Product Market Competition and Productive Managerial Effort

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Abstract

This paper analyzes a mechanism through which product market competition affects allocation of the managerial efforts. There are two types of firms, incumbents and entrants. Each incumbent firm delegates its control to a manager and cannot observe the manager's effort. The managers of incumbent firms allocate their effort to two different activities: cost reduction (productive effort) and rent protection (unproductive effort). An increase in competition, measured by the number of incumbent firms, has two effects: an "output effect" which decreases the managerial incentive for productive effort, and an "effort substitution effect" that makes managers exert more productive effort and less unproductive effort. This paper identifies the conditions under which product market competition lowers the cost of providing incentives for productive effort and hence, to the conclusion that increased competition leads to increased efficiency.

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Key Words: Competition, cost reduction, rent protection, output effort, effort substitution effect, managerial incentives

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1 Introduction

It has long been believed that product market competition disciplines firms into efficient operation, while market power brings slack and X-inefficiency. This view is reflected in the arguments that a monopolist is X-inefficient or that international trade has positive welfare effects in reducing internal slack in firms. It has been a driving force behind numerous policy changes such as deregulation of many sectors in the OECD countries, EC single market program, and reforms in Eastern Europe.

There would be no scope for slack when a firm operates in a perfectly competitive product market. Even in an imperfectly competitive market, competition would play a disciplinary role if there were no separation of ownership and control. That is, competitive outcome and efficiency could be achieved or approximated arbitrarily closely as the intensity of competition increases. However, once the principal (the owner, shareholders) delegates control to the agent or the manager, and faces a moral hazard problem, it is not obvious whether competition disciplines the agent to make his decision in accordance with the principal's objective. This is because the manager takes actions in conflict with profit maximization and the marginal return from managerial effort may decrease with more intense competition.

This paper reexamines the role of product market competition as a disciplinary device. Specifically, this paper addresses the following questions: "What is a mechanism through which competition affects the agency problem?" and "Does competition promote internal efficiency of the firm?" Although it is very important to understand how competition works in the presence of moral hazard theoretically and practically, these questions have received little attention from researchers. More surprisingly, *there is no strong theoretical support to the common belief that competition promotes efficiency.*

Several papers[1] have analyzed the effect of product market competition on agency problems. Contrary to conventional wisdom that product market competition disciplines firms into efficient operation, most of the papers cast doubt on the disciplinary role of competition. In my view, the reason that these papers are skeptical about the role of competition

[1] These include Hart (1983), Scharfstein (1988) and Schmidt (1997) among others.

lies in a too narrow interpretation of the manager's role. The previous literature assumes that the manager has only one job, production or cost reduction. This assumption leads to the model where cost of managerial effort is independent of market structure and of the degree of competition.

In reality, the manager is engaged in various activities whose costs and benefits are influenced by market structure. For example, the managers may take political actions as market strategies besides production decision. Petersen (1989) reports that the Bell system was active in promoting regulations to restrict competition in the early years of the 20th century after its patents expired. And the Bell system did the same thing in the late 50s after microwave transmission technology was available. Viscusi, Vernon and Harrington (1992) also provide evidence of how incumbent firms manipulate regulatory authorities to establish entry barriers. As long as the benefits associated with these two activities are realized in market, allocation of managerial effort is influenced by market structure under which the firms operate. Therefore, market conditions affect and change the relative values of different kinds of effort.

I model this situation by considering two types of managerial activities, among all. One is productive effort for cost reduction and the other is unproductive effort for rent protection. Productive effort is standard in the principal-agent literature. The second type is new in my model. This is called unproductive because this yields pecuniary returns but does not produce goods.[2] Unproductive effort is thought of as lobbying effort to establish entry barriers against potential entrants.

In this setting, I analyze a mechanism through which product market competition affects allocation of managerial effort in two different activities. There are two types of firms, incumbents and entrants. Each incumbent firm delegates its control to its agent and cannot observe the agent's choice of total effort. An increase in competition, as measured by the number of incumbent firms, has two effects on managerial incentives.[3]

[2]Unproductive effort, however, is perfectly compatible with profit maximization though it does not contribute to production. This is directly unproductive, profit-seeking(DUP) activity *à la* Bhagwati (1982).

[3]Adelman(1969) shows that the reciprocal of Herfidahl-Hirschmann index is the number of equal-size firms that would generate that measure. Therefore, although the number of firms is not the measure that

First, there is the "effort substitution effect": An increase in competition provides a direct incentive to spend more productive effort since lowered lobbying effort reduces the cost of productive effort. Furthermore, there is an indirect effect because it becomes cheaper for the owner of the firm to induce a higher level of productive effort. The effort substitution effect shows that cost of implementing a higher level of productive effort unambiguously decreases as competition becomes more intense.

There is a second effect called the "output effect," however, that may make the relations between competition and productive effort non-monotonic. This effect exists if and only if the manager is paid a rent in excess of his reservation utility. In general, increased competition reduces (expected) profits, so it may also affect the value of cost reduction and thus the benefits of inducing a higher level of productive effort. This effect has an ambiguous sign. If the value of cost reduction decreases with increasing competition, then the owner of the firm is less inclined to pay a high rent to the manager in order to induce high effort. Thus, the overall effect that the more competitive environment, the lower productive effort is made may be the case.[4] This paper identifies conditions under which the first effect dominates the second effect and as a result, competition provides incentives for productive managerial effort.

The model also delivers implication for competition policy and institution design, which is confirmed by historical observations. As Baumol (1990) notes, variations in the rules of game and associated reward structures change the allocation between productive and unproductive effort. My model suggests that higher productive effort can be induced as a result of changes in the rule of game. Lowering entry barriers, whether legal or not, facilitates higher productive effort. Changes in the reward structure in a direction discouraging unproductive effort help induce higher productive effort. [5]

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reflects all the aspects of competition, it does have a practical meaning.

[4]This effect is related to the huge literature on the value of innovation under different market structures. Most of the literature shows that increasing competition may have an ambiguous effect on the incentives to innovate.

[5]Baumol observes the same phenomenon. Before the industrial revolution, the English reward structure favored unproductive effort such as rent seeking and as a result, productive entrepreneuership barely took place. The dominant way of accumulating wealth in this era was pushing competitors away through legal

The idea of the role of competition as a disciplinary device goes back to Adam Smith. Smith notes that "Monopoly is a great enemy to good management, which can never be universally established but consequence of that free and universal competition which forces everyone to have recourse to it for the sake of self-defense." Then Hicks (1935) echoes Smith and asserts that "The best of all monopoly profit is a quiet life."

The disciplinary role of product market competition, however, often faces challenges. Especially, Jensen and Meckling (1976) argue that since agency cost affects all firms equally, there is no difference whether firms are operating in a competitive market or not. This view ignores the possibility that the environment affects the set of contracts. Moreover, empirical investigations such as Berger and Hannan (1998), Djankov and Hoekman (2000), Hay and Liu (1997), Nickell (1996) and Scherer and Ross (1990) show that Jensen and Meckling's view is not quite right. These studies provide evidence, though fragmentary, that the higher the market concentration, the lower is technical efficiency.

Compared to empirical research, however, theoretical studies do not provide strong support for the role of competition. An early innovative work by Hart (1983) lends a theoretical support. In the Hart's model, market price conveys information about common shock across firms[6] and the principal uses this information to improve upon a contract concluded in the absence of competition. Hart finds the monotone relationship between the degree of competition and managerial slack. Hart's positive result on the role of competition, however, critically depends on the manager's utility function. By assuming that the manager is infinitely risk-averse, the compensation scheme plays no role in providing incentives and a fixed wage contract is optimal independently of the degree of competition.

In a subsequent work, Scharfstein (1988) shows that Hart's result is not robust against the specification of the managerial utility functions. With managerial incentives that are sensitive to monetary compensation, Scharfstein shows that an increase in competition lowers the value of managerial effort and as a result, raises cost of implementing a given effort

barrier and getting monopoly grants. By the time the industrial revolution began, there were no longer grants of monopoly and the structure of reward encouraged productive entrepreneuership.

[6]This aspect of competition is also noted by Holmström (1982) and Nalebuff and Stiglitz (1983).

level. Therefore, as long as the manager's marginal utility of income is positive, competition exacerbates the agency problem.[7]

These two papers focus on the informational effect of competition and present contradictory results. In a hidden action model, Hermalin (1992) confirms that the informational effect of competition on managerial incentives is ambiguous. This paper abstracts from any informational effect of competition, not because this is not important, but because its focus lies elsewhere.

Schmidt (1997) and Stennek (2000) are related to this paper in the sense that both abstract from the informational effect. These papers analyze how competition affects financial constraints that the firm faces. Schmidt observes that increased competition may force the firm to go bankrupt. When firms go bankrupt, managers also bear costs, for instance, they must search for new jobs. So when the probability of bankruptcy increases as competition gets more intense, the threat of liquidation provides incentives not to shirk. Schmidt, however, takes the market structure as given while I endogenize it.

Stennek (2000) develops a similar model to Schmidt's. Facing limited liability, the principal is more likely not to pay wages to the manager when managerial effort is low. Considering increased competition typically reduces a firm's revenue, an increase in competition may induce the manager to make higher managerial effort and lower expected costs. Stennek's model is similar to this paper in a way that the number of firms is determined endogenously. My departure from Stennek is that while he takes entry barriers as given, I consider the cost of establishing entry barriers within the model and focus on the effort substitution effect rather than limited liability of the principals.

In sum, a few papers identify conditions under which competition enhances internal efficiency. Though they provide useful insights about how competition works, they neglect the facts that managers are engaged in various activities. I model this situation and analyze another mechanism through which competition affects the internal efficiency of the firm.

[7]Bertoletti and Poletti (1996, 1997), Horn et al. (1994, 1995), Martin (1993), and Willig (1987) also investigate the effect of competition on internal efficiency. Though slightly different, the models that these papers study are qualitatively identical to the one that Scharfstein studies and the same results are obtained.

This is not to say that the mechanism analyzed in this paper is the way that competition works, but to point out a mechanism that is complementary to the ones studied in the previous literature.

The rest of the paper is organized as follows. In section 2, I present the model followed by preliminary analysis. In section 4, I present main results on the effect of competition on the managerial effort allocation. I identify conditions under which an increase in competition leads to higher productive effort. In section 5, I make some remarks on the extension and conclude the paper. The proofs of the results are contained in the appendix.

2 The Model

There are n identical incumbent firms and a large number of identical potential entrants. Each incumbent is identified as a pair of principal-agent. At date 0, the principal of the incumbent firm hires an agent in a competitive market for identical managers. The principal delegates control to the agent whose main task is to improve internal efficiency of the firm and to establish a barrier to entry. The principal, however, cannot observe (total) effort exerted by the agent. So separation of ownership and control in the incumbents creates classical moral hazard problems.

The principal of an incumbent is risk-neutral so she is an expected-profit maximizer. The manager of the incumbent firm is also assumed to be risk-neutral but he is protected by limited liability. Therefore, the manager should get paid at least w_0 as wages, which is normalized to be zero. The manager can guarantee the outside option utility denoted by $\underline{U} \geq 0$. Hence, the manager's expected utility from accepting the contract offer from the principal must be at least as high as $\underline{U}$.

At date 1, the manager of the incumbent makes an effort to establish the entry barrier. I call this lobbying effort and denote by $l^i \in \mathbb{R}_+$ for $i = 1, ..., n$. In the following, the entry barrier is interpreted as entry fee which should be paid by entrants when they join the industry.[8] When there are n incumbents and an incumbent i makes lobbying effort, l^i, entry fee is determined by a function $f = f(l^1, l^2, ..., l^n)$. In setting the entry barrier, only the sum of lobbying effort is important so I set $f = f(\sum_{i=1}^{i=n} l^i)$, where f is assumed to be increasing.[9]

After the entry barrier is set by the incumbents, each entrant decides whether to join the industry or not. The entrant is assumed to be an entrepreneurial firm in Hart's (1983) sense. The principals of the entrants are owner-managers so there is no moral hazard problem in the entrants.[10] Entry will occur until gross profit to the entrant is equal to entry fee f.

The entrants are assumed not to exert any lobbying effort to reduce the entry barrier. This asymmetry between the incumbents and the entrants is reasonable in a situation where unlike the established incumbents, the entrants are often cash-constrained so they have difficulty in finding cash to bribe. In many cases, new firms are not part of government and have no established lobbies while the established firms do have organized lobbies through, for example, industry associations.[11] Moreover, as long as the incumbents have greater power to establish entry barriers than the entrants, the results does not change qualitatively.

At date 2, the manager of the incumbent exerts an effort to improve efficiency of the firm. Although I can apply my model to all types of manager's action, I focus on actions that affect firm's cost. Cost reduction effort, for example, could be a reorganization of the firm, adoption of new technology, selling-off of unprofitable divisions, and so on. Call this productive effort and denote by $e^i \in \mathbb{R}_+$ for $i = 1, ..., n$.[12] Only the manager himself knows how much effort he makes. The probability that manager's cost reduction effort is successful stochastically depends on the amount of productive effort. I suppose that cost realization can be either high (c_H) or low (c_L) with $c_H > c_L$. By making productive effort, the manager

[8] f can be interpreted as legislative barriers to entry or advertising to establish brand name. That is, f is any additional payment or effort from the entrants as compared to the incumbents.

[9] When the policymaker's preferences are single-peaked on the number of firms, given aggregate monetized lobbying effort and increasing in aggregate monetized lobbying effort, f becomes increasing in aggregate lobbying effort.

[10] This is for simplification. Our results hold in a case where entrants also face the moral hazard problem.

[11] Vickers(2003) also note that "[C]entral to the political economy of pro-competitive reform is the fact that the potential losers - protected incumbents (especially the less efficient) - tend to have a much louder voice than the far larger number of gainers - new entrants and above all the general public as consumers."

[12] Henceforth, we drop the notation for the identity of the incumbents unless it makes confusion.

increases the probability that cost realization is low, $Pr(c = c_L|e) \equiv P(e)$. I make the following assumption on $P(\cdot)$:

Assumption P $P(0) = 0$, $P'(e) > 0$, $P''(e) < 0$ and $P'''(e) < 0$ for all $e \in \mathbb{R}_+$. $P(e) < 1$ for all $e \in \mathbb{R}_+$. Moreover, $\lim_{e \to 0} P'(e) = \infty$ and $\lim_{e \to \infty} P'(e) = 0$.

Assumption P is concavity of $P(\cdot)$. First, $P(0) = 0$ means that initially the firm's cost is high without productive effort. By making productive effort, the manager increases the probability of successful cost reduction. It is more likely that cost realization will be c_L, the higher productive effort. However, productive effort exhibits diminishing returns. That is, $P(\cdot)$ increases at decreasing rate as productive effort increases. The negative third derivative is necessary for the global concavity of the optimization problem. Also the third derivative condition enables me to exclude the optimal contracts that prescribe stochastic cost targets. I impose a condition of $P(e) < 1$ for all $e \in \mathbb{R}_+$ because otherwise, the problem collapses into perfect information case. The Inada condition is imposed for the interior solution. For simplicity, the entrants are also assumed to share the same technology with the incumbents. That is, conditional on productive effort, e, the entrants have the same $P(\cdot)$ with the incumbents.

At date 3, each firm's cost realization is publicly observable to all the players and firm compete one another in the product market. It is assumed that the equilibrium in this stage is symmetric among the incumbents and among the entrants respectively. That is, conditional on identical cost realization, incumbents (respectively entrants) produce the same amount of output and hence receive the same amount of expected profit.

To complete the model, the utility functions of the players need to be specified. As mentioned earlier, all the payers are risk-neutral. The manager of the incumbent exerts two kinds of effort: productive effort (e), and lobbying effort (l). Productive effort and lobbying effort are assumed to be perfect substitutes to each other. Hence what matters to the agents is the sum of the two efforts. Let $g(e, l) = g(e + l)$ be cost of effort to the managers when exerting total effort $e + l$.[13] The following assumption is made about the cost of effort $g(\cdot)$:

Assumption G $g(0) = 0$, $g'(e + l) > 0$ for all $e + l > 0$. $\frac{g'(e+l)}{g(e+l)}$ is increasing. $g'''(e + l) \geq 0$.

Assumption G is basically convexity of cost of effort. But this requires the cost function to be sufficiently convex in total effort. The non-negative third derivative is imposed for the maximization problem to be well-behaved.

I assume that the manager's utility function is quasilinear and separable between wage and cost of effort. Then with the risk-neutrality assumption, the manager's utility function can be given by $U = w - g(e + l)$.

Cost of effort to the entrants is assumed to be identical to that of the incumbents' managers without l. So cost of effort to the entrants is just $g(e)$ for $e \in \mathbb{R}_+$.

3 Preliminary Analysis

In this section, I solve entrant's problem and characterize the optimal contract for the incumbent under full information and asymmetric information respectively. I compare the levels of productive effort in the different regimes and utilize the results in the next section for the analysis on the effect of competition.

3.1 Entrant's Problem

Let $\Pi_i(n+s)$ denote the expected reduced-form gross profit of the firm when cost realization is c_i and the number of firms is $n + s$ (n-incumbents plus s-entrants) where $i = L$ or H. Assume that $\Pi_L(n + s) > \Pi_H(n + s)$ for all $n + s$. The firm gets higher profit with lower cost, which, I think, is reasonable. And define

$$\Delta\Pi(n + s) \equiv \Pi_L(n + s) - \Pi_H(n + s)$$

[13]We conjecture that $g = g(e, l)$ and $\frac{\partial^2 g(e,l)}{\partial e \partial l} > 0$ would deliver the same results.

This is the difference between expected profits with different cost realizations. This measures benefit from productive effort. If $\Delta\Pi(n+s)$ is increasing in the number of firms, $(n+s)$, then cost reduction becomes more valuable as $(n+s)$ increases and vice versa.

Since the entrant is a traditional profit maximizer, the entrant maximizes expected profit. Once entering the market, each entrant knows how many firms are in the market. Given the number of firms, $n+s$, where there are n-incumbents and s-entrants, the entrant decides how much productive effort it would make by solving the following problem:

$$\max_{e} \;\; P(e)\Pi_L(n+s) + (1-P(e))\Pi_H(n+s) - g(e) \tag{1}$$

So the effort level chosen by entrants, e^{ent}, is determined by the following first-order condition:

$$P'(e^{ent})\Delta\Pi(n+s) - g'(e^{ent}) = 0 \tag{2}$$

Define expected gross profit of the entrant by

$$\mathbf{E}\Pi^{ent}(n+s) \equiv P(e^{ent})\Pi_L(n+s) + (1-P(e^{ent}))\Pi_H(n+s) - g(e^{ent})$$

when there are n incumbents and s entrants.

Entry occurs until expected gross profit is non-negative. Given that entry fee is set at f and that there are n-incumbents, s-entrants would enter if and only if:

$$\mathbf{E}\Pi^{ent}(n+s) - f \geq 0, \qquad\qquad \mathbf{E}\Pi^{ent}(n+s+1) - f < 0 \tag{3}$$

(2) and (3) determine the number of entrants and effort level when there are n incumbents and entry fee is f.

How $\mathbf{E}\Pi^{ent}(n+s)$ varies as the number of firms changes affects the entrant's decision to enter the market. I suppose that $\mathbf{E}\Pi^{ent}(n+s)$ is decreasing in $n+s$, which reflects business stealing effect. It is reasonable to assume that expected profit decreases as the number of firms grows. This assumption makes it possible to focus on the specific post-entry game among firms whose features are imperfect competition and business stealing effect. When a firm operates in a perfectly competitive market, the number of firms does not affect the profit level to each firm. Otherwise, the business stealing effect exists and the profit level falls as the number of firms grows. This seems a reasonable restriction that characterizes most imperfectly competitive markets.

3.2 Full Information

Consider the problem when the principal of the incumbent has full information and effort levels are verifiable. Let the manager be paid w_L when realized cost is c_L and w_H otherwise. The principal of incumbent offers a contract specifying productive effort, lobbying effort and wage scheme. For the contract to be implementable, the contract should ensure that the manager's expected utility from accepting the contract is at least as high as this outside option utility, $\underline{U}$. If the manager does not get payoff at least as much as what he would have gotten from outside option, he would not accept the contract. Then the individual rationality constraint becomes:

$$(IR) \qquad P(e)w_L + (1 - P(e))w_H - g(e + l) \geq \underline{U}$$

Thus when the principals can contract on cost-reducing effort as well as lobbying effort, the principal's problems is

$$\begin{aligned} \max_{e,l,w_L,w_H} \quad & P(e)(\Pi_L - w_L) + (1 - P(e))(\Pi_H - w_H) \\ s.t. \quad & (IR) \;\; P(e)w_L + (1 - P(e))w_H - g(e + l) \geq \underline{U} \end{aligned} \tag{4}$$

It is obvious that under full information, the principal leaves no rent to the manager by setting $w_L = w_H = g(e + l) + \underline{U}$. Then the maximization problem under full information becomes:

$$\max_{e,l} P(e)\Pi_L + (1 - P(e))\Pi_H - g(e + l) - \underline{U} \tag{5}$$

Given lobbying effort l, productive effort is determined by the first-order condition:

$$P'(e^{FI})\Delta\Pi(n+s) - g'(e^{FI}+l) = 0 \tag{6}$$

After solving out for e^{FI} as a function of l, the principal chooses l so as to maximize expected profit.

Comparison of e^{FI} with e^{ent} shows how the presence of lobbying effort affects the level of productive effort. The following lemma shows the relationship between e^{FI} and e^{ent}.

Lemma 1 *If $l > 0$, then $e^{FI} < e^{ent}$.*

Lemma 1 says that even under full information, the incumbent makes less productive effort than the entrant if the incumbent exerts any lobbying effort. This is because the two types of effort are substitutes and it becomes more costly for the principal to induce a given level of productive effort.

It is also of interest to see how productive effort varies as the number of incumbent changes. Let l_n denote per incumbent lobbying effort when there are n incumbents. Then lemma 2 describes the effect of changes in the number of incumbents on productive effort, provided that aggregate lobbying effort at the industry level decreases as the number of incumbents grows:

Lemma 2 *Suppose $n \cdot l_n > n' \cdot l_{n'}$ for all $n < n'$ and the principal has full information. Then productive effort per incumbent increases if $\Delta\Pi$ increases in the number of firms.*

The above lemma says that the level of productive effort increases if the value of cost reduction also grows in the number of firms operating in the market. In many cases, the value of cost reduction is monotonic in the number of firms. Hence, productive effort is expected to be non-monotonic, which will be confirmed in the discussion of the effect of competition on productive effort.

3.3 Optimal Contract for the Incumbents

In this section, I characterize the optimal contract for the manager of the incumbent under asymmetric information.[14] Productive effort is assumed to be neither observable nor verifiable. Therefore, the incentive scheme cannot be contingent on productive effort. Cost realization, however, is assumed to be not only observable but also contractible, which allows the principal to reward the agent for his effort to reduce costs. I suppose that the structure of the entry barrier function, f, is common knowledge among the principals and the agents. Then since the number of firms is observable and verifiable, the principal can perfectly infer lobbying effort level from the number of firms via f. Hence the contract can be contingent on lobbying effort. In sum, the contract is contingent on the number of firms in the market (hence lobbying effort) and cost realization.

For the contract to be implementable, the contract should satisfy the individual rationality constraint given in previous subsection. In addition, the contract should induce the desired level of effort in an incentive compatible way. Because the principal cannot observe manager's productive effort, she should tie the compensation to realized cost so that it is optimal for the manager to choose the desired level of productive effort voluntarily. Hence, the incentive compatibility condition is:

$$(IC) \qquad e \in \arg\max P(\tilde{e})w_L + (1 - P(\tilde{e}))w_H - g(\tilde{e} + l)$$

where w_L is the wage payment if realized cost is c_L and w_H otherwise.

Limited liability to the manager implies that the compensation to the manager must be non-negative in both states of the world:

$$(LL) \qquad w_L \geq 0, \;\; w_H \geq 0$$

If Π_L and Π_H are large enough, then the limited liability constraint is not binding and the allocation under full information is implementable since the manager is risk-neutral. This

[14] Henceforth, I drop the notation for the number of firms unless it makes confusion.

uninteresting case is excluded by the following assumption:

Assumption L $\Delta\Pi(n+s) - g(e^{FI}+l) - \underline{U} \geq 0$ for all n.

Given the above constraints, the problem that the principals solves is:

$$\begin{aligned}
\max_{e,l,w_L,w_H} \quad & P(e)(\Pi_L - w_L) + (1-P(e))(\Pi_H - w_H) \qquad (7)\\
s.t. \quad & (IR)\ \ P(e)w_L + (1-P(e))w_H - g(e+l) \geq \underline{U} \\
& (IC)\ \ e \in \arg\max P(\tilde{e})w_L + (1-P(\tilde{e}))w_H - g(\tilde{e}+l) \\
& (LL)\ \ w_L \geq 0, \ \ w_H \geq 0
\end{aligned}$$

Limited liability simplifies the problem because of the following lemma.

Lemma 3 *At the optimal contract,* $w_L > 0$ *and* $w_H = 0$*.*

The intuition for lemma 3 is that what is important for incentive is the difference between w_L and w_H. Given the amount of expected wages, the principal is better off making the difference between w_L and w_H as large as possible. This is because paying positive w_H has no incentive effect but increases the total expected wage. As a result, it is always optimal to set w_H equal to zero. This compensation scheme is a bonus payment. When the cost realization is high (c_H), only base salary (which is normalized to be zero) is given to the manager. Only when the cost realization is low (c_L), bonus is paid out to the manager.

Also note that limited liability is a binding constraint by assumption L. Without limited liability, the principal can implement the full information effort level because the manager is risk-neutral. But the conflict between limited liability and incentive compatibility makes punishments infeasible, which in turn leads the principal to give up some *ex ante* rent to the agent.

Since the above problem involves one more variable than the standard agency model, I take two steps to solve the principal's problem. First, I consider the optimal contract given lobbying effort. Then I decide the number of entrants allowed to enter the market by choosing l. Since I assume that lobbying effort is contractible, I can easily characterize the optimal contract after solving out the optimal contract give lobbying effort.

Given l, e is determined as follows. The first-order condition for the incentive constraint is:

$$P'(e)w_L - g'(e+l) = 0 \tag{8}$$

Then substituting (8) into IR, we have

$$P(e)\frac{g'(e+l)}{P'(e)} - g(e+l) \geq 0 \tag{9}$$

By assumption P and assumption G, the LHS of (9) is non-positive when $e = 0$ and is positive when e goes to ∞. The intermediate value theorem assures that there exists e^{IR} such that

$$P(e^{IR})\frac{g'(e^{IR}+l)}{P'(e^{IR})} - g(e^{IR}+l) = 0$$

Note that when l is positive, there exists positive e that satisfy the above equation. When l is equal to zero, $e = 0$ satisfies the above equation.

Since the LHS of (9) is increasing in e, the effort level such that $e \geq e^{IR}$ is implementable. Then given l, the principal's problem is

$$\begin{aligned} \max_{e} \quad & P(e)\Pi_L + (1-P(e))\Pi_H - \frac{P(e)}{P'(e)}g'(e+l) \\ & s.t \;\; e \geq e^{IR} \end{aligned} \tag{10}$$

Ignoring the constraint for the problem (10), the first order condition is given by

$$P'(e)(\Pi_L - \Pi_H) - g'(e+l) + \frac{P(e)P''(e)}{(P'(e))^2}g'(e+l) - \frac{P(e)}{P'(e)}g''(e+l) = 0 \tag{11}$$

Let e^{IC} be the effort level that satisfies (11). If e^{IC} is greater than or equal to e^{IR}, then e^{IC} is the effort level implemented under optimal contract. Otherwise, e^{IR} is the effort level under optimal contract. The following lemma characterizes the optimal contract, given lobbying effort l.

Lemma 4 *At the optimal contract, the followings hold:*

$$P'(e^{IC})(\Pi_L - \Pi_H) - g'(e^{IC} + l) + \frac{P(e^{IC})P''(e^{IC})}{(P'(e^{IC}))^2} g'(e^{IC} + l) - \frac{P(e^{IC})}{P'(e^{IC})} g''(e^{IC} + l) = 0 \quad (12)$$

$$P(e^{IR}) \frac{g'(e^{IR} + l)}{P'(e^{IR})} - g(e^{IR} + l) = 0 \quad (13)$$

The effort level implemented under optimal contract is

$$e^{SB} = Max\{e^{IC}, e^{IR}\} \quad (14)$$

The wage scheme is

$$(w_L, w_H) = (\frac{g'(e^{SB} + l)}{P'(e^{SB})}, 0) \quad (15)$$

After solving out for e as a function of l, the principals of incumbents choose l to maximize expected profit and hence to determine the number of firms in the market.

The following lemma compares the level of productive effort under different information structures, namely, full information and asymmetric information.

Lemma 5 $e^{SB} < e^{FI}$ for all $n + s$.

To pin down the individual lobbying effort level and the number of entrants cannot be obtained without having specific profit functions. Since the manager's cost of effort is a function of total effort, it may be the case that with more firms, it is optimal to induce higher level of rent-seeking effort not only at the industry but also at the individual level.

For example, suppose that optimal contract under monopoly allows five new firms to enter so the total number of firms is six. Under duopoly, it may be optimal to allow only two new firms to enter and this may not be so costly since two firms share the burden of lobbying. Depending on profit functions, the number of firms operating in the market may be non-monotonic in the number of incumbents.

4 Effect of Competition

This section examines how competition affects the level of productive effort. As mentioned, how much productive effort is made depends partly on the level of lobbying effort, which, in turn, depends on the rate of change in expected profit with respect to the number of firms. Hence to analyze the effect of competition on productive effort, it is necessary to know the general properties of the expected profit. Unfortunately, not much is known about the properties of profit functions. Ad hoc assumptions on profit functions restricts the modes of competition a lot. So rather than directly imposing restrictions on profit function, I consider two different possible cases. The first case is the one where blocking entry is always profitable for the incumbents. In the second case, the incumbents allow entry, though they make lobbying effort.

4.1 No Entry Case

The case where blocking entry is always profitable means that the profit level decreases sufficiently fast as the number of firms grows. Consider two different situations where there are n incumbents and n' incumbents respectively, with $n < n'$. Let l_n denote lobbying effort per incumbent when there are n incumbents. If blocking entry is always profitable, entry fee is set such that $f(n \cdot l_n) = \mathbf{E}\Pi^{ent}(n+1)$. Since expected gross profit of the entrant, $\mathbf{E}\Pi^{ent}$, is decreasing in the number of firms, it follows that $l_n > l_{n'}$ and $n \cdot l_n > n' \cdot l_{n'}$ for $n < n'$, i.e., not only per-firm but also aggregate lobbying effort at the industry level is decreasing in the number of incumbents. In this case, the effect of competition is stated in Proposition 1.

Proposition 1 *If one of the following conditions holds, the manager of the incumbent exerts higher productive effort with n' incumbents than with n incumbents:*
(a) *IR is binding in both cases.*
(b) *IR is binding when there are n incumbents and IC is binding when there are n' incumbents.*
(c) $\Pi_L - \Pi_H$ *is non-decreasing in the number of incumbents.*

Proposition 1 says that if IR constraint is binding with fewer incumbents, productive effort is always increasing in the number of incumbents. Binding IR implies that the manager gets no rent in excess of reservation utility, which means that he just gets his marginal product. Hence, what (a) and (b) in the proposition mean is that competition is effective in promoting internal efficiency of the firm if two blades of the scissors work: competition in the product market as well as labor market. Product market competition by itself is not enough to guarantee the disciplinary role of competition if the conflicts between limited liability and incentive compatibility force the principal to give up some *ex ante* rent to the agent. Contractual deficiencies that leave any rent above the outside option payoff blur the disciplinary role of product market competition.

Binding individual rationality constraint as a sufficient condition for competition to work is observed in other papers. Hart (1983), and Aghion et al. (1999) assume that the individual rationality constraint is always binding while Schmidt (1997) derives the similar conditions to proposition 1. Schmidt examines the effect of competition with the possibility of bankruptcy and concludes that if IR is binding, then productive effort is increasing in the degree of competition. In his model, IR is more likely binding when there are many firms already in the market. Therefore, only if there is enough competition already, increasing competition works. In my model, however, IR is more likely binding with fewer firms since lobbying effort is higher with fewer firms. For example, consider the case of monopoly and duopoly. To prevent entry, the manager of the monopolist needs to exert lobbying effort to satisfy $f(l_1) \geq E\Pi^{ent}(2)$ while lobbying effort under duopoly is $f(2 \cdot l_2) \geq E\Pi^{ent}(3)$. Since $E\Pi^{ent}(2) >$

$E\Pi^{ent}(3)$, $l_1 > 2 \cdot l_2$. Hence under monopoly, it is difficult to implement high productive effort since cost of inducing high productive effort is very high. The amount of lobbying effort is lower under duopoly than under monopoly. Therefore, cost of implementing high productive effort is lowered because productive and unproductive efforts are substitutes.[15]

Hence practically Proposition 1 provides more justification for promoting competition than any other papers. Moreover, my model predicts that removing (or lowering) entry barrier is beneficial in three respects: reduction in unproductive effort, increase in productive effort and hence increase in consumer surplus through increase in output.

The prediction is confirmed in the process of trucking industry deregulation. The Interstate Commerce Commission(ICC) had regulated trucking industry on freight rates and entry into the market since the Motor Carrier Act was passed in 1935.[16] Under regulation by the ICC, the trucking industry set prices above costs and enjoyed considerable profits. Moreover, the American Trucking Association(ATA), one of the best organized and disciplined lobbying group, actively engaged in direct political activity. The ATA succeeded in lobbying the ICC to prevent entry that would have occurred otherwise. In particular, any firm who made a petition for entry should provide evidence showing that there was not enough supply that met demand. So the burden of proof was on the firm seeking entry. Entry barriers were so high that virtually no new firm entered market.

In the late 70s and the early 80s, deregulation occurred, even though the trucking industry opposed to deregulation. As a result of deregulation, firms faced unprecedented freedom of competition and entry and/or exit. The effect of deregulation was remarkable. From 1978

[15]The other difference is differentiability. Schmidt assumes the reduced form profit function is differentiable with respect the measure of competition. For some cases, integer constraint is not binding and approximation works well to deliver the results. But if the degree of competition is measured by the number of firms, this is not the case. And even if IR is binding locally, one cannot be sure which of IR or IC will be binding by some local change. More specifically, under quantity competition with decreasing $\Delta\Pi$, Schimidt's model does not lead us to higher productive effort in case that IRs are binding both with fewer firms and more firms. Considering that not all measures of competition are continuous variables, our approach is more appropriate one. Moreover, in Schmidt, the first-order condition is supermodular in productive effort and the degree of competition, which delivers the results. But this is not the case in my model.

[16]In fact, the ICC was established for the purpose of regulating the railroad at the beginning. Later on the ICC expanded its role to regulation of trucking (1935) and certain water barge transportation (1940).

Table 1: **Distribution of Average Cost of Trucking Industry**

	$0-0.05^a$	0.05-0.1	0.1-0.2	0.2-0.3	0.3-0.4	0.4-0.5	0.5-0.6
1977	22.6^b	9.4	18.9	9.4	15.1	5.7	3.8
1983	47.2^b	28.3	9.4	5.7	1.9	5.7	-

Source: Viscusi, Vernon and Harrington Jr. (1992)

a: unit-per ton miles

b: percentage

to 1985, the number of firms operating in the trucking industry increased from 16,874 to 33,823. Table 1 shows the distribution of average cost per ton-mile under regulation (1977) and under deregulation (1983). Before deregulation, unit cost ranged from 0.0084 per ton mile to 2.798 with an average of 0.3438 while after deregulation, from 0.0032 to 0.6343 with an average of 0.1001. Along with this significant cost reduction, there was a decrease in price.[17]

4.2 Entry Case

When entry occurs, there are three possible cases. The first case is that lobbying effort at the industry level falls as the number if incumbents grows and as a result, lobbying effort per firm is decreasing, too. In this case, the result in the previous subsection still holds, which is summarized as follows:

Proposition 2 *Suppose aggregate lobbying effort at the industry level decreases as the number of incumbents increases. Then more productive effort is exerted with more incumbents if one of the following conditions holds:*

(a) IR constraints are binding in both cases.

(b) IR is binding when there are n incumbents and IC is binding when there are n' incumbents.

(c) $\Pi_L - \Pi_H$ is non-decreasing in the number of incumbents.

[17] Ying(1990) provides estimates of cost saving, 9 percent in 1982, 23 percent in 1984 as well as substantial productivity growth.

The second case is the one that with more incumbents, lobbying effort at the industry level is increasing but lobbying effort at individual firm level is decreasing. In the second case, the result in the previous subsection still holds except Proposition 2(c), which is summarized as follows:

Proposition 3 *Suppose that with more incumbents, lobbying effort at the industry level is increasing but lobbying effort at individual firm level is decreasing. If either of the following conditions holds, then with more incumbents, the managers of incumbents exert higher effort:*
(a) IR constraints with two different numbers of incumbents are binding.
(b) IR is binding with fewer incumbents and IC is binding with more incumbents

The intuition for Proposition 2 and 3 is identical to Proposition 1. A decrease in lobbying effort makes it less costly to implement productive effort.

Given the general profit function, the number of firms performing in the market cannot be determined. If I restrict the number of firms, however, then more can be said.

Proposition 4 *Suppose n incumbents and n' incumbents exert the same amount of lobbying effort at the industry level with $n < n'$. Then more productive effort is exerted with more incumbents.*

When both aggregate and per firm lobbying effort are increasing in the number of incumbents, then it is ambiguous whether productive effort is increasing in the number of firms or not. Moreover, it is hard to expect that conditions in Proposition 2, 3, or 4 are globally satisfied. Therefore, generally the relationship between productive effort and the degree of competition is non-monotonic.[18]

[18] The similar non-monotonicity between competition and innovation is observed in Aghion *et al.* (2002).

5 Conclusion

Despite the widespread belief that competition disciplines firms into efficient operation, there has been no strong theoretical support. This paper lends a support to the common belief by analyzing a mechanism through which product market competition affects the allocation of the managerial effort. Unlike the previous literature, the managers are engaged in two different activities — cost reduction and rent protection. This paper shows that an increase in competition, measured by number of incumbent firms, has two effects. One is the "output effect" which decreases a manager's incentive to engage in productive effort. The other is the "effort substitution effect" that makes the managers undertake more productive effort. This paper identifies the conditions under which product market competition lowers the cost of providing incentives for productive effort and hence, competition leads agents to exert more productive effort.

There are several ways to extend this paper. This paper takes the lobbying game as given and considers the case of cooperative lobbying among the incumbents. Admittedly this is rather restrictive. Relaxing this restriction by endogenizing lobbying would add details on the working of competition.

This paper considers product market competition as the sole source of corporate governance. There are other mechanisms to ensure that managers pursue the shareholders' interest. Takeover, and debt contract serve this role. It is interesting to examine the interaction between product market competition and these mechanisms. While we have many models describing how each corporate control mechanism works in isolation, we know little about how they interact. For example, debt and product market competition are generally thought, in isolation, to be the two instruments that reduce the amount of quasi-rents appropriated by management. But the use of debt may crowd out the effectiveness of product market competition, increasing rather than decreasing managerial rents. The overall effects are not obvious. Investigating under what conditions two different tools are complements or substitutes is obviously important. Moreover, this will provide a better understanding of the functioning of market competition as a corporate control mechanism.

6 Appendix

Proof of Lemma 3 I prove lemma 3 in two steps.

Step 1: $w_L > w_H$

Suppose on the contrary $w_L \leq w_H$. From the incentive compatibility condition,

$$P'(e)(w_L - w_H) - g'(e + l) = 0$$

Hence, if $w_L \leq w_H$, then no positive productive effort can be implemented. Contradiction.

Step 2: $w_L > 0$ and $w_H = 0$

Suppose $w_L > 0$ and $w_H > 0$ at the optimal contract. Since the limited liability constraint is not binding, the first-best is implementable. Moreover, both the individual rationality and incentive compatibility constraints are binding. From (IC),

$$P'(e)(w_L - w_H) - g'(e + l) = 0$$

Since the first-best is implementable,

$$w_L - w_H = \Pi_L - \Pi_H$$

Then from (IR),

$$P(e)(w_L - w_H) - g(e + l) - \underline{U} = -w_H$$

By assumption 3, the LHS is strictly positive and w_H is negative. This violates the limited liability constraint. Therefore, w_H cannot be positive.■

Proof of Proposition 1

(a) Suppose the IR constraints are binding. Then

$$P(e_n)\frac{g'(e_n + l_n)}{P'(e_n)} - g(e_n + l_n) = 0 \tag{16}$$

which is

$$\frac{P'(e_n)}{P(e_n)} = \frac{g'(e_n + l_n)}{g(e_n + l_n)} \tag{17}$$

Claim : Total effort level, $e_n + l_n$, is decreasing in n.

Proof of Claim: Suppose total effort level, $e_n + l_n$, is non- decreasing in n. Then $e_{n+1} \geq e_n + l_n - l_{n+1} > e_n$ since $l_n > l_{n+1}$. Assumption (1) implies

$$\frac{P'(e_{n+1})}{P(e_{n+1})} < \frac{P'(e_n)}{P(e_n)} \tag{18}$$

$$\frac{g'(e_{n+1} + l_{n+1})}{g(e_{n+1} + l_{n+1})} \geq \frac{g'(e_n + l_n)}{g(e_n + l_n)} \tag{19}$$

Contradiction.

But even though total effort level, $e_n + l_n$, is decreasing in n, e_n is increasing.

To see this, compare the following two:

$$\frac{P'(e_n)}{P(e_n)} = \frac{g'(e_n + l_n)}{g(e_n + l_n)} \tag{20}$$

$$\frac{P'(e_{n+1})}{P(e_{n+1})} = \frac{g'(e_{n+1} + l_{n+1})}{g(e_{n+1} + l_{n+1})} \tag{21}$$

Since total effort is decreasing, the righthand side of (15) is greater than that in (16) by assumption 1. So

$$\frac{P'(e_{n+1})}{P(e_{n+1})} < \frac{P'(e_n)}{P(e_n)} \tag{22}$$

By concavity of P, it follows that $e_{n+1} \geq e_n$.

(b) Suppose IR constraint is binding when the number of incumbents is n and IC is binding when n' with $n < n'$. Then

$$g(e_{n'} + l_{n'})\{\frac{P(e_{n'})}{P'(e_{n'})}\frac{g'(e_{n'} + l_{n'})}{g(e_{n'} + l_{n'})} - 1\} \geq g(e_n + l_n)\{\frac{P(e_n)}{P'(e_n)}\frac{g'(e_n + l_n)}{g(e_n + l_n)} - 1\} = 1 \tag{23}$$

(i) If $e_{n'} + l_{n'} \geq e_n + l_n$, $e_{n'} \geq e_n + l_n - l_{n'} > e_n$.

(ii) If $e_{n'} + l_{n'} < e_n + l_n$, then by assumption 1

$$g(e_{n'} + l_{n'}) < g(e_n + l_n)$$

$$\frac{g'(e_{n'}+l_{n'})}{g(e_{n'}+l_{n'})} < \frac{g'(e_n+l_n)}{g(e_n+l_n)}$$

Therefore $\frac{P(e_{n'})}{P'(e_{n'})} < \frac{P(e_n)}{P'(e_n)}$ follows and this implies $e_{n'} > e_n$.

(c) If $\Pi_L - \Pi_H$ is non-decreasing in the number of incumbents, then it is obvious. So it is omitted. ■

Proof of Proposition 4 Suppose total number of firms after allowing entry is $n+s = n'+s'$. Since total lobbying effort with n incumbents and with n' incumbents is the same, the following holds: $l_n > l_{n'}$. Then from (10) and (11), $e_n^{IC} < e_{n'}^{IC}$ and $e_n^{IR} < e_{n'}^{IR}$. Therefore, $e_n = max\{e_n^{IC}, e_n^{IR}\} < max\{e_{n'}^{IC}, e_{n'}^{IR}\} = e_{n'}$. ■

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