcome from the perspective of target's executive in maximizing his self-interest.

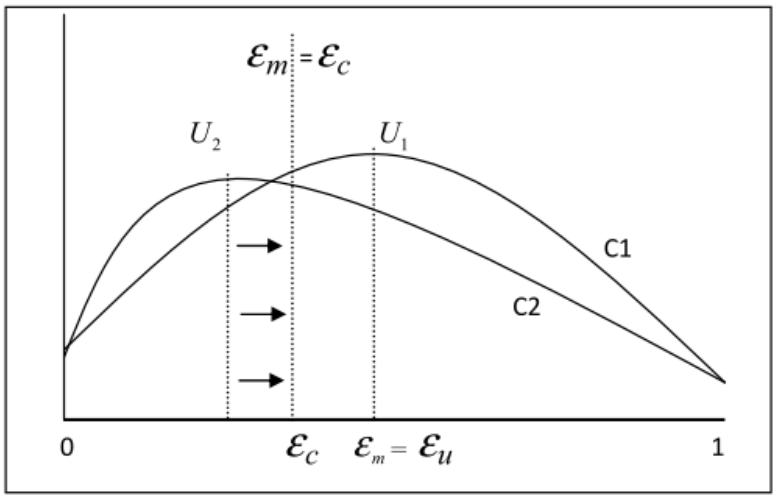

Figure 1.4: Equilibrium outcome of the game

Proposition III: (a) *If* $\varepsilon_u \geq \varepsilon_c$ *the equilibrium level of quality differential (*ε_m *) will be equal to the executive's optimal choice* ε_U .

(b) *If* $\varepsilon_u < \varepsilon_c$ *the equilibrium level of quality differential (*ε_m *) will be equal to the critical level* ε_c.

Proof: Because the choice is now dependent on the possibility of staying in the target firm (minimizing the possibility of hostile takeover) executive would choose the level of quality differential by interacting his utility maximizing choice with the critical limit of being hostile takeover.C1 and C2 curves in figure 1.4 are the two utility curves showing the utility maximization choices. Executive knows that if his utility maximization choice (U_1) is greater than the critical limit (ε_c) his firm's hostile takeover is zero. He doesn't have any incentive to distort this level and hence he will keep this utility maximizing choice, equilibrium outcome is established at $\varepsilon_m (= \varepsilon_u)$. However, in cases when the utility maximizing choice (U_2) is less than the critical limit (ε_c) he would have strong incentive to distort it. At this choice (U_2), his firm is a good takeover target and therefore executive will spend less on R&D and adverting to increase the level of quality differential (ε) , at least equal to the critical limit (ε_c). Distorting the

quality differential in the industry and setting it equal to the critical limit will makes his firm's possibility of hostile takeover equal to zero. The equilibrium outcome will be established at the critical limit $\varepsilon_c (= \varepsilon_m)$.

At last, whatever be the executive's utility maximizing choice it is always greater than or equal to the critical limit and therefore, makes the industry more differentiated in terms of product's quality. Moreover, since the executives have discretionary power over R&D and advertising expenditures and they use it as a defense against hostile takeover attempts, it can be said that the firm's takeover type is endogenously determined.

4. Conclusions:

The top executive's legal obligation is to get a good deal for shareholders, which often means allowing the hostile takeover of their firm. However, executive's own interest is to save his job and the non-monetary benefits, which he often loses after a hostile takeover. Hence, due to this self-interest behavior executives are motivated to defeat their firm's hostile takeover attempts. Apart from the explicit defensive tactics against the hostile takeovers, executives are utilizing their discretionary power over R&D and advertising expenditures as an implicit defense against hostile takeovers.

This paper proposed a two-stage game theoretic model of a vertically differentiated industry, in the first stage, non-cooperative behavior of firms establishes the level of quality (product) differentiation between their products. And in the second stage, this level of quality differential determines the firm's attempt to hostile takeover his rival. We find the solution of this game by backward induction method. The solution reveals that at equilibrium, executives are keeping low level of R&D and advertising to make their firm less attractive target for hostile takeover attempts. Moreover, executive's self-interest behavior makes the industry more differentiated in quality and the firm's takeover types either hostile or friendly is endogenously determined by the target's executives. Validity of this model can be easily tested by using empirical data and econometric techniques. The model hypothesize that an increase in R&D and advertising expenditure tends to decrease the firm's likelihood of hostile takeover but we leave it for future research.

Appendix:

A.1. Derivation of profits under Bertrand competition

The demand enjoyed by $Firm_1$ and $Firm_2$ are $\tilde{\theta}-\underline{\theta}$ and $\bar{\theta}-\tilde{\theta}$ respectively and their profits functions are $\prod_1 = p_1(\tilde{\theta}-\underline{\theta})$ and $\prod_2 = p_2(\bar{\theta}-\tilde{\theta})$, where $\tilde{\theta}=\frac{p_2-p_1}{\varepsilon}$.Then, individual firm's profit maximization under Bertrand competition yields the following reaction functions.

$$p_1(p_2)=\frac{1}{2}[p_2-\underline{\theta}\varepsilon] \quad \text{and} \quad p_2(p_1)=\frac{1}{2}[p_1+\bar{\theta}\varepsilon]$$

The equilibrium prices are

$$p_1=\frac{1}{3}\varepsilon(\bar{\theta}-2\underline{\theta}) \quad \text{and} \quad p_2=\frac{1}{3}\varepsilon(2\bar{\theta}-\underline{\theta})$$

and the corresponding profits are

$$\prod_1(\varepsilon)=\frac{1}{9}(\bar{\theta}-2\underline{\theta})^2\varepsilon \quad \text{and} \quad \prod_2(\varepsilon)=\frac{1}{9}(2\bar{\theta}-\underline{\theta})^2\varepsilon$$

A.2 Derivation of bidder's profits after hostile takeover

The maximization problem is conceptually equivalent to the problem of a monopolist producing two different qualities. Therefore, joint profits are

$$\sum \prod_m = p_1(\tilde{\theta}-\frac{p_1}{s_1})+p_2(\bar{\theta}-\tilde{\theta})$$

Setting the partial derivatives w.r.t. prices (p_1 and p_2) equal to zero yields the following corresponding prices.

$$p_1=\frac{1}{2}\bar{\theta}s_1 \quad \text{and} \quad p_2=\frac{1}{2}\bar{\theta}(s_1+\varepsilon)$$

and the profit is

$$\prod_m=\frac{1}{4}\bar{\theta}^2 s_2$$

A.3 Critical level of quality differentiation for attempting the hostile takeover

The hostile takeover is only profitable for the acquirer when the below given condition is satisfied.

$$\frac{1}{4}\bar{\theta}^2 s_2 - \frac{1}{9}(2\bar{\theta} - \underline{\theta})^2 \varepsilon \; > \; 0 \quad \text{Or} \qquad \frac{1}{9}(2\bar{\theta} - \underline{\theta})^2 \varepsilon < \; \frac{1}{4}\bar{\theta}^2 s_2$$

Or

$$\varepsilon < \frac{9}{4}\left[\frac{\bar{\theta}^2 s_2}{(2\bar{\theta} - \underline{\theta})^2}\right]$$

A.4 Manager's utility maximizing choice of product differentiation

Executive is facing the below given optimization problem, in which the level of quality differentiation is determined by his choice of product's quality.

$$\max_{\varepsilon} \; S + \psi \prod\nolimits_1 (\varepsilon) + B(1 - \varepsilon^2)$$

Taking the derivative with respect to ε and setting it equal to zero yields the following first order condition.

$$\psi \frac{1}{9}(\bar{\theta} - 2\underline{\theta})^2 - 2B\varepsilon = 0$$

Thus, the executive's self-interest maximizing level of quality differential is equal to

$$\varepsilon_u = \frac{1}{18}\left[\frac{\psi}{B}(\bar{\theta} - 2\underline{\theta})^2\right]$$

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