Market Value Maximization through Strategic Delegation

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Abstract

In this paper, we develop a model of strategic delegation in which shareholders maintain an objective of market value maximization (MVM) of the firm's assets as measured by a capital asset pricing model (CAPM). Optimal delegation requires that managers maximize a linear combination of expected profits and firm values. The model allows for a much deeper consideration of an investor's view of risk that, up until now, has been widely ignored in the delegation and industrial organization literature. In particular, we focus on the CAPM's distinction of nondiversifiable risk as opposed to the more general concept of profit or revenue variability. The results indicate that strategic delegation of the MVM objective mitigates competition in both price and quantity games relative to the standard profit maximization objective. We further show that the prisoner's dilemma common in quantity delegation games is functionally impractical because shareholders would have to reward managers for lower stock values. In addition, we demonstrate that the disparity of equilibrium outcomes in quantity and price games is smaller with delegation than without delegation. As products become more differentiated, the mentioned difference becomes very small. The results suggest that mode of competition issues remain important but are less pressing than commonly believed.

Keywords: market value maximization, strategic delegation, quantity competition, price competition, product differentiation.

JEL Codes: D43, G12, L13, L21

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1 Introduction

Dating back to at least Berle and Means (1932), economists have wrestled with the incentive compatibility issue between firm ownership and firm management. Marris (1963) was the first major effort to reconcile key divergent goals of each party within the context of a formal model. Under the condition of balanced growth of capital and product demand, the model structure provides for a contemporaneous maximization of managerial and ownership utility and suggests that strong and important linkages exist between capital and product markets. Early views on this subject were correctly reserved to cases of imperfect competition (see Cyert and March (1963), Marris (1963), Simon (1955), Baumol (1967), and Williamson (1963)). Despite the notable progress in dealing with the so-called marginalist controversy, Kuehn (1969), in summing up the state of the literature, indicated that nothing had emerged in the way of a managerial objective function that could effectively replace the profit maximization assumption.

Fershtman and Judd (1987), and Sklivas (1987) (hereafter FJS) extended and greatly refined the understanding of owner-manager relations. They demonstrated that profit-maximizing owners can precommit managers using a linear combination of profits and sales incentives to generate outcomes more (less) collusive in price (quantity) setting duopolies.[1] The strategic delegation literature has since branched out significantly to cover various topics of interest, for example: merger incentives (Ziss, 2001; Gonzalez-Maestre and Lopez-Cunat, 2001; Banal-Estanol and Ottaviani, 2006), multiproduct firm incentives (Barcena-Ruiz and Espinosa, 1999; Moner-Colonques et al., 2004), wage bargaining (Szymanski, 1994; Conlin and Furusawa, 2000), relative performance measures (Fumas, 1992; Aggarwal and Samwick, 1999; Miller and Paz-

[1]Similar strategic outcomes were developed by Eaton and Grossman (1986) in a trade context and by Brander and Lewis (1986) in a model of capital structure.

gal, 2001, 2005) and supergames (Spagnolo 1999, 2000, 2005). Much of the strategic delegation literature has focused on the differential effects of internal payment schemes, leaving little in the way of guidance as to the proper specification of the owner's objective function. Reitman (1993) inserts stock options in a FJS-type incentive package, but values them only through firm profits. Spagnolo (2000) considers an owner's objective to be shareholder value maximization. However, he assumes away physical assets, leaving the market value of stock to be the perpetuity of firm profits.

In the present paper, we take the straightforward stance that shareholders of large corporations pursue an objective of capital market value maximization (MVM) as determined through a certainty equivalent Capital Asset Pricing Model (CAPM) framework. The model allows for a much deeper consideration of an investor's view of risk that, up until now, has been widely ignored in the delegation and industrial organization literature. In particular, we focus on the CAPM's distinction of nondiversifiable risk as opposed to the more general concept of profit or revenue variability. Our approach shows that the strategic delegation for MVM shareholders leads to a consideration of expected profits and revenue-weighted nondiversifiable risk in making product market decisions. Such a delegation is possible with commonly observed practices involving profit bonuses and stock held in escrow.

The model fleshes out several new developments of interest. As Fershtman and Judd (1987) among others point out, the shareholders in a duopoly delegation setup are essentially joint Stackelberg leaders and thus obtain the prisoner's dilemma outcome in the sense that they would be better off not engaging in quantity games involving the delegation of a profit-sale incentive. In the case of strategic complements, the delegated incentives work to increase the owner's expected profits. Miller and Pazgal (2001, 2005) illustrate the equivalence of price and quantity competitions by a relative performance measure in which managers are rewarded based on a weighted sum of the firm's own profit and its rival's profit. However, information about the specifics of a rival's profit is difficult to attain and such formal incentives are not observed in practice. Moreover, as Fershtman and Judd (1987) and Spagnolo (2005) are correct to point out, use of the relative performance delegation provides an incentive to collude and would therefore come under the scrutiny of competition agencies. In our model, optimal delegation contracts, relative to the benchmark Cournot equilibrium, mitigates competition and demonstrates that the disparity of equilibrium outcomes in quantity and price competitions is smaller with delegation than without delegation. Furthermore, we show that the aforementioned prisoner's dilemma is functionally impractical because shareholders would have to reward managers for lowering the value of the stock. The model implicitly recognizes that investors manage diversifiable risk and is therefore agnostic about the supergame incentives brought forth in Spagnolo (1999, 2000, 2005). Because a firm's nondiversifiable risk profile can be altered by changing the boundary of the firm, this paper sheds new light on incentives for vertical contracts, new product development, and both vertical and horizontal mergers.

The remainder of the paper is organized as follows. Section 2 examines a model of a two-stage game in which the shareholders decide a combined objective of firm's anticipated profit and CAPM-styled value of equity for their managers in the first period, and managers compete in either quantity or price in the second period. We compare quantity-setting and price-setting equilibrium outcomes in three different scenarios, including general MVM, typical MVM, and profit maximization objectives. Concluding remarks and suggestions for future research are offered in section 3.

2 The Model

A model built on the concept of asset value maximization necessarily involves a framework for dealing with uncertainty. We assume a financial market characterized by the single-period Sharpe-Lintner equilibrium. That is,

$$E(\tilde{r}_i) = r + \beta_i \left[E(\tilde{r}_m) - r\right], \tag{1}$$

where r is the risk-free interest rate, $E(\tilde{r}_i)$ and $E(\tilde{r}_m)$ are expected rates of return of asset i and market portfolio, respectively, while β_i is systematic risk or market risk defined by $Cov(\tilde{r}_i, \tilde{r}_m)/Var(\tilde{r}_m)$. The firm i's market value can be obtained by $V_i = \widetilde{\pi}_i/(1 + \tilde{r}_i)$, where $\widetilde{\pi}_i$ is the stochastic cash flow of net earnings.

The objective function of MVM firm can be easily derived. Because $\widetilde{\pi}_i = (1+\tilde{r}_i)V_i$,

$$\begin{aligned} \frac{E(\widetilde{\pi}_i)}{V_i} &= 1 + E(\tilde{r}_i) = 1 + r + \frac{Cov(\tilde{r}_i, \tilde{r}_m)}{Var(\tilde{r}_m)} \left[E(\tilde{r}_m) - r\right] \\ &= 1 + r + \left[\frac{E(\tilde{r}_m) - r}{Var(\tilde{r}_m)}\right] \frac{Cov(\widetilde{\pi}_i, \tilde{r}_m)}{V_i}. \end{aligned} \tag{2}$$

Rearranging (2) yields firm i's "market value"objective function:

$$V_i = \frac{1}{1+r} \left[E(\widetilde{\pi}_i) - \lambda Cov(\widetilde{\pi}_i, \widetilde{r}_m)\right], \tag{3}$$

where λ is the equilibrium shadow price of market risk, defined by $[E(\widetilde{r}_m) - r]/\sigma_m^2$ and $\sigma_m^2 = Var(\tilde{r}_m)$.

The model in this study is essentially a two-stage sequential duopoly game. In the first stage, the owners (shareholders) of each firm delegate the product market decision to managers by properly arranging a linear combination of the firm's anticipated profit and the CAPM-styled value of equity. In the second stage, the manager of each firm decides the quantity to produce or the price to charge in the product market. Following the framework in Vickers (1985) and FJS the objective function facing manager i is given by

$$M_i = (1-\theta_i)E\Pi_i + \theta_i V_i, \tag{4}$$

where θ_i is an incentive parameter chosen by shareholders in firm i, $E\Pi_i = E(\widetilde{\pi}_i)/(1+r)$, and V_i is defined in (3).[2] By rearranging (4), we have

$$M_i = \frac{1}{1+r}\left[E(\widetilde{\pi}_i) - \theta_i \lambda Cov(\widetilde{\pi}_i, \widetilde{r}_m)\right]. \tag{5}$$

Note that if shareholders delegate the incentive: $\theta_i = 1$, we arrive back to equation (3), which implies a full incorporation of a CAPM-styled financial objective. It turns out that equation (1) facing the manager in the general MVM framework can be rewritten as

$$E(\tilde{r}_i) = r + \theta_i \beta_i \left[E(\tilde{r}_m) - r\right], \tag{6}$$

where θ_i may be interpreted as to how the market risk is perceived by shareholders in firm i relative to the standard CAPM benchmark that $\theta_i = 1$. Practically speaking, equations (4) and (5) show that managers can receive the desired shareholder incentive using a simple combination of profit-sharing bonuses and managerial stock holdings held in escrow.

Assume that each firm faces uncertain demand and that the same constant marginal cost (c) is known with certainty. Both firms' revenues are subject to a random shock that neither can observe when the strategic variables are chosen. As a result, firm i's total revenue is given by

$$\tilde{R}_i = p_i X_i (1+\tilde{e}), E(\tilde{e}) = 0, Var(\tilde{e}) = \sigma_e^2, \tag{7}$$

where p_i is the price, X_i is the quantity produced, and the random variable $\tilde{e}$ is an idiosyncratic shock on the revenue of firm i. Without loss of generality, it is assumed

[2] In general, the manager's objective function should be $A + B \times M_i$, where A and B are constant and $B > 0$. Both A and B are irrelevant to the product market decisions.

to have mean of zero. σ_e is the standard deviation of the shock.[3] It is further assumed for every demand curve that the support of the noise is small enough so that negative revenue never occurs. Thus, the expected net earnings are

$$E(\widetilde{\pi}_i) = E\left[p_i X_i(1+\tilde{e})\right] - X_i c = p_i X_i - X_i c.$$

Moreover, because $Cov(\widetilde{\pi}_i, \tilde{r}_m) = Cov(\tilde{e}, \tilde{r}_m) p_i X_i$,

$$V_i = \frac{p_i X_i(1 - \lambda Cov(\tilde{e}, \tilde{r}_m)) - X_i c}{1+r} = \frac{\phi p_i X_i - X_i c}{1+r} = \frac{\phi X_i(p_i - d)}{1+r}, \tag{8}$$

where certainty equivalent $\phi = 1 - \lambda Cov(\tilde{e}, \tilde{r}_m) = 1 - \lambda\rho\sigma_e\sigma_m$ and ρ is the correlation coefficient between the revenue shock and the return on a market portfolio. In general, $\phi \in [0, 1]$ and $d = c/\phi$ is adjusted marginal cost, provided that $\phi \neq 0$.[4]

By a parallel logic, the manager's objective becomes:

$$M_i = \frac{p_i X_i(1 - \theta_i \lambda Cov(\tilde{e}, \tilde{r}_m)) - X_i c}{1+r} = \frac{\phi_i X_i(p_i - d_i)}{1+r}, \tag{9}$$

where $\phi_i = 1 - \theta_i\lambda\rho\sigma_e\sigma_m$ and $d_i = c/\phi_i$. To simplify the analysis and rule out possible counter-intuitive results, we focus positive ρ and assume that $\theta_i < 1/(\lambda\rho\sigma_e\sigma_m)$ and $\lambda\rho\sigma_e\sigma_m \neq 0$.

Suppose further that each firm faces a linear inverse product market demand function[5] given by:

$$p_i = \alpha - bX_i - \gamma X_j,\ b \geq \gamma \geq 0,\ i, j = 1, 2,\ i \neq j. \tag{10}$$

$b \geq \gamma$ implies that the own effect (b) is at least as large as the cross effect (γ) and $\gamma \geq 0$ presumes the case of substitutes. In addition, we assume $\alpha > d$. We also

[3]The shareholders perceive risk derived from $\tilde{e}$ to be revenue variation outside of managerial control and also nondiversifiable.

[4]Our results easily generalize to include independent cost uncertainty in equation (8). By defining ψ as a certainty equivalent parameter on the cost side, for a strictly convex cost function, $\psi > 1$, and $d = c\psi/\phi$ implying that $d > c$.

[5]See also Dixit (1979), Singh and Vives (1984), and Vives (1999).

define $\delta = \gamma/b$ to model the degree of (horizontal) product differentiation.[6] The more differentiated the products ($\delta \downarrow$), the smaller the effect of a change in quantity (price) of brand j on the price (quantity) of brand i. Note that by assumption $0 \leq \delta \leq 1$. Therefore, (10) can be rewritten as

$$p_i = \alpha - b(X_i + \delta X_j),\ 0 \leq \delta \leq 1,\ i, j = 1, 2,\ i \neq j. \tag{11}$$

Lemma 1 provides a useful way to determine the range of θ.

Lemma 1. (a) $d_i \gtreqless d \Longleftrightarrow \theta_i \gtreqless 1$ and (b) $d_i \gtreqless c \Longleftrightarrow \theta_i \gtreqless 0$.

Proof. By definition, $d_i = d \Longleftrightarrow \theta_i = 1$ and $d_i = c \Longleftrightarrow \theta_i = 0$. By assumptions $\theta_i < 1/(\lambda\rho\sigma_e\sigma_m)$ and $\phi = 1 - \lambda\rho\sigma_e\sigma_m \neq 0$, with monotonicity that

$$\frac{\partial d_i}{\partial \theta_i} = \frac{\partial}{\partial \theta_i} \frac{c}{1 - \theta_i \lambda\rho\sigma_e\sigma_m} = \frac{\lambda\rho\sigma_e\sigma_m c}{(1 - \theta_i \lambda\rho\sigma_e\sigma_m)^2} > 0,$$

lemma 1 is proved. □

By the one-to-one mapping for θ_i and d_i, Lemma 1 allows us to focus on the adjusted marginal cost d_i. We may easily characterize the properties of incentive parameter θ_i via a simple transformation from d_i.

The product markets are evaluated under both price and quantity competition. The two-stage game is solved via backward induction.

Quantity Competition

Under quantity competition, managers in both firms choose quantity strategies simultaneously, taking each other's strategy as a given. In the second period, manager i faces the objective function

$$M_i = \frac{\phi_i}{1+r} X_i (p_i - d_i) = \frac{\phi_i}{1+r} X_i \left[\alpha - b(X_i + \delta X_j) - d_i\right]. \tag{12}$$

[6] Note that the definition here differs from the common setting seen in, for example, Shy (1995).

Taking a derivative with respect to X_i and rearranging yield

$$2X_i + \delta X_j = \frac{\alpha - d_i}{b}. \tag{13}$$

Equation (13) implicitly defines manager i's reaction function. Impacts of an increase in d_i under quantity competition are depicted in Figure 1(a). As we can see, MVM delegation strategies mitigate competition relative to the traditional Cournot benchmark. Similarly, we can get manager j's reaction function. Solving for optimal quantity and price yields

$$X_i^c = \frac{\alpha(2-\delta) - 2d_i + \delta d_j}{b(2+\delta)(2-\delta)}, \quad p_i^c = \frac{\alpha(2-\delta) + (2-\delta^2)d_i + \delta d_j}{(2+\delta)(2-\delta)}. \tag{14}$$

Therefore, the value of the firm facing the shareholders in quantity competition becomes

$$\begin{aligned} V_i^c &= \frac{\phi X_i^c (p_i^c - d)}{1+r} \qquad (15) \\ &= \frac{\phi}{1+r}\left[\frac{\alpha(2-\delta) - 2d_i + \delta d_j}{b(2+\delta)(2-\delta)}\right]\left[\frac{\alpha(2-\delta) + (2-\delta^2)d_i + \delta d_j}{(2+\delta)(2-\delta)} - d\right]. \end{aligned}$$

The reaction function[7] for shareholders in firm i is

$$4(2-\delta^2)d_i + \delta^3 d_j = (2-\delta)\left[2(2+\delta)d - \alpha\delta^2\right]. \tag{16}$$

We may write equilibrium d_i in quantity competition as

$$d^c = \frac{2(2+\delta)d - \alpha\delta^2}{4+2\delta-\delta^2} = d - \frac{(\alpha-d)\delta^2}{4+2\delta-\delta^2}. \tag{17}$$

Therefore, equilibrium quantity, price, and firm value in quantity competition can be given by

$$\begin{aligned} X^c &= \frac{2(\alpha-d)}{b(4+2\delta-\delta^2)}, \quad p^c = \frac{(2-\delta^2)\alpha + 2(1+\delta)d}{4+2\delta-\delta^2}, \\ V^c &= \frac{\phi(\alpha-d)^2}{b(1+r)}\frac{2(2-\delta^2)}{(4+2\delta-\delta^2)^2}. \end{aligned}$$

[7] The choice variable should be θ_i. However, as proved in lemma 1, d_i is increasing monotonically in θ_i as long as $\theta_i \neq 1/(\lambda\rho\sigma_e\sigma_m)$.

We are interested in the range of θ in quantity competition. As a result, proposition 1 follows.

Proposition 1. (a) $\theta^c \leq 1$.

(b) $\theta^c \geq 0$ if

$$c \geq \frac{\alpha\phi\delta^2}{2\,(2+\delta)\,(1-\phi)+\phi\delta^2} \equiv \underline{c}. \tag{18}$$

Proof. (a) By subtracting d from d^c, we get

$$d^c - d = \frac{-(\alpha-d)\delta^2}{4+2\delta-\delta^2} \leq 0,$$

because $\alpha > d$ and $0 \leq \delta \leq 1$. Since $d^c \leq d$, by lemma 1(a), $\theta^c \leq 1$.

(b) To obtain $\theta^c \geq 0$, we need to show $d^c \geq c$ by lemma 1(b). Thus,

$$\begin{aligned} d^c - c &= d^c - d + (1-\phi)d = \frac{-(\alpha-d)\delta^2}{4+2\delta-\delta^2} + (1-\phi)d \\ &= \frac{1}{4+2\delta-\delta^2}\left[-\delta^2\alpha + \frac{2\,(2+\delta)\,(1-\phi)+\phi\delta^2}{\phi}c\right] \\ &\geq 0, \text{ by condition in (18).} \end{aligned}$$

□

Proposition 1 demonstrates that the incentive parameter depends in part on the marginal cost-demand intercept ratio (c/α). By proposition 1(b), the minimal cost $\underline{c}$ for $\theta^c \geq 0$ depends, *ceteris paribus*, on the degree of product differentiation. Figure 2 presents the relationships found in proposition 1(b). The curved line through Figure 2 represents the loci of points between δ and c/α such that $c/\alpha = \underline{c}/\alpha$ and $\theta^c = 0$. The numerical assumptions about the price of risk follow examples presented in Dixit and Pindyck (1994) and $\phi = 0.96$.[8] Note that in the lower right half of Figure 2

[8] Dixit and Pindyck (1994) use the New York Stock Exchange Index as the market and get $E(\tilde{r}_m) - r \approx 0.08$ and $\sigma_m \approx 0.2$, so $\lambda = [E(\tilde{r}_m) - r]/\sigma_m^2 \approx 2$. We produce Figure 2 by assuming $\lambda = 2$, $\sigma_m = 0.2$, $\sigma_e = 0.2$, and $\rho = 0.5$.

shareholders optimally set θ^c to punish managers for increasing the firm value: a condition suggestive of mangers holding a short position in the firm's stock. Returning to equation (9), we can see that $\theta^c < 0$ signals the manager to become more aggressive in maximizing revenues. Of course, the impact of being more aggressive in a market with strategic substitutes is at the heart of the prisoner's dilemma common to the strategic delegation literature. While such an outcome is feasible in our model, it seems to be highly impractical (i.e. θ^c should be nonnegative). Indeed, because shareholders would not sign off on the unilateral incentive package that rewards a manager for lowering the stock price, they can essentially avoid the prisoner's dilemma outcome. Additionally, we find in our model many instances when θ^c is optimally positive, which signals a less aggressive stance in the product market. As shown in Figure 2, the more differentiated the product ($\delta \downarrow$), the less minimal cost ($\underline{c} \downarrow$) required; i.e., $\partial \underline{c}/\partial \delta \geq 0$ for positive θ^c. We will assume that (18) holds throughout the paper and therefore $0 \leq \theta^c \leq 1$.

Impacts of degree of product differentiation on optimal delegation are examined in the following proposition.

Proposition 2. $\partial \theta^c/\partial \delta \leq 0$, $\partial d^c/\partial \delta \leq 0$, $\partial X^c/\partial \delta \leq 0$, $\partial p^c/\partial \delta \leq 0$, and $\partial V^c/\partial \delta \leq 0$.

Proof. By $\partial d_i/\partial \theta_i > 0$, for $\partial \theta^c/\partial \delta \leq 0$, we only need to show $\partial d^c/\partial \delta \leq 0$. Thus,

$$\begin{aligned}
\frac{\partial d^c}{\partial \delta} &= \frac{-2(\alpha - d)(4+\delta)\delta}{(4+2\delta-\delta^2)^2} \leq 0, \\
\frac{\partial X^c}{\partial \delta} &= \frac{-4(\alpha - d)(1-\delta)}{b(4+2\delta-\delta^2)^2} \leq 0, \\
\frac{\partial p^c}{\partial \delta} &= \frac{-2(\alpha - d)(2+2\delta+\delta^2)}{(4+2\delta-\delta^2)^2} \leq 0, \\
\frac{\partial V^c}{\partial \delta} &= \frac{-4\phi(\alpha - d)^2}{b(1+r)} \frac{(4+\delta^3)}{(4+2\delta-\delta^2)^3} \leq 0.
\end{aligned}$$

□

By rewriting (11), $p_i = \alpha - b(X_i + \delta X_j) = (\alpha - b\delta X_j) - bX_i$. It implies that as the product becomes more differentiated ($\delta \downarrow$), the residual demand facing firm i increases, which leads to more emphasis on MVM objective, more output, higher price, and higher firm value. Proposition 2 is straightforward because the product market is less competitive when the product is more differentiated.

Let us define equilibrium quantity, price, and firm value under stylized equilibrium market value maximization ($\theta = 1$) and profit maximization ($\theta = 0$) to be X_m^c, p_m^c, V_m^c and X_p^c, p_p^c, V_p^c, respectively. We have

$$\begin{aligned} X_m^c &= \frac{\alpha - d}{b(2+\delta)},\ p_m^c = \frac{\alpha + (1+\delta)d}{2+\delta}, V_m^c = \frac{\phi(\alpha - d)^2}{b(1+r)}\frac{1}{(2+\delta)^2}; \quad (19) \\ X_p^c &= \frac{\alpha - c}{b(2+\delta)},\ p_p^c = \frac{\alpha + (1+\delta)c}{2+\delta}, \quad (20) \\ V_p^c &= \frac{(\alpha - c)}{b(1+r)}\frac{\{\phi\alpha - [(2-\phi) + (1-\phi)\delta]\, c\}}{(2+\delta)^2}. \end{aligned}$$

Now, by holding the differentiation parameter constant, comparing equilibrium quantity, price, and firm value in three different scenarios leads to proposition 3.

Proposition 3. Suppose that (18) holds, $X_m^c \leq X^c \leq X_p^c$, $p_m^c \geq p^c \geq p_p^c$, and $V_m^c \geq V^c \geq V_p^c$.

Proof. Let us define equilibrium outcomes in quantity competition as

$$\begin{aligned} X_e^c &= X_e^c(d_e^c) = \frac{\alpha - d_e^c}{b(2+\delta)},\ p_e^c = p_e^c(d_e^c) = \frac{\alpha + (1+\delta)d_e^c}{2+\delta}, \\ V_e^c &= V_e^c(d_e^c) = \frac{\phi}{1+r}\frac{\alpha - d_e^c}{b(2+\delta)}\left[\frac{\alpha + (1+\delta)d_e^c}{2+\delta} - d\right], \end{aligned}$$

where $d_e^c = d^c, d$, and c for $\theta = \theta^c, 1$, and 0, respectively. For quantity and price, it is easy to see $\partial X_e^c / \partial d_e^c < 0$ and $\partial p_e^c / \partial d_e^c > 0$. By proposition 1, we have $d \geq d^c \geq c$. Therefore, $X_m^c \leq X^c \leq X_p^c$ and $p_m^c \geq p^c \geq p_p^c$. For firm value,

$$\frac{\partial V_e^c}{\partial d_e^c} = \frac{\phi\left[\delta(\alpha - d) - 2(1+\delta)(d_e^c - d)\right]}{b(1+r)(2+\delta)^2}.$$

Thus,

$$\frac{\partial V_e^c}{\partial d_e^c} > 0, \text{ for } d_e^c \leq d + \frac{\delta(\alpha - d)}{2(1+\delta)} \equiv \overline{d}_e^c.$$

Because $d \geq d^c \geq c$, we have $\overline{d}_e^c \geq d \geq d^c \geq c$. This completes the proof. □

Proposition 3 shows that when shareholders maximize firm's market values, optimal delegation mitigates product market competition in a quantity-setting game compared with the results obtained from the stylized profit maximization objective; that is, $X^c \leq X_p^c$, $p^c \geq p_p^c$, and $V^c \geq V_p^c$. Another interesting feature of the model emerges in the comparison of stylized MVM ($\theta = 1$) with optimal delegation ($\theta = \theta^c$). Here, optimal delegation leads to a more competitive outcome. The story here parallels that of Fershtman and Judd (1987) (and also Eaton and Grossman, 1986), which we discuss in the concluding comments of this section.

Price Competition

Turning now to competition in price space, the corresponding demand function is

$$X_i = \frac{1}{b(1-\delta^2)} \left[\alpha(1-\delta) - p_i + \delta p_j\right]. \tag{21}$$

In the second period, manager i maximizes the objective function

$$M_i = \frac{\phi_i}{1+r} X_i(p_i - d_i) = \frac{\phi_i}{1+r} \frac{1}{b(1-\delta^2)} \left[\alpha(1-\delta) - p_i + \delta p_j\right](p_i - d_i). \tag{22}$$

As a result, manager i's reaction function in price competition is

$$2p_i - \delta p_j = \alpha(1-\delta) + d_i. \tag{23}$$

Impacts of an increase in d_i on reaction functions are depicted in Figure 1(b). Solving for optimal price and quantity yields

$$p_i^b = \frac{\alpha(1-\delta)(2+\delta) + 2d_i + \delta d_j}{(2+\delta)(2-\delta)}, \ X_i^b = \frac{\alpha(1-\delta)(2+\delta) - (2-\delta^2)d_i + \delta d_j}{b(1-\delta^2)(2+\delta)(2-\delta)}. \tag{24}$$

In the first period, the shareholders' objective function is

$$\begin{aligned} V_i^b &= \frac{\phi X_i^b(p_i^b - d)}{1+r} \qquad (25) \\ &= \frac{\phi}{1+r}\left[\frac{\alpha(1-\delta)(2+\delta)-(2-\delta^2)d_i+\delta d_j}{b(1-\delta^2)(2+\delta)(2-\delta)}\right]\left[\frac{\alpha(1-\delta)(2+\delta)+2d_i+\delta d_j}{(2+\delta)(2-\delta)} - d\right]. \end{aligned}$$

The reaction function for shareholders in firm i is

$$4(2-\delta^2)d_i - \delta^3 d_j = \alpha(1-\delta)(2+\delta)\delta^2 + (2-\delta^2)(4-\delta^2)d. \qquad (26)$$

We may write equilibrium d_i in price competition as

$$d^b = \frac{\alpha(1-\delta)\delta^2 + (2-\delta^2)(2-\delta)d}{4-2\delta-\delta^2} = d + \frac{(\alpha-d)(1-\delta)\delta^2}{4-2\delta-\delta^2}. \qquad (27)$$

Therefore, equilibrium quantity, price, and firm value in price competition are given by

$$\begin{aligned} X^b &= \frac{(2-\delta^2)(\alpha-d)}{b(1+\delta)(4-2\delta-\delta^2)}, \quad p^b = \frac{2(1-\delta)\alpha+(2-\delta^2)d}{4-2\delta-\delta^2}, \\ V^b &= \frac{\phi(\alpha-d)^2}{b(1+r)}\frac{2(1-\delta)(2-\delta^2)}{(1+\delta)(4-2\delta-\delta^2)^2}. \end{aligned}$$

From (27) we have proposition 4.

Proposition 4. $\theta^b \geq 1$.

Proof. By (27) and assumptions that $\alpha > d$ and $0 \leq \delta \leq 1$, we have

$$d^b - d = \frac{(\alpha-d)(1-\delta)\delta^2}{4-2\delta-\delta^2} \geq 0.$$

Together with lemma 1(a), $\theta^b \geq 1$. □

Under price competition, those managers pursuing profit maximization are penalized ($1-\theta^b \leq 0$). The overcompensation for firm's market value ($\theta^b \geq 1$) can be interpreted as shareholders imposing a tax on the manager that forces a consideration of nondiversifiable risk in product market decisions. From (6) and proposition 4, the tax mitigates competition and assures the firm that it will earn CAPM-styled firm values or higher.

Similar to proposition 2, we have proposition 5.

Proposition 5. $\partial p^b/\partial\delta \leq 0$ and $\partial V^b/\partial\delta \leq 0$.

Proof.

$$\frac{\partial p^b}{\partial \delta} = \frac{-2(\alpha-d)[1+(1-\delta)^2]}{\left(4-2\delta-\delta^2\right)^2} \leq 0,$$

$$\frac{\partial V^b}{\partial \delta} = -\frac{4\phi(\alpha-d)^2}{b(1+r)} \frac{\left\{(1-\delta)[3+(1-\delta^2)^2]+\delta^3\right\}}{(1+\delta)^2\left(4-2\delta-\delta^2\right)^3} \leq 0.$$

□

Proposition 5 shows that the product market is less competitive when the product is more differentiated: price and firm value are strictly increasing as δ declines. Unlike the quantity game case that $\partial X^c/\partial\delta \leq 0$, we get negative $\partial X^b/\partial\delta$ with small δ, but positive $\partial X^b/\partial\delta$ with large δ.[9] As we move across the spectrum from homogeneous products to complete differentiation, this implies that managers will initially look to cut output in response to a higher level of differentiation (i.e. when δ is large). When products are sufficiently differentiated, managers will react to greater differentiation by increasing output and raising price. Under product homogeneity, strategic delegation assures the firm that it will avoid the Bertrand paradox and provide CAPM-prescribed returns to shareholders. The model thus describes a condition in which a zero Lerner index is not the appropriate benchmark for competition agencies and that some economic profit is attributable to simply a return to the firm for operating with systematic risk. While we have no conclusion on $\partial d^b/\partial\delta$ (or $\partial\theta^b/\partial\delta$),

[9] This U-shaped relationship of X^b and δ can be seen by examining firm i's residual demand in equation (21) as well.

the difference ($d^b - d$ or $\theta^b - 1$), which can be interpreted as shareholders' strategic motives, varying with δ has some interesting implications. We will investigate more on this feature under quantity and price competitions in proposition 7.

Let us define equilibrium quantity, price, and firm value under stylized equilibrium market value maximization ($\theta = 1$) and profit maximization ($\theta = 0$) to be X_m^b, p_m^b, V_m^b and X_p^b, p_p^b, V_p^b, respectively, under price competition. We have

$$X_m^b = \frac{\alpha - d}{b(1+\delta)(2-\delta)}, p_m^b = \frac{\alpha(1-\delta)+d}{2-\delta}, V_m^b = \frac{\phi(\alpha-d)^2}{b(1+r)}\frac{1-\delta}{(1+\delta)(2-\delta)^2}; \tag{28}$$

$$X_p^b = \frac{\alpha - c}{b(1+\delta)(2-\delta)}, p_p^b = \frac{\alpha(1-\delta)+c}{2-\delta}, \tag{29}$$

$$V_p^b = \frac{(\alpha-c)}{b(1+r)}\frac{[\phi(1-\delta)\alpha - (2-\phi-\delta)c]}{(1+\delta)(2-\delta)^2}.$$

By comparing equilibrium quantity, price, and firm value in three different scenarios, we have proposition 6.

Proposition 6. $X^b \leq X_m^b \leq X_p^b$, $p^b \geq p_m^b \geq p_p^b$, and $V^b \geq V_m^b \geq V_p^b$.

Proof. Let us define equilibrium outcomes in price competition as

$$X_e^b = X_e^b(d_e^b) = \frac{\alpha - d_e^b}{b(1+\delta)(2-\delta)},\ p_e^b = p_e^b(d_e^b) = \frac{\alpha(1-\delta)+d_e^b}{2-\delta},$$

$$V_e^b = V_e^b(d_e^b) = \frac{\phi}{1+r}\frac{\alpha - d_e^b}{b(1+\delta)(2-\delta)}\left[\frac{\alpha(1-\delta)+d_e^b}{2-\delta} - d\right],$$

where $d_e^b = d^b, d,$ and c for $\theta = \theta^b, 1,$ and 0, respectively. For quantity and price, it is easy to see $\partial X_e^b/\partial d_e^b < 0$ and $\partial p_e^b/\partial d_e^b > 0$. Thus, from proposition 4 and $d \geq c$, we have $X^b \leq X_m^b \leq X_p^b$ and $p^b \geq p_m^b \geq p_p^b$. For firm value,

$$\frac{\partial V_e^b}{\partial d_e^b} = \frac{\phi\left[\delta(\alpha-d) - 2(d_e^b - d)\right]}{b(1+r)(1+\delta)(2-\delta)^2}.$$

Therefore,

$$\frac{\partial V_e^b}{\partial d_e^b} > 0,\ \text{for } d_e^b \leq d + \frac{\delta(\alpha-d)}{2} \equiv \overline{d}_e^b.$$

Because $d^b \geq d \geq c$, all we need to show is $\overline{d}_e^b \geq d^b$.

$$\overline{d}_e^b - d^b = \frac{\delta(\alpha - d)(2-\delta)^2}{2(4-2\delta-\delta^2)} \geq 0.$$

This completes the proof. $\square$

Proposition 6 shows the results similar to those found in quantity competition: when shareholders maximize firm's market values, optimal delegation mitigates product market competition in a price-setting game compared with the results obtained from the stylized profit maximization objective; that is, $X^b \leq X_p^b$, $p^b \geq p_p^b$, and $V^b \geq V_p^b$. Optimal delegation mitigates competition even more than stylized MVM ($\theta = 1$). The shareholders achieve even higher firm value ($V^b \geq V_m^b$) by delegating product market decision to managers and the delegation gain for shareholders is ($V^b - V_m^b$) because the choice variable, price in the product market is a strategic complement. See Figure 1(b) for more details.

Comparison of Quantity and Price Competitions

In this section we compare strategic motives of shareholders and equilibrium outcomes under quantity and price competitions. In the discussion of proposition 5, we mention that $(d^b - d)$ can represent shareholders' strategic motives and this implication can be extended to the case of quantity competition. If there exist no strategic concerns, intuitively, the MVM shareholders will select adjusted marginal cost d by setting $\theta = 1$ for either quantity or price competition. By subtracting d from d^c or d^b, we can measure the intensity of shareholders' strategic motives to manipulate managers' product market decisions. Proposition 7 examines how shareholders' strategic motives vary with the degree of product differentiation.

Proposition 7. Shareholders have no strategic motives when (1) $\delta = 0$ (monopoly, quantity and price competitions coincide), and (2) $\delta = 1$ (standard Bertrand competition). However, shareholders have the strongest strategic motives when $\delta = 1$ (standard Cournot competition).

Proof. From (17) and (27), we have

$$\Delta^c(\delta) \equiv d^c - d = \frac{-(\alpha - d)\delta^2}{4 + 2\delta - \delta^2}, \qquad \frac{\partial \Delta^c}{\partial \delta} = -\frac{2\delta(4+\delta)(\alpha - d)}{\left(4 + 2\delta - \delta^2\right)^2}; \tag{30}$$

$$\Delta^b(\delta) \equiv d^b - d = \frac{(\alpha - d)(1-\delta)\delta^2}{4 - 2\delta - \delta^2}, \quad \frac{\partial \Delta^b}{\partial \delta} = \frac{\delta(8 - 14\delta + 4\delta^2 + \delta^3)(\alpha - d)}{\left(4 - 2\delta - \delta^2\right)^2}. \tag{31}$$

For $\delta \in [0,1]$, Δ^c is monotonically decreasing in δ and $\Delta^c(0) = 0$ and $\Delta^c(1) = -(\alpha - d)/5$ from (30). From (31), $\Delta^b(0) = \Delta^b(1) = 0$. Note that $\Delta^c(0) = \Delta^b(0) = \Delta^b(1) = 0$ for cases of no strategic motives as $d^c = d$ and $d^b = d$. Moreover, we know that Δ^b and $\partial\Delta^b/\partial\delta$ are continuous and differentiable in domain $[0,1]$, $\partial\Delta^b(0^+)/\partial\delta > 0$ and $\partial\Delta^b(1)/\partial\delta < 0$. Thus, there exists at least one maximum. Though it is available for an analytical solution to $\max_{\delta} \ \Delta^b(\delta), \ \forall\delta \in [0,1]$, we only present it numerically for illustrative purposes. The maximal Δ^b is $0.0731(\alpha - d)$ when $\delta = 0.778$, which can be referred to Figure 3. It turns out that $|\Delta^c(1)| > |\Delta^b(0.778)|$. □

The graphs of $\Delta^c(\delta)$ and $\Delta^b(\delta)$ are depicted in Figure 3. When $\delta = 0$, the product markets are separate, each firm is a monopolist in its own market, and quantity and price decisions coincide. In this case, shareholders have no incentives to act strategically and managers are instructed to maximize the firm's capital market value. An interesting case emerges that when products are homogeneous ($\delta = 1$): shareholders have opposite strategies under quantity and price competitions. For the case of homogeneous products, we arrive at standard Cournot and Bertrand competitions. The rationale for such an outcome is straightforward. Under price competition and product homogeneity, the traditional Bertrand paradox suggests each firm will undercut its competitor by some small price change until price equals marginal cost. This undercutting pattern stops in the MVM model at the adjusted marginal cost (d), the equilibrium value of the firm is zero and shareholders have no incentive to be strategic in writing the incentive contract. The Lerner index of market power is $(d-c)/d = (c-\phi c)/c = 1-\phi$, which is positive in the presence of systematic risk and shareholders are paid a CAPM return on their invested capital based on their risk profile. Thus, in the strictest sense of the definition of "zero economic profits," it does not exist in our model. Antitrust challenges to mergers should recognize systematic risk in simulation models. In quantity competition, strategic motives become the most important when products are homogeneous as shown in proposition 7.

We further compare the equilibrium outcomes under different modes of competition. By looking at propositions 3 and 6, we have no conclusion on comparisons of equilibrium outcomes between profit-maximizing quantity competition (i.e., X_p^c, p_p^c, V_p^c) and general MVM price competition (i.e., X^b, p^b, V^b) because they depend on the certainty equivalent measure ϕ. For a large ϕ, it is more competitive in the general MVM price game and more likely to get $X_p^c \leq X^b$, $p_p^c \geq p^b$, and $V_p^c \geq V^b$. In what follows, instead, we are interested in the comparison of delegation equilibria under quantity and price competitions.

Proposition 8. $X^c \leq X^b$, $p^c \geq p^b$, and $V^c \geq V^b$.

Proof. We directly compute the corresponding differences:

$$X^c - X^b = \frac{2(\alpha - d)}{b(4+2\delta-\delta^2)} - \frac{(2-\delta^2)(\alpha-d)}{b(1+\delta)(4-2\delta-\delta^2)} \tag{32}$$
$$= \frac{-\delta^4(\alpha-d)}{b(1+\delta)(4+2\delta-\delta^2)(4-2\delta-\delta^2)} \leq 0,$$

$$p^c - p^b = \frac{(2-\delta^2)\alpha + 2(1+\delta)d}{4+2\delta-\delta^2} - \frac{2(1-\delta)\alpha + (2-\delta^2)d}{4-2\delta-\delta^2} \tag{33}$$
$$= \frac{\delta^4(\alpha-d)}{(4+2\delta-\delta^2)(4-2\delta-\delta^2)} \geq 0,$$

$$
\begin{aligned}
V^c - V^b &= \frac{\phi(\alpha-d)^2}{b(1+r)}\frac{2(2-\delta^2)}{(4+2\delta-\delta^2)^2} - \frac{\phi(\alpha-d)^2}{b(1+r)}\frac{2(1-\delta)(2-\delta^2)}{(1+\delta)(4-2\delta-\delta^2)^2} \qquad (34)\\
&= \frac{\phi(\alpha-d)^2}{b(1+r)}\frac{4(2-\delta^2)\delta^5}{(1+\delta)(4+2\delta-\delta^2)^2(4-2\delta-\delta^2)^2} \geq 0.
\end{aligned}
$$

(32)-(34) complete the proof. □

Proposition 8 shows that the delegation price competition is more competitive than the delegation quantity competition, though the former is less competitive than the stylized MVM game from proposition 6. Together propositions 3 and 6 with 8, we have $X_m^c \leq X^c \leq X^b \leq X_m^b$, $p_m^c \geq p^c \geq p^b \geq p_m^b$, and $V_m^c \geq V^c \geq V^b \geq V_m^b$. The differences of equilibria between quantity and price competitions are smaller under optimal delegation. From proposition 8, we also notice that the differences decrease rapidly when the products are more differentiated and these differences are not important if the products are sufficiently differentiated.

In Fershtman and Judd (1987), the shareholders' objective is to maximize profits leading to a delegation strategy of a linear combination of profits and revenues. The result is that under quantity competition the firm is actually worse off relative the standard Cournot outcome, while it is better off under price competition. Their finding raised the critique about the sensitivity of these models to the mode of conduct. However, in the current MVM framework, where managers maximize a linear combination of firm values and expected profits, the firm is better off under both quantity and price competitions relative to the results with the profit maximization objective. We further show that the differences of delegation equilibrium outcomes under different modes of competition are very small when the products become more differentiated. The results suggest that mode of competition issues remain important but are less pressing than commonly believed.

3 Concluding Remarks

In this paper, we developed a model of equity value maximization that allows shareholders to manipulate the manager's incentives by strategically arranging a manager's objective scheme in a duopoly framework. In a two-stage setting, the shareholders delegate to the manager in the first stage to maximize a specific linear combination of anticipated profits and CAPM-styled firm values. Managers subsequently compete in either quantity or price in the second stage. This study sheds light on several important areas of interest to industrial organization economists, business and finance strategists, and government policymakers. Because shareholders are free to diversify their portfolios, our analysis isolates on nondiversifiable risk to show how shareholders optimally provide incentives to managers to consider such risk in product market decisions. Our findings lay the groundwork for a new approach to analyzing oligopolistic behavior.

According to equation (6), the incentive parameter, θ, represents how nondiversifiable risk is perceived by shareholders relative to the standard CAPM framework. For both quantity and price games, nonnegative θ leads to less aggressive product market competition and $\theta = 1$ infers the case of no strategic opportunity and shareholders signal managers to maximize the firm's capital value. Optimal delegation contracts for quantity games are $0 \leq \theta^c \leq 1$. Although $\theta^c < 0$ represents a possible optimal delegation, it is functionally impractical to presume the firm would reward a manager for lowering the firm value. This represents a key feature of our model because choosing $\theta^c < 0$ is the only way that the traditional prisoner's dilemma in quantity delegation models can emerge. Depending on the interaction of demand conditions and nondiversifiable risk, we could observe equilibrium outcomes that support sole profit maximizing behavior by the firm, i.e., $\theta^c = 0$. However, this is an industrydependent outcome and a subject of future empirical work. In price setting games, optimal incentives are chosen where $\theta^b \geq 1$. Thus, sole profit maximization will never occur and, as in other delegation studies, we find the firm in an advantageous position to increase value (and profit) when competing in a market of strategic complements.

The impacts of the degree of product differentiation on optimal delegation are examined. In general, the product market is less competitive when the product is more differentiated and, eventually, increased product differentiation leads to monopoly and the elimination of a strategic incentive (i.e. $\theta = 1$ in both price and quantity competitions). As the product market become less differentiated, shareholders under quantity competition have an increasingly stronger incentive to delegate toward a greater emphasis on profits and less on firm value. Under price competition, there exists a complex interaction between changes in product differentiation and the incentive parameter. In equilibrium, price is monotonically decreasing as the product market becomes more homogeneous. However, the strategic incentive parameter peaks before products become perfect substitutes and managers begin to receive incentive packages toward CAPM-styled firm values after the peak. Finally, the model effectively eliminates the Bertrand paradox. Under perfect substitutes, firm value drops to zero and the firm earns nonnegative profits that only compensate investors for nondiversifiable risk. The model suggests that the benchmark Lerner index for competition authorities should account for this adjustment.

We compared equilibrium quantity, price, and firm value in three different scenarios, including MVM delegation, stylized CAPM ($\theta = 1$), and profit maximization ($\theta = 0$) for both quantity and price games. The results indicate that strategic delegation of the MVM objective mitigates competition in both price and quantity games compared with the results obtained from the typical profit maximization objective. By manipulating the incentive parameter and allowing managers to consider market risk in product market decisions, the optimal delegation leads to greater market coordination, higher profits, and higher stock values. In addition, we demonstrate that the disparity of equilibrium outcomes in quantity and price games is smaller with delegation than without delegation. As products become more differentiated, the mentioned difference becomes very small. The results suggest that mode of competition issues remain important but are less pressing than commonly believed.

There are significant and interesting extensions of this research. First, the model brings forth several empirically testable hypotheses. One hypothesis could involve testing if $\theta = 0$, using applied demand models under imperfect competition. Verifying whether or not product markets are impacted by the presence of nondiversifiable risk would be an important step in determining the importance of capital market-based managerial incentives. In the context of cross-industry analysis, the model suggest that managers in industries playing price games are more likely to receive larger incentives based on maximizing firm value relative to the incentive packages for managers in predominant quantity setting industries. This could be testable using standard data sources such as Compustat. The concept of nondiversifiable risk presumes the boundary of the firm remains fixed through time. In reality, firms regularly contract or expand the firm's boundaries through new product development, R&D, input and output market contracts, and, of course, mergers and spinoffs. These events have the potential to alter the covariance of the firms earnings to the capital market, which changes the optimal incentive contract. As well, in an evolutionary process, shareholders may set incentive contracts to encourage a more (or less) activist role in the manager's shaping of the firm boundaries. These are areas for future theoretical development.

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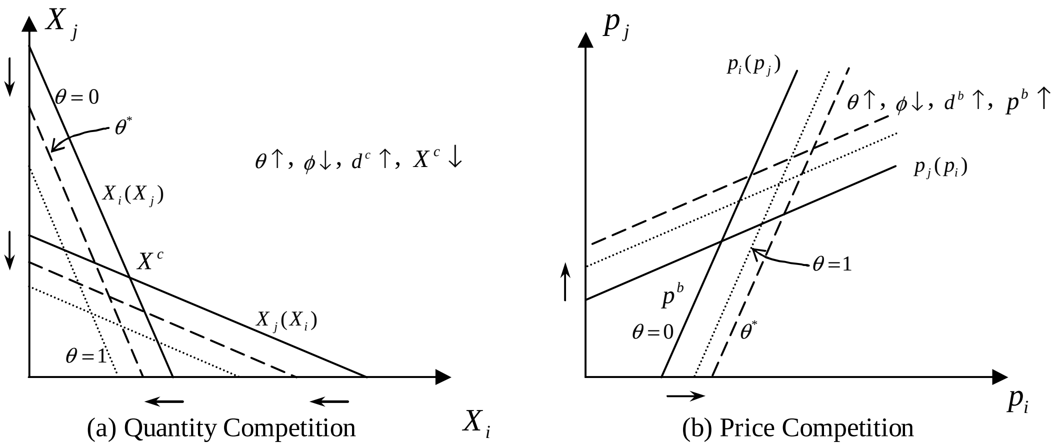

Figure 1: Effects of an Increase in θ

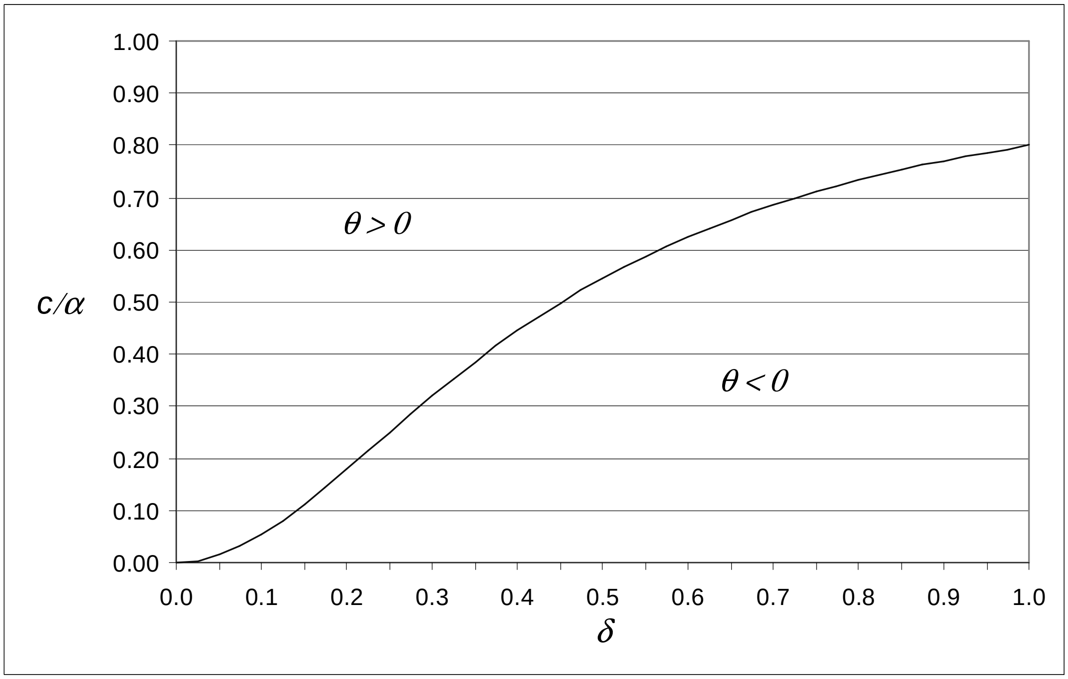

Figure 2: Marginal Cost-Demand Intercept Ratio (c/α) vs. Degree of Product Differentiation (δ) under Quantity Competition [$\phi = 0.96$]

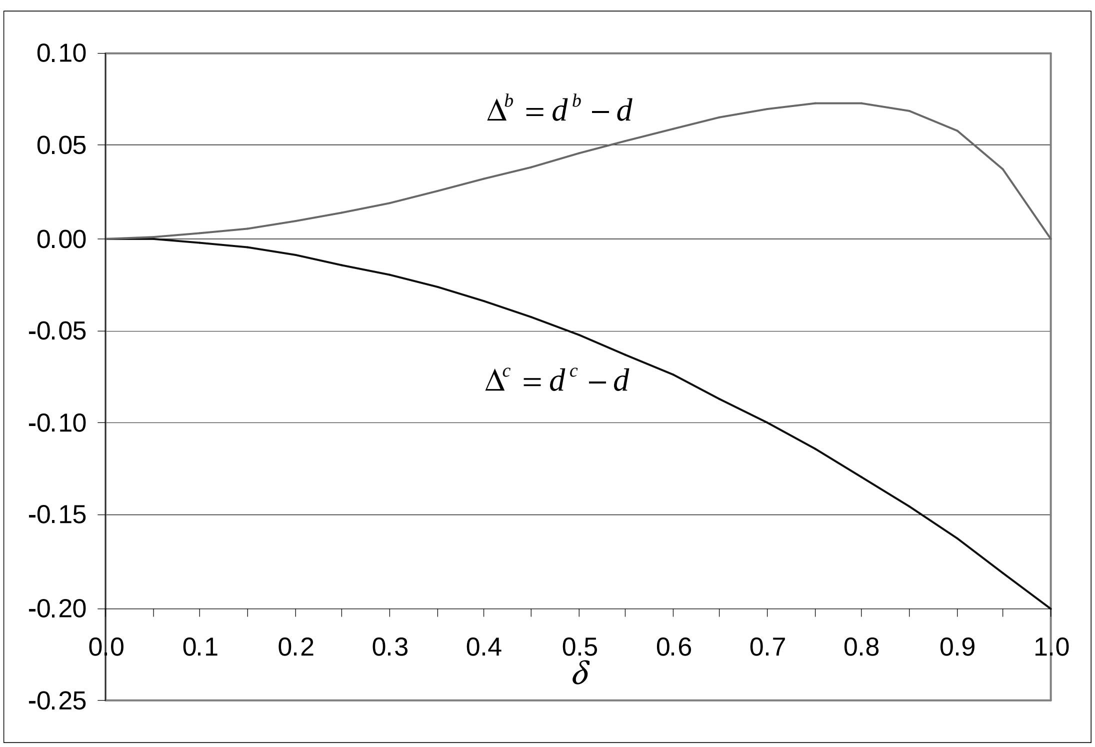

Figure 3: Strategic Motives of Shareholders under Quantity and Price Competitions [α - d = 1]