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Competition and Agency Cost

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Abstract

We look at the effect of competition on the level of cost reducing effort made by an agent in an industry where competition is in quantity with homogeneous products. We find that the principal prefers to keep all the profit rather than sharing it with the agent, who ends up exerting no effort regardless of the number of firms in the industry (provided it is greater than two). This suggests that profit sharing contracts might not be the appropriate mechanism to provide incentives in an industry characterized by principal-agent relationships and where firms compete in quantity.

All errors are mine.
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1 Introduction

This paper considers the effect of competition on the level of cost reducing effort made by an agent. It is initially supposed the principal and the agent are the same person (first-best). Then, agency cost is introduced by assuming they are distinct (second-best).

The theoretical literature on the effects of competition on agency cost (which arises because of conflicting interests among contracting parties making up a firm and the inability to observe precisely effort) is surprisingly thin. In Hermalin (1992), the main impact of competition is channeled through an income effect. Because leisure is a normal good, Hermalin (1992)'s argument is that competition, by reducing income, should lead the manager to consume less leisure and work more. For Schmidt (1997), the increased threat of liquidation associated with competition motivates the manager to exert more effort. In Raith (2003), the effects of competition on incentives and efforts take place through a change in the number of firms and the degree of product substitutability. The model is such that each firm competes in price with its immediate neighbours on a circle of circumference 1. For a given market structure, the effects of competition on managerial incentives are ambiguous. Baggs and de Bettignies (2007) distinguish between the agency and the direct pressure effects of competition using a Hotelling model of competition with two firms. The intensity of competition is measured by the parameter capturing transportation cost. When a principal cannot verify product quality (or equivalently marginal cost), Baggs and de Bettignies (2007) find a negative effect of competition on incentives and efforts. Finally, Beiner *et al.* (2011) use a Cournot duopoly model where the intensity of competition is measured by a change in the degree of product substitutability. Each agent is offered a contract that is a function of the observed cost reduction, which is influenced by the agent's effort. They find a convex relationship between incentives and efforts and the degree of product substitutability. A common result of the papers mentioned above is the agent's effort is positive.

This paper's main result is that the presence of agency cost results in no effort being undertaken by the risk-neutral agent when pay is linked to profit and firms compete in quantity with homogeneous products (i.e., Cournot competition). It is simply too costly, in

terms of lost profit, for the principal to provide incentives to the agent for exerting effort.

The paper proceeds as follows. Section 2 describes the model used to conduct the analysis. Section 3 presents the case where the agent and the principal are the same person (first-best with no agency cost). Section 4 considers the situation where the agent and the principal are different persons (second-best with agency cost). Section 5 provides concluding remarks. All proofs are available from the author upon request.

2 Model

Consider an industry with $n \geq 2$ firms producing a homogeneous good, competing in quantity, and facing the inverse demand $p = a - Q$ with $Q = \sum_{i=1}^{n} q_i$: p is the market price, a denotes the absolute size of the market, and q_i refers to firm i's output. An increase in competition is represented by an increase in n.

Each firm is composed of a principal and an agent, both of whom are risk-neutral. The principal-agent relationship can be interpreted as one between a manager (Board of Directors) and an employee (Chief Executive Officer). For convenience, we refer to the principal as female and to the agent as male.

Each firm has an initial marginal cost $c + x$. The random variable x is such that $E(x) = 0$ and $V(x) = \sigma^2$.[1] Firm i's marginal cost can be reduced to $c_i = c + x - e_i$, with e_i denoting the effort exerted by agent i.

The timing of the game is as follows. At date 0, principal i makes a take-it-or-leave-it contractual offer to agent i, who has a reservation wage of zero. Principal i's offer is only observable to agent i.

At date 1, agent i exerts effort e_i at a cost $k_i(e_i) = e_i^2$. This effort determines firm i's marginal cost.

At date 2, principal i chooses quantity q_i after observing marginal cost c_i. The same results apply if the output decision is given to agent i.

At date 3, quantities are sold and profits are realized. Firm i's profit, π_i, is shared between the agent, who receives a payoff w_i according to the contract signed at date 0, and the principal who keeps $\pi_i - w_i$.

[1] It is assumed that all firms can produce a positive quantity for any value taken by x.

Although costs are not verifiable and cannot be contracted upon, it is assumed that revenues and profits are contractible. Hence, the contract between principal i and agent i can be made contingent on realized profits: $w_i = w_i(\pi_i)$. Two conditions must hold for a contract to be feasible. First, agent i's incentive compatibility constraint (ICC) must be satisfied: agent i exerts effort e_i to maximize his expected payoff $w_i(\pi_i) - k_i(e_i)$. Second, agent i's participation constraint (PC) must be satisfied: agent i's expected payoff must be greater than or equal to his (zero) reservation wage.

The game is solved backward using the subgame perfect equilibrium as the solution concept.

3 First-Best: Equilibrium with Verifiable Cost

The goal of this section is to determine the first-best (FB) effort level, i.e., the one that would be exerted if the principal and the agent were the same person. It is then possible to analyze how this effort level is affected by competition.

When cost is verifiable, principal i can elicit the first-best effort level, e_i^{FB}, from agent i by offering the following contract at date 0: agent i receives wage $w_i(e_i^{FB}) = k_i(e_i^{FB}) = (e_i^{FB})^2$ if $e_i = e_i^{FB}$ and $w_i = 0$ otherwise. Agent i accepts this contract that satisfies both his ICC and PC and provides effort e_i^{FB} implying there is no agency cost.

At date 3, principal i receives payoff $\pi_i(q_i, e_i, q_{-i}, e_{-i}) - w_i(e_i)$, where q_{-i} (e_{-i}) denotes the output (effort) chosen by all principals (agents) in the industry other than i.

At date 2, principal i chooses q_i to maximize her expected payoff, taking effort levels as given. Solving the system of n first-order conditions leads to firm i's equilibrium quantity

$$\hat{q}_i(e_i, e_{-i}) = \frac{a - n(c - e_i) + \sum_{j \neq i}^{n}(c - e_j)}{n + 1}. \tag{1}$$

At date 1, agent i exerts the effort e_i^{FB} stipulated in the contract.

At date 0, principal i chooses the effort level e_i to elicit from the agent. This effort level maximizes the principal's expected payoff $\pi_i[\hat{q}_i(e_i, e_{-i}), \hat{q}_{-i}(e_i, e_{-i}), e_i] - k_i(e_i)$. Taking the first-order condition and exploiting the symmetry among firms, the first-best effort level

chosen by principal i is

$$e_i^{FB} = \frac{(a-c)n}{n^2+n+1} \tag{2}$$

implying that firm i produces

$$q_i^{FB} = \frac{(a-c)(n+1)}{n^2+n+1}. \tag{3}$$

Firm i's cost reduction and output decrease with an increase of competition as measured by the number of firms in the industry (Vives, 2008).

4 Second-Best: Equilibrium with Non-Verifiable Cost

When cost is observable but non-verifiable, it cannot be contracted upon and contracts can be made contingent on profits. The focus is on linear contracts of the form $w = \alpha\pi$.

At date 3, principal i receives the payoff $(1-\alpha_i)\pi_i(q_i, e_i, q_{-i}, e_{-i})$.

At date 2, principal i chooses q_i to maximize her expected payoff taking costs as given. Firm i's output is the same as in Section 3 generating $\pi_i(e_i, e_{-i}) = [\hat{q}_i(e_i, e_{-i})]^2$.

At date 1, agent i chooses e_i to maximize his expected payoff $\alpha_i\pi_i(e_i, e_{-i}) - k_i(e_i)$ taking e_{-i} as given. Thus, agent i's ICC holds when $e_i = \hat{e}_i$ such that

$$\alpha_i = \frac{\partial k_i(e_i)/\partial e_i}{\partial \pi_i(e_i, e_{-i})/\partial e_i} = \frac{\hat{e}_i(n+1)}{n\hat{q}_i(\hat{e}_i, e_{-i})}. \tag{4}$$

At date 0, principal i offers contract α_i to agent i. To determine the optimal contract, principal i maximizes $(1-\alpha_i)\pi_i(\hat{e}_i, e_{-i})$ with respect to α_i and $\hat{e}_i$ subject to equation (4) and agent i's PC

$$\alpha_i\pi_i(\hat{e}_i, e_{-i}) - k_i(\hat{e}_i) \geq 0. \tag{5}$$

Solving the corresponding Lagrangian

$$\mathcal{L} = \left[[\hat{q}_i(\hat{e}_i, e_{-i})]^2 - \frac{\hat{e}_i(n+1)\hat{q}_i(\hat{e}_i, e_{-i})}{n}\right] - \lambda\left[\frac{\hat{e}_i(n+1)\hat{q}_i(\hat{e}_i, e_{-i})}{n} - \hat{e}_i^2\right] \tag{6}$$

and using the symmetry among firms, the second-best effort level chosen by principal i is

$$e_i^{SB} = 0 \tag{7}$$

which is independent of n. Firm i produces

$$q_i^{SB} = \frac{a-c}{n+1}. \tag{8}$$

With $\alpha_i^{SB} = 0$, both agent i's ICC and PC are satisfied. It is too costly, in terms of lost profit, for the principal to provide incentives to the agent for exerting effort.

5 Conclusion

This paper considers the effect of competition on the level of cost reducing effort (incentive) made (offered) by a risk-neutral agent (principal) in an industry where competition is in quantity with homogeneous products. The presence of agency cost results in no incentive being offered by the principal and no effort being undertaken by the agent when pay is linked to profit. This results implies that the agent's effort and the principal's incentive are independent of the number of firms in the industry. It also suggests that profit sharing contracts might not be the appropriate mechanism to provide incentives for exerting efforts in an industry characterized by principal-agent relationships, risk-neutrality, and Cournot competition.

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