Managerial Incentives and Strategic Investor Behavior

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Using a simple two stage duopoly model, we demonstrate that risk-averse investors generally will not wish a firm's manager to maximize the value of the firm due to the strategic (commitment) impact of managerial incentive contracts. Hence, we cannot assume that risk aversion implies that investors will wish contracts, incentives, and executive compensation to be based purely on maximizing firm value. We show that an executive's incentive package will cause the manager to act as if investors are less risk averse than they actually are. This indicates that firm behavior and the observed selection of risky projects may not be a good measure of investors' true risk preferences due to the distortions caused by strategic industry effects. Thus, the strategic value of managerial incentives, which is inherently linked to the industry structure of the firm's product market, cannot be ignored when examining investor behavior.

Introduction

The managerial incentives present in firms owned by outside investors recently have been discussed, particularly in terms of the goals given to managers. The conventional wisdom is that if investors or firm owners are risk averse, the goal of the firm's managers should be the maximization of firm value rather than discounted expected profits (Shaffer, 1991) because the maximization of expected cash flows does not take into account the inherent risk of the firm's operations. This argument, however, ignores the market structure in which the firm and managers operate. Recent economic literature has recognized that in many industries managerial incentives can have strategic effects (Fershtman and Judd, 1987; Sklivas, 1987; and

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Reitman 1993).[1] We use a simple duopoly framework in conjunction with the Capital Asset Pricing Model (CAPM) to demonstrate that industry structure has profound effects on the type of contracts that investors will form with their managers.

The model supposes that each firm is characterized by a separation of ownership and management. The firm is owned by risk-averse investors whose objective is the maximization of firm value. The investors form contracts with their managers where compensation is based on a linear combination of firm value and realized net cash flow. Assuming general demand and cost functions, we show that risk-averse investors optimally will move their managers away from pure value maximization and toward the maximization of discounted net cash flows or profits as long as the covariance between firm profits and cash return of the market portfolio increases as production increases. Thus, surprisingly, our model indicates that risk-averse investors may sign contracts with their managers that provide compensation based on both value and profit maximization due to the strategic industry effects of managerial incentives. Our findings suggest that as long the covariance between firm profits and the cash return of the market portfolio is increasing in output, investors will encourage their managers to act in a more aggressive fashion. The managers attempt to capture a larger market share than pure value-maximizing behavior would indicate. This implies one cannot assume that risk-averse investors or firm owners will design managerial contracts or compensate executives based exclusively on maximizing firm value.

This result suggests that we cannot infer investors' true risk preferences simply by observing firm behavior due to the strategic manipulation of managerial incentives. A further implication of the analysis is that when these strategic industry effects are present, *endogenously* driven changes in the covariance between firm profits and cash return of the market portfolio may occur due to changes in product demand or manufacturing cost. What appear to be exogenous structural changes in the estimation of the CAPM model are potentially endogenous effects and may occur with great frequency. Hence, time series tests of the CAPM model may be plagued by structural shifts that are related to strategic contracting behavior. As a result, care must be taken in the estimation and interpretation of these models.[2]

[1] In essence, this literature argues that, due to strategic considerations, principals may wish to hire an agent and then structure the incentive contract such that the agent maximizes an objective function different from the principal's. The strategic use of contracts in terms of their *commitment* ability is the underlying intuition and rationale for findings elsewhere in the literature and in this paper. For brevity, we use the term *strategic* to embody this notion (contractual commitment role managerial incentives provide).

[2] Many studies attempt to test CAPM or calculate market betas. See Ferson et al. (1987), Bodurtha and Mark (1991), and Ng (1991) for recent examples.

Additionally, our model provides another possible explanation of why firms and managers do not always invest in projects with positive net cash flows.[3] Many studies, such as DeCanio (1993) and Harris et al. (1982), conclude that there are many barriers to these profitable investments. Our results suggest the strategic commitment effects of contracts and managerial incentives also can impact investment decisions and managerial behavior.

A Model of Strategic Investor Contracting

As in Fershtman and Judd (1987) and Sklivas (1987), we suppose that there is a separation of ownership and management.[4] These authors analyze the strategic use of managerial incentives in a linear demand constant marginal cost two stage game where a manager's compensation depends upon a linear combination of profit and sales revenue. These authors show that the strategic impact of managerial incentives can induce risk-neutral firm owners to sign contracts with managers that result in lower prices and profit than found in traditional Cournot behavior.[5] Our approach differs—we do not assume the owner/investor is risk neutral, nor do we assume that a manager's contract implies that he or she will seek to maximize a linear combination of sales and profit. Instead, our model contains risk-averse investors who wish to maximize firm value based on the CAPM when firms operate in imperfectly competitive output markets. We model the effect of industry structure upon managerial incentives by allowing managerial compensation to depend upon a linear combination of firm value and net cash flows (profit). Further, our model is more general because demand and cost are not assumed to be linear functions of output.

Suppose there are two firms in a given industry indexed by i and j where each firm is owned by different risk-averse investors. These investors employ managers to run their firms, given a stochastic demand for output. Risk-neutral managers are hired to observe the relevant demand realizations and make the appropriate production decisions based on the incentives provided by the investors.[6] Thus, we have a

[3] Although our model does not explicitly show that positive NPV projects may not be undertaken, it does indicate that the firm may not make the value-maximizing output decision. By an admittedly casual generalization, if the firm does not make the value-maximizing output decision, then it may not choose all projects that have a positive NPV (as it would if it were solely interested in value maximization).

[4] To make the analysis tractable, as in the previous literature, the model assumes the separation of ownership and management is exogenously determined. In other words, the firm comprises separate investors and managers, perhaps due to capital market considerations.

[5] More recently, Reitman (1993) uses these authors' basic framework to show that stock options may be used to reduce the aggressiveness of managers, implying higher profits in equilibrium. Additionally, Goering (1996) shows that if the firms' executives have different managerial styles, owners may write contracts that penalize the executives for sales.

[6] The existence of an uncertain demand implies forcing contracts, such as quantity forcing contracts, will not be optimal because investors want managers to be able to adapt to the

simple two-stage game where in the second stage firm i's manager selects a quantity q_i after the realization of the random variable x. In the first stage the investors must choose the managerial incentives (specific form of the contract) without precise knowledge of the demand for output, and managers must decide whether to accept the contract given the uncertain demand. In other words, during contracting in period one product demand is unknown by all participants, but in stage two it is revealed to managers working in the industry.

The inverse industry demand is given by p(Q, x) where $Q = q_i + q_j$ is industry output. This demand is assumed to be twice continuously differentiable with $p_Q < 0$ and $p_x > 0$. Hence, demand is downward sloping in industry output but is increased by larger realizations of the random variable x.[7] We also suppose that each firm's marginal revenue is decreasing in the other firm's output, implying that $p_Q + p_{QQ} q_j < 0$ for firm i (Hahn, 1962).

On the production side, the manufacturing costs for firm i are given by $c_i(q_i)$ where firm costs are twice continuously differentiable with $c_i'(q_i) > 0$. Thus, firms do not necessarily have the same cost structure in our model.

Although the manager can observe realizations of x in stage two, investors cannot. Investors, however, do have full knowledge of the distribution of x. Thus, investors are assumed to know the probability density function f(x) as well as its supports [$\underline{x}$, $\overline{x}$]. If r is the risk-free one period return, then

$$\delta = \frac{1}{1+r}$$

is the appropriate discount factor. In stage one the investor's expected firm value based on CAPM can be defined as:

$$E[\delta V_i] = \delta \int_{\underline{x}}^{\overline{x}} \left[p(Q,x)q_i - c_i(q_i) - \alpha\theta_i(q_i)\right] f(x)dx\ , \tag{1}$$

where:

α = The market price per unit of risk; and

$\theta_i(q_i)$ = The covariance between the firm's profit π_i and the total cash return of the market portfolio.[8]

observed demand conditions. Note also that, as in the earlier models in this area, the analysis abstracts from shirking behavior and other types of agency problems and their solutions. The model instead focuses on the strategic choice of managerial incentives when a separation of ownership and management is maintained.

[7] This is a rather general formulation of a stochastic demand. For example, in a linear demand setting x may be interpreted as the level of demand or intercept term, i.e., p = x - bQ. See Goering (1993) for a similar stochastic demand specification in a durable goods model.

[8] See Sharp (1964), Lintner (1965), and Subrahmanyam and Thomadakis (1980) for the basic statement of the CAPM model in a similar collapsed form and Shaffer (1991) for a duopoly application of the CAPM model assuming consistent conjectures.

We initially suppose that the firm is relatively small in comparison to the capital market, suggesting that the firm is a risk price-taker so α is a constant. On the other hand, as Shaffer (1991) notes, in most cases if market share increases the covariance between the firm's profit π_i and the market portfolio return would increase. Thus, typically $\theta_i'(q_i) > 0$, but we do not place any restriction on the sign of $\theta_i'(q_i)$ for completeness.[9] Note also that initially we are assuming that firm i's covariance θ_i only depends upon its own output level. This assumption allows us to focus on the strategic effects due to demand interdependence because in many cases a firm may have a rather large impact on its rival's demand and marginal revenue curves but a negligible impact on its rival's covariance. We later will relax this assumption and explore the impact of allowing a firm's covariance to depend upon both firms' output levels.

Investors must decide the appropriate managerial incentives to provide to the managers of their firm to maximize the expected firm value shown in equation (1), net of any compensation paid to the manager. As in Fershtman and Judd (1987), we restrict our attention to linear contracts. We assume that firm i's manager will be compensated in the second stage according to:

$$w_i = \lambda_i + \tau_i K_i, \tag{2}$$

where:

K_i = The linear combination of net cash flows π_i and the firm value V_i from the investors perspective. Thus $K_i = (1-\gamma_i)\pi_i + \gamma_i V_i$ where:

$$\pi_i = p(Q, x)q_i - c_i(q_i), \tag{3}$$

and

$$V_i = \pi_i - \alpha\theta_i(q_i), \tag{4}$$

remembering that the manager observes the realizations of the random variable x after contracting. Managers know that their total compensation w_i depends upon a linear combination of the functions π_i and V_i. This formulation implicitly assumes that although investors cannot observe the realization of demand or the manager's quantity choice, they do observe the subsequent realizations of π_i, V_i, and the rival manager's contract.[10]

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[9] We are treating the covariance θ as a known function in the model. Thus, both the investor and manager are assumed to have full knowledge of this function. The only uncertainty on the part of investors is due to the stochastic demand variable x and the resultant output choice q(x). All other information in the model is assumed to be common knowledge, such as the rival manager's contract, which is critical for contracts to serve a strategic commitment role.

[10] There are several unknowns specified jointly in equation (4), q_i , q_j , and x, i.e., there is only one piece of information and three unknowns. Hence, it is not possible for the owner/investors to uncover these unknowns. Moreover, even if these values were recoverable, as in the original framework of Fershtman and Judd (1987), one could assume a high cost to owner/investors (in terms of time involved etc.) in uncovering these values so they would have no incentive to do so. This is a central assumption in this strand of literature (that it is too costly for owners/investors to track day-to-day output decisions etc.) and that owners instead

At this point it is perhaps worth reiterating the sequence of events using a time line:

t = 0		t = 1	
Investors offer contracts to prospective managers	Managers decide whether to accept contracts based on uncertain demand	Managers observe demand realization and select output levels	Investors observe π and V and compensate managers accordingly

The timeline shows the contracts are signed before the managers' choice of output q_i and the demand realization x (which are *not* observable or recoverable, as shown in footnote 10). Thus, the market/investors are uncertain about the value of the company when contracts are signed. In other words, the market makes its valuation in our model after contracts are signed. Managers are hired by investors to run the firm based on the specific demand realization that is unknown to the market at large.

Equation (2) indicates that investors in firm i have three different incentive variables under their control: λ_i, τ_i, and γ_i. As long as the manager is risk neutral, they will accept the contract if they are paid at least their opportunity cost of participation. Consequently, in stage two investors will seek to maximize $K_i = (1 - \gamma_i)\pi_i + \gamma_i V_i$, given any $\tau_i > 0$.[11] Furthermore, because manager i's total compensation is given by equation (2), owner i will set λ_i and τ_i so the manager's participation constraint is met, given K_i. In other words, the investor will select the optimal γ_i that yields K_i and then set λ_i, and τ_i so that w_i equals the manager's opportunity cost (in expectation). This indicates w_i can be treated as a fixed cost that does not vary in terms of the incentive parameter of interest γ_i. This suggests that λ_i and τ_i will be set to ensure the manager's participation constraint is met; therefore, these variables are of little interest. More importantly, this indicates the value of γ_i that maximizes expected firm value net of the manager's compensation is the value that maximizes the expected firm value shown in equation (1).[12]

condition their managerial incentives on more readily available information such as profits and market value.

[11] The assumption of risk neutrality is not a strong one in our linear contract setting, and our findings remain intact even if it is removed. The manager's risk preferences only influence the decision to accept or not accept the investor's compensation contract. Once the contract is accepted, all uncertainty is resolved for the manager. (The manager sees the realization of the demand variable x.) If a manager is risk averse, however, he or she will have to be compensated at a higher level to accept the contract, i.e., a risk premium will have to be added. The owner/investor can adjust λ_i and τ_i in equation (2) so the manager's participation constraint is met even in the case of risk aversion (albeit at higher levels than the risk-neutral case). Thus, a risk-averse manager still would seek to maximize K_i, the linear combination of net cash flows and the firm for any positive τ_i.

[12] Because the maximization of expected firm value net of the manager's compensation is equivalent to the simple maximization of the expected firm value, the objective function of the

The main question that our model addresses is the type of managerial incentives γ_i that investors optimally would choose, i.e., the form of the contract. The incentive γ_i can be viewed as the weight that the investor instructs the manager to place on value maximization versus net cash flow maximization. Equivalently, γ_i can be viewed as the weight that managers place on the investor's disutility of risk. This can be seen by noting that the difference between equations (3) and (4) is given by the term $\alpha\theta_i(q_i)$. Empirical financial research suggests that the covariance θ_i and its associated beta coefficient (systematic risk) are generally positive. Thus, we can interpret $\alpha\theta_i(q_i)$ as investor cost or premium associated with risk.[13] If managers take this risk cost fully into account, $\gamma_i = 1$. As γ_i is reduced below 1, managers place less weight on this risk cost. Conversely, as γ_i is increased above 1, managers place more weight on risk costs than the true value.

Conventional wisdom would suggest that risk-averse investors would set $\gamma_i = 1$, so the manager would maximize firm value. Managers would be instructed to take into account the actual risk preferences of the investors. This type of reasoning often is used in financial models to argue that the firm's or the manager's goal will be the maximization of firm value rather than profits when investors are risk averse. This argument, however, ignores the strategic commitment value of managerial incentive contracts. For example, by decreasing γ_i below 1, investors may be able to induce their manager to act more aggressively and capture a larger market share. Hence, as we show in the next section, even when risk-averse investors care only about maximizing expected firm value (1), they will instruct their managers to place some weight on the maximization of net cash flow (profits) due to the strategic industry effects of managerial incentives.

Optimal Managerial Incentives for Risk-Averse Investors

As is typical in game theoretic models we solve the problem in reverse order to ensure the resulting equilibria are subgame perfect. In the second stage, from equations (2), (3), and (4) we know the manager of firm i will seek to maximize:

$$K_i = (1-\gamma_i)\pi_i + \gamma_i V_i = p(Q, x)q_i - c_i(q_i) - \gamma_i\, \alpha\theta_i(q_i), \tag{5}$$

through the choice of an output level q_i. Assuming Cournot behavior in the output market, the first order condition for this problem yields:

$$p(Q, x) + p_Q(Q, x)q_i - c_i'(q_i) - \gamma_i\, \alpha\theta_i'(q_i) = 0 \qquad \text{for i and j.} \tag{6}$$

Assuming an interior solution (6) gives the equilibrium conditions for the second stage of the game, recognizing that the managers of the two firms can observe the

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investor in stage one is assumed to be given by equation (1), recognizing that, strictly speaking, it is equation (1) net of the compensation paid to the manager. We also suppose that $E[\delta V_i]$ is strictly concave in γ_i to ensure the resultant solutions are global maximums.

[13] The sign of θ_i is not important in the model. Interpreting $\alpha\theta_i(q_i)$ as a risk cost, i.e., as a positive function, is convenient for expositional purposes. The model's conclusion are unchanged if the covariance is negative.

realization of the random demand shock x and each other's managerial contract.[14] Further, equation (6) shows that managers will select their production levels depending upon the incentives given to them by their respective investors. As noted in the previous section, the incentive parameter γ_i can be interpreted as the weight that managers are told to place on the risk cost of investors. As γ_i is lowered, managers will place less importance on this cost.

To solve for the investors' optimal choices of γ_i at the first stage of the game, we need know how the equilibrium values of q_i and q_j change as the incentive parameters are varied. Thus, we implicitly differentiate the system in equation (6) and use Cramer's rule to obtain:[15]

$$\frac{\partial q_i}{\partial \gamma_i} = \frac{\alpha \varphi_j \theta_i^{'}}{|J|} \tag{7}$$

$$\frac{\partial q_i}{\partial \gamma_i} = -\frac{(p_Q + p_{QQ} q_j)\alpha \theta_i^{'}}{|J|}, \tag{8}$$

where:

$|J|$ = The determinant of the Jacobian matrix of the system; and

$\varphi_j = (2p_Q + p_{QQ} q_j - c_j'' - \gamma_j \alpha\, \theta_j'')$.

Equation (8) shows the strategic commitment effect of managerial incentive contracts from an investor's perspective. Investors can not only influence their own manager's choice of output, but also can influence their rival's choice. It is the existence of this strategic output effect that will imply that a risk-averse investor will not wish his or her manager to maximize firm value and will choose a γ_i that is not equal to 1. Thus, due to the firm's market power in the output market, investors may move their manager away from pure value maximization. To more fully examine the impact of this strategic factor, we need to examine the sign of the strategic effect.

By second order conditions, $\varphi_j < 0$. We also know $(p_Q + p_{QQ} q_j) < 0$ as long as each firm's marginal revenue is decreasing in its rival's output. We further assume

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[14] Note that if the realization of x is low enough, the optimal solution will imply $q_i = 0$ (e.g., price may be below marginal cost for all $q_i \geq 0$), regardless of the second order conditions. To avoid this complication, the analysis assumes that the lower support $\underline{X}$ is large enough to rule out corner solutions where production is optimally zero. In addition, equation (6) does not necessarily provide a unique solution. As Tirole (1988, p. 226) shows, a sufficient condition for a unique solution (in a standard two firm Cournot model) "is that the derivative of the reaction functions must be less than 1 in absolute value over the relevant range." In our model this implies that

$$\left| \partial^2 k_i \big/ \partial q_i^2 \right| > \left| \partial^2 k_i \big/ \partial q_i \partial q_j \right|$$

is sufficient for uniqueness.

[15] See the appendix for a detailed derivation of equations (7) and (8) and the Jacobian matrix. Specifically, see equations (A1) and (A2).

that the equilibrium is stable so that $|J| > 0$.[16] Thus, the signs of equations (7) and (8) are dependent upon the sign of $\theta_i'(q_i)$. As noted previously, typically one would suspect that the covariance between firm i's profits and the total cash return of the market portfolio would increase as the firm's market share grows. Thus, θ_i' in most cases would be positive, implying that

$$\frac{\partial q_i}{\partial \gamma_i} < 0 \text{ and } \frac{\partial q_j}{\partial \gamma_i} > 0.$$

In this case as γ_i decreases firm i's manager will act more aggressively and reduce its rival's market share

$$\left(\frac{\partial q_j}{\partial \gamma_i} > 0 \right).$$

On the other hand, if covariance between the firm's profit and the total cash return of the market portfolio is decreased by a larger market share, then $\theta_i'(q_i) < 0$, and consequently,

$$\frac{\partial q_j}{\partial \gamma_i} < 0.$$

In this case firm j's market share decreases as γ_i increases. With this in mind, we can move to the first stage of the game to analyze investors' choice of managerial incentives.

Because investors cannot observe the realization of the stochastic demand variable x and are risk-averse, they will seek to maximize the expected value of the firm (rather than expected profit). Investor i will maximize equation (1), recognizing that the managers' reactions in the second stage quantity-setting equilibrium is implicitly determined by equations (7) and (8). In other words, investor i rationally recognizes that both managers' choice of output is influenced by his or her choice γ_i. The maximization of equation (1) subject to equations (7) and (8) implies:[17]

$$\frac{\partial E[\delta V_i]}{\partial \gamma_i} = \delta \int_{\underline{x}}^{\overline{x}} [\{p(Q,x) + p_Q(Q,x)q_i - c_i'(q_i) - \alpha\theta_i'(q_i)\} \frac{\partial q_i}{\partial \gamma_i} + \{p_Q(Q,x)q_i\} \frac{\partial q_j}{\partial \gamma_i}] f(x)dx = 0 \text{ for i and j.} \tag{9}$$

remembering that q_i and q_j are implicitly functions of the random variable x.

[16] Stability suggests that the firm's reaction functions must cross appropriately. Seade (1980) and Dixit (1986) show that this is closely related to second order conditions. Most commonly used demand and cost functions would imply $|J| > 0$. For example, with linear demand $p = x - bQ$, constant marginal production costs, and a constant marginal cost of risk: $|J| = 3b^2 > 0$.

[17] See the discussion in the appendix for a more complete derivation of equation (9).

The derivatives in equation (9) show the two effects of investors' choice of managerial incentives: the direct impact on the investors' own manager's output choice and the strategic influence it exerts on the rival manager's choice of output. Hence, equation (9) immediately reveals that if strategic effects are present

$$\left(\frac{\partial q_j}{\partial \gamma_i} \neq 0\right)$$

a risk-averse investor will not instruct his or her manager to maximize the value of the firm. Investors will move the firm's managers away from pure expected value-maximizing behavior for strategic purposes. As long as the covariance between firm profits and the total cash return of the market portfolio is an increasing function of market share ($\theta_i'(q_i) > 0$), equations (6), (8), and (9) suggest that investors will optimally choose $\gamma_i < 1$. [18]

Proposition: Risk-averse investors optimally will provide incentives that move the firm's manager away from pure value maximization toward profit maximization as long as the covariance between firm profits and the total cash return of the market portfolio is increased by larger market shares.

Proof: If managerial incentives imply strict value maximizing behavior then $\gamma_I = 1$. Evaluating equation (6) with $\gamma_i = 1$ and substituting this relation into equation (9) implies:

$$\frac{\partial E[\delta V_i]}{\partial \gamma_i} = \delta \int_{\underline{x}}^{\overline{x}} \{p_Q(Q, x) q_i \frac{\partial q_j}{\partial \gamma_i}\} f(x)dx \neq 0, \tag{9'}$$

because the first bracketed term in equation (9) vanishes at the optimal quantity level. This establishes that it is not optimal for investors to set $\gamma_i = 1$ given the existence of the strategic effect, i.e., when

$$\frac{\partial q_j}{\partial \gamma_i} \neq 0.$$

Moreover, if θi'(qi) > 0 then equation (8) implies that

[18] As an anonymous referee correctly argues this proposition is sensitive (as most game theoretic models are) to the type of competition (price versus quantity) in the output market. As Sklivas (1987) and Fershtman and Judd (1987) show, with differentiated products and price as the manager's choice variable, the manager will tend to act less aggressively rather than more aggressively. Thus, it is the existence of any strategic effect, be it price- or quantity-driven, which will cause a divergence between observed firm behavior and investor risk preferences in our model. The likely result of Bertrand competition would be a distortion away from pure value maximization in the opposite direction ($\gamma_i > 1$) as compared to our Cournot findings in this proposition.

$$\frac{\partial q_j}{\partial \gamma_i} > 0 \text{ and we see that } \frac{\partial E[\delta V_i]}{\partial \gamma_i} < 0$$

when evaluated at $\gamma_i = 1$ (regardless of the value of γ_j). Because $E[\delta Vi]$ is strictly concave in γ_i,

$$\frac{\partial E[\delta V_i]}{\partial \gamma_i}$$

is decreasing in γ_i, which indicates that investors will optimally decrease γ_i below 1 to ensure

$$\frac{\partial E[\delta V_i]}{\partial \gamma_i} = 0$$

in equilibrium. A similar analysis may be applied to investor j. Thus, as long as the covariance between firm profits and the total cash return of the market portfolio increases with firm output, risk-averse investors optimally will select $\gamma_i < 1$ and $\gamma_j < 1$.

The proposition and its proof indicate that risk-averse investors may strategically move the firm's manager toward expected profit maximization. If the covariance θ is increased by larger market shares, investors will instruct their respective managers to act more aggressively by ignoring, at least in part, investors' true risk preferences. This aggressive behavior, ceteris paribus, tends to reduce the rival's market share.[19] We would expect θ to be greater in cases where strategic effects are present than in cases where the strategic effect vanishes (e.g., perfectly competitive output markets).

This suggests that we cannot necessarily assume that risk-averse investors would wish to design contracts or base an executive's compensation exclusively on maximizing firm value. Even though investors may be risk averse and require a risk premium, for strategic purposes they may want firm managers to ignore some of the risk cost associated with production.[20]

The results are unchanged even if the model is generalized by relaxing the assumption that the firm is small in relation to the capital market, i.e., the firm is a

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[19] As we mentioned earlier, empirical financial research indicates that we often can interpret $\alpha\theta_i(q_i)$ as the cost or premium associated with investors' risk. Thus, Shaffer's (1991) finding that $\theta_i'(q_i)$ is typically positive would imply that any weight placed on profit maximization would tend to lead to higher output levels than consistent with value maximization because value maximization has an additional cost of output associated with it. Hence, in this typical equilibrium we know that if $\gamma_i < 1$ and $\gamma_j < 1$ the total industry output produced will be greater than under pure value-maximizing behavior.

[20] On the other hand, if the covariance is decreased as market share increases ($\theta_i'(q_i) < 0$), it is easy to show that investors will instruct managers to act more aggressively by increasing γ_i above 1. Here, managers act as if the risk premium associated with investors is greater than its actual value, i.e., set $\gamma_i > 1$ and $\gamma_j > 1$, as the covariance is decreased as output increases.

risk price-taker (α is a constant). If we let the per unit market price of risk α vary, then the strategic effect shown in equation (8) becomes:

$$\frac{\partial q_j}{\partial \gamma_i} = - \frac{(p_Q + p_{QQ} q_j)(\alpha \theta_i^{'} + \theta_i \alpha^{'})}{|J|}$$

where the determinant of this new system still is assumed to be positive for stability. As long as $\theta_i \alpha'(q)$ has the same sign as $\theta_i'(q)$, the conclusions of the model are not affected. If these signs differ, then the optimal managerial incentive selected by investors will vary from strict value-maximizing incentives (i.e., from 1) depending upon the magnitude of these terms. In other words, the sign of

$$\frac{\partial q_j}{\partial \gamma_i}$$

will depend upon the strength of the opposing terms.

Similarly, if we relax the assumption that a firm's covariance only depends on its own output, i.e., if we assume $\theta_i(q_i, q_j)$, it implies that equation (8) contains an additional term:[21]

$$\frac{\partial q_j}{\partial \gamma_i} = - \frac{\alpha \dfrac{\partial \theta_i}{\partial q_i} (p_Q + p_{QQ} q_j + \gamma_j \alpha \dfrac{\partial^2 \theta_j}{\partial q_j \partial q_i})}{|J|}.$$

Our results are unaffected here as long as the added term (which captures the interdependence of the firms' covariances at the margin)

$$\gamma_j \alpha \frac{\partial^2 \theta_j}{\partial q_j \partial q_i}$$

does not change the sign of the term in the parentheses. Thus, if this term is a relatively small positive value or negative, it is still true that in stable equilibria when manager i acts more aggressively (γ_i is decreased) it reduces its rival's market share assuming

$$\frac{\partial \theta_i}{\partial q_i} > 0.$$

Note also that if $\theta_i(q_i, q_j)$, equations (9) and (9') also contain an additional term due to the direct impact of the rival's output level on the covariance. In particular, equation (9') becomes:

$$\frac{\partial E[\delta V_i]}{\partial \gamma_i} = \delta \int_{\underline{x}}^{\bar{x}} \{(p_Q(Q, x) q_i - \alpha \frac{\partial \theta_i}{\partial q_j}) \frac{\partial q_j}{\partial \gamma_i}\} f(x) dx.$$

This equation indicates that our main proposition is unchanged as long as

[21] To focus on the impact of allowing a firm's covariance to depend on a rival's output level we assume that α is constant once again.

$$\frac{\partial q_j}{\partial \gamma_i} > 0 \text{ and } p_Q(Q, x)q_i - \alpha \frac{\partial \theta_i}{\partial q_j} < 0.$$

In most cases it would seem that a firm's impact on its rival's covariance would be relatively small vis-à-vis its impact on the rival's demand curve, ensuring these conditions will hold. In addition, even if these conditions are not satisfied, it means that an owner's optimal managerial incentive will vary from 1 (strict value-maximization) depending upon the magnitude of these additional terms. Even in cases where we allow one firm's output choice to directly impact its rival's covariance, our result that managerial incentives tend to diverge from pure value-maximizing behavior still holds.

We could generalize the model further by allowing more than two firms in the industry. The model will become significantly more complicated, but the strategic effect would still be present (assuming a finite number of firms), and managerial incentives still would diverge from strict value-maximizing behavior. This indicates that in an imperfectly competitive environment, we generally would expect the strategic manipulation of managerial incentives

$$\left(\frac{\partial q_j}{\partial \gamma_i} \neq 0 \right).$$

These extensions suggest that investors in imperfectly competitive industries may use managerial incentives strategically if: 1) the covariance between the firm's profit and the return of the market portfolio is influenced by market shares, and 2) the market price of risk is not constant. Risk-averse investors will not necessarily wish managers simply to take into account the investors' actual risk preferences. We would expect instead, most commonly, for executive incentive packages to be structured such that managers act as if the investors' are less risk averse than they actually are. Firm behavior and the observed selection of risky projects may not be a good measure of investors' true risk preferences due to the distortions caused by strategic industry effects. Our model suggests that one cannot assume that a firm's behavior will reflect the true risk preferences of investors due to the strategic use of managerial incentives.[22] This behavior by firms also may contribute to the "equity premium puzzle" discussed by Mehra and Prescott (1985). While individual firms may conduct riskier projects than would be expected, given investors' risk preferences, these projects will increase the covariance between a firm's profits and the return of the market portfolio. If this strategic behavior increases the variance of the

[22] Interestingly, Sobel (1981) shows that agents may wish to strategically distort their risk preferences or utilities in a bargaining game. Our model indicates that we may expect an investor to induce the manager to act as if the investor's risk is different than it truly is. Both models indicate that individuals may disguise their true risk preferences for strategic purposes.

market portfolio, however, the equity premium may be higher than that expected by the degree of risk aversion.[23]

In addition, in our model changes in product demand or costs would tend to influence the managerial incentives selected because equations (7) and (8) depend upon demand and costs. The change in managerial incentives in turn would affect the output choice of managers and the covariance between a firm's profits and the return of the market portfolio. Hence, in the simplest case when time series data are used to estimate and test the CAPM, these structural shifts would lead to time-varying beta coefficients. In other words, if θ tends to be larger when strategic effects are present and these strategic effects are influenced by demand and cost, we would expect time-varying beta coefficients due to changes in demand and costs. If the structural shifts are not incorporated into the estimation procedure or if structural stability tests are not employed, results from these tests may not be reliable. This problem also occurs when the estimation techniques incorporate autoregressive conditional heteroskedasticity (ARCH).[24] In this case, changes in managerial incentives would be expected to lead to structural changes in the underlying ARCH process.

Finally, our results may help explain why managers do not necessarily choose investments that maximize firm value or profit. Due to strategic effects, managers may appear to maximize neither firm value nor profit.

Concluding Remarks

We examine a simple two stage duopoly model where in the first stage risk-averse investors select the optimal incentives to provide to the firm's managers, who subsequently in the second stage select a production level. Our analysis suggests that researchers cannot assume that risk aversion implies that investors will wish contracts, incentives, and managerial compensation to be based purely on maximizing firm value. Further, it indicates that one cannot immediately infer the risk preferences of investors by examining firm behavior. Firms may act as if the investors' disutility from risk is lower than it actually is due to industry strategic effects. In addition, when strategic effects are present, shifts in product demand and cost will have direct impacts on the observed covariance between firm profits and the total cash return of the market portfolio, suggesting that the beta coefficients will tend to be time varying. Therefore, care must be taken in the estimation and interpretation of tests of the CAPM.

In summary, the type of managerial incentives preferred by investors is linked closely to the industry structure in which the firm operates and, in general, cannot be ignored when analyzing investor behavior. Although we used a purely non-coopera-

[23] Because this speculation is subject to a possible fallacy of composition, the effect of individual firm's strategic behavior upon the market portfolio would need to be explored in a general equilibrium setting.

[24] For examples, see Ng (1991) and Bodurtha and Mark (1991).

tive Cournot framework, one would suspect that a more collusive/cooperative framework (where some form of joint value maximization were the objective rather than individual firm value) also may reveal a link between market structure and investment behavior. Likewise, a Bertrand price-setting framework undoubtedly would show a link between the two.

Our model and other principal agents models focusing on the strategic use of managerial incentives assume that ownership and control are separate. An interesting, although perhaps difficult, extension would be to allow for an endogenous determination of the separation of ownership and management in a three stage game. This would allow a rich environment for analyzing risk sharing and other forms of agency problems not possible in the current two stage model. For example, to remove all risk, investors could sell the firm to the risk-neutral manager. An interesting question immediately arises: would the rival investor also like to sell his or her firm to the manager?

From a strategic standpoint, it is not obvious that the rival investor's best response would be to sell the firm. We speculate that by keeping ownership and management separate, rival investors could give their managers commitment ability, allowing the managers to act as Stackelberg leaders in the output market. This would tend to enhance rival investors' expected profit or firm value. This increase in expected profit would have to be weighed against investors' risk costs of maintaining ownership to ascertain whether selling the firm in this expanded game is optimal. There are also constraints, such as capital market constraints, that would make it difficult or impossible for owners to sell the firm to the manager. Additionally, the risk preferences of the manager also may come into play in a more expanded game. If the manager is risk averse, the *optimal* type of contract offered by the owner in an expanded principal agent setting (where compensation contracts are not restricted to a linear space) likely will be affected. These sorts of three stage strategic models are beyond the scope of the current analysis, however, and are left for future research.

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Appendix

In this appendix we provide the full system and Jacobian matrix for equation (6) and derivation of equations (7), (8), and (9).

The system of first order equations for the two firms [found by differentiating K_i and K_j shown in equation (5)] is:

$$\frac{\partial K_i}{\partial q_i} = p(Q,x) + p_Q(Q,x)q_i - c_i^{'}(q_i) - \gamma_i \alpha \theta_i^{'}(q_i) = 0$$

$$\frac{\partial K_j}{\partial q_j} = p(Q,x) + p_Q(Q,x)q_j - c_j^{'}(q_j) - \gamma_j \alpha \theta_j^{'}(q_j) = 0. \quad \text{(A1)}$$

System (A1) is the complete systems for equation (6). Implicitly differentiating (A1) with respect to the managerial incentive parameters γ_i and yields:

$$\begin{bmatrix} 2p_Q + p_{QQ}q_i - c_i^{''} - \alpha\gamma_i\theta_i^{''} & p_Q + p_{QQ}q_i \\ p_Q + p_{QQ}q_j & 2p_Q + p_{QQ}q_j - c_j^{''} - \alpha\gamma_j\theta_j^{''} \end{bmatrix} \begin{bmatrix} \dfrac{\partial q_i}{\partial \gamma_i} \\ \dfrac{\partial q_j}{\partial \gamma_i} \end{bmatrix} = \begin{bmatrix} \alpha\theta_i^{'} \\ 0 \end{bmatrix}, \quad \text{(A2)}$$

where the first matrix in (A2) is the Jacobian matrix of the system. Using Cramer's rule to solve for

$$\frac{\partial q_i}{\partial \gamma_i} \text{ and } \frac{\partial q_j}{\partial \gamma_i}$$

in (A2) gives equations (7) and (8).

To see the derivation of equation (9), note that in the first stage of the game the investor correctly will anticipate that the manager's output decisions depend upon the compensation parameter γ_i. In other words, investor i knows that $q_i(\gamma_i, \gamma_j, x)$ and $q_j(\gamma_i, \gamma_j, x)$ in the investor's objective function (1). Furthermore, investor i rationally recognizes that

$$\frac{\partial q_i}{\partial \gamma_i} \text{ and } \frac{\partial q_j}{\partial \gamma_i}$$

are determined implicitly by (A2), [i.e., equations (7) and (8)]. We directly can differentiate equation (1) with respect to γ_i, using Leibniz's formula and the chain rule, which gives equation (9).