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Intra-firm Conflicts and Interfirm Competition

Werner Güth*, Kerstin Pull** and Manfred Stadler***

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Abstract

We study interaction effects between intra-firm conflicts and interfirm competition on a duopolistic market with seller firms employing one or more agents and implementing tournament incentives. We show that inter-firm competition leads to higher incentive intensity, higher efforts and output levels but lower profits.

Keywords: Tournament; Worker compensation; Strategic competition

JEL Classification: C72, L22, M52

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1 Introduction

Principal-agent-theory has been developed to overcome the limitations of the monolithic firm model of classical microeconomics. While it has undoubtedly enhanced our understanding of many aspects of the firm (e.g. of delegated contracting as analyzed by Gick 2008), its basic flaw is that it solely focuses on intra-firm conflicts without considering that these are embedded in interfirm competition. While Berninghaus et al. (2007) introduce hiring competition on the labor market into a principal-agent-setting, we analyze intra-firm conflicts in an environment where firms compete on the product market (selling competition).

Concerning *intra*-firm conflicts, we rely on a simple model of tournament incentives where agent compensation is based on relative rather than absolute performance (Lazear, Rosen 1981). However, while the literature so far has basically focused on fixed tournament prizes in the sense that the prizes to be awarded are set in advance, the size of tournament prizes in the model we propose is based both on the absolute aggregate performance and on an individual's relative performance. While this type of tournament offers much plausibility, it has not been analyzed so far within the principal-agent-framework. Even though related to the so-called J-tournament as discussed by Kräkel (2003) where an individual agent's share of the total prize sum also depends on his relative performance, the prize sum in our tournament model is not predefined by a preceding collective bargaining process, but endogenously determined.

Concerning *inter*-firm competition our analysis complements the wide class of strategic competition models. In the Industrial Organization literature, the main focus has been on the strategic implications of managerial incentives on price and quantity competition (see, e.g. Fershtman, Judd 1987, 2006, Sklivas 1987, Reitman, 1993). In these models, the delegation problem is reduced to the incentive schemes for managers implemented by the owners of the firms. However, the intra-firm conflicts between the agents within a single firm are excluded from the analysis.

Concerning the combination of intra-firm conflicts and interfirm competition on product markets, our work relates to that of Raith (2003) as well as to that of Lin (2008). However, Raith analyzes compensation systems based on piece rates rather than tournament structures and focuses on the product market structure being endogenously determined by firms' entry and exit decisions. Lin (2008) studies the effect of the product market price on tournament incentives, but the interaction effects between intra-firm conflicts and interfirm competition are rather underdeveloped as the product price in his model is not endogenously determined by agents'

effort choices.

The remainder of the paper is structured as follows: Section 2 presents a simple model of a seller firm with several agents to study intra-firm conflicts in isolation as a benchmark. Section 3 adds a second seller to analyze the additional effects of interfirm competition. Section 4 concludes.

2 The Monopolistic Seller Firm

We begin our analysis by limiting strategic interaction to conflicts within the same organization as in traditional principal-agent theory. Assuming a homogeneous market will allow us to compare the behavior of such a monopolistic seller firm to the behavior of two seller firms which strategically interact in market competition.

Consider a product market with a linear demand function that can be normalized (via appropriate choices of monetary and sales units) to

$$D(p) = 1 - p .$$

If the single seller firm produces q units of the homogeneous good, market clearing requires the price or unit profit

$$p = 1 - q .$$

Let the firm employ n agents whose effort choices $e_k \geq 0; k = 1, \dots, n$; determine the output level q via

$$q = \sum_{k=1}^n e_k .$$

Unlike in traditional principal-agent-models individual output is a perfect signal of individual efforts. Let effort cost be private, but commonly known. For simplicity, we assume that all agents have the same quadratic effort cost function

$$c(e_k) = e_k^2/2 .$$

Since all agents are already employed, there is no participation constraint and fixed wages can be assumed to be zero without loss of generality. What the principal of the firm therefore decides, is the revenue share $s \in [0, 1]$, offered to all of his agents, thereby excluding discrimination. Agents are identical and distribute their share of

the revenue $spq = s(1-q)q$ proportionally according to e_k/q , as suggested by equity theory (Homans 1961). Thus, each agent receives

$$U(e_k) = se_kp - e_k^2/2 = se_k(1-q) - e_k^2/2.$$

Maximization of $U(e_k)$ yields the first-order condition

$$s(1-q-e_k) - e_k = 0$$

for $k = 1, \dots, n$. The second-order condition is obviously fulfilled. The unique solution of this system of equations is symmetric ($q = ne_k$) yielding

$$e^*(s) = \frac{s}{1 + (n+1)s}.$$

The agents' equilibrium effort hence depends positively on the revenue share s but negatively on the number of agents in the firm. Anticipating the agents' effort decision, the profit function of the principal is given by

$$\begin{aligned} \pi(s) &= (1-s)ne^*(1-ne^*) \\ &= \frac{ns(1-s^2)}{[1+(n+1)s]^2}. \end{aligned}$$

The first-order condition for maximizing $\pi(s)$ is given by the cubic equation

$$(n+1)s^3 + 3s^2 + (n+1)s - 1 = 0$$

featuring a negative relationship between the number of agents n and the revenue share s offered by the principal. The cubic equation has a single real solution, given by

$$s^* = u + v - 1/(n+1)$$

where $u = (D^{1/2} - b)^{1/3}$, $v = (-D^{1/2} - b)^{1/3}$, $D = a^3 + b^2$, $a = [(n+1)^2/3 - 1]/(n+1)^2$, $b = -[(n+1)^2 - 1]/(n+1)^3$.

Table 1 gives the details of the solution for various numbers $n = 1, 2, \dots$ of agents employed by a monopoly seller. As can be seen, the equilibrium revenue share s^* decreases in the number of agents. The same is true for the equilibrium effort levels e^* . The revenue approaches the level of 1/4 of the traditional monopoly model when $n \rightarrow \infty$. The reason is that the equilibrium effort of each agent becomes negligible

and that marginal effort costs converge to 0 when the number of agents approaches infinity.

n	$n = 1$	$n = 2$	$n = 3$	$n = 4$...	$n \rightarrow \infty$
s^*	0.317	0.250	0.208	0.176	...	0.000
e^*	0.194	0.144	0.114	0.094	...	0.000
q^*	0.194	0.288	0.341	0.374	...	0.500
p^*	0.806	0.712	0.659	0.626	...	0.500
π^*	0.107	0.153	0.178	0.193	...	0.250
U^*	0.031	0.015	0.009	0.006	...	0.000

Table 1: Solution results ($s^*, e^*, q^*, p^*, \pi^*, U^*$) for various numbers $n = 1, 2, \dots$ of agents employed by a monopoly seller.

3 Seller Competition

When several firms compete in serving demand, the assumption that principals share revenues with their agents implies that interfirm competition involves both, principals as well as agents. We thus have to analyze both strategic interactions within and between firms. To demonstrate the effects of such intra-firm as well as interfirm competition, we restrict ourselves to the case of two competing firms $i = 1, 2$ in the market with firm specific sales amounting to $q_i = \sum_k e_{i,k}$, $i = 1, 2$, $k = 1, \dots, n$. Thus, the inverse demand function can be written as

$$p = 1 - q_1 - q_2 .$$

Each of the agents, employed by firm $i = 1, 2$, earns

$$U_{i,k}(e_{i,k}) = s_i e_{i,k} p - e_{i,k}^2 / 2 = s_i e_{i,k} (1 - q_1 - q_2) - e_{i,k}^2 / 2 .$$

Maximization with respect to the efforts $e_{i,k}$ yields the first-order condition

$$s_i (1 - q_1 - q_2 - e_{i,k}) - e_{i,k} = 0; \quad i = 1, 2; \quad k = 1, \dots, n.$$

The symmetric solution is

$$e_i^*(s_1, s_2) = \frac{s_i(1 + s_j)}{1 + (n + 1)(s_i + s_j) + (2n + 1)s_i s_j}, \quad i = 1, 2, \quad i \neq j.$$

Anticipating equilibrium effort levels the profit functions of the two principals are given by

$$\pi_i(s_1, s_2) = (1 - s_i)ne_i^*(1 - ne_i^* - ne_j^*), \quad i = 1, 2, \quad i \neq j.$$

The first-order condition for maximizing $\pi_i(s_1, s_2)$ with respect to s_i ; $i = 1, 2$; and the obvious symmetry of the solution imply the quadratic equation

$$(2n + 1)s^2 + 2s - 1 = 0 ,$$

featuring again a negative relationship between the number n of agents in each firm and the revenue shares s^* , offered by the principals. The quadratic equation has the solution

$$s^* = \frac{\sqrt{2n + 2} - 1}{2n + 1} \in (0, 1)$$

implying the identical effort level

$$e^*(s^*) = \frac{s^*}{1 + (2n + 1)s^*} = \frac{\sqrt{2n + 2} - 1}{(2n + 1)\sqrt{2n + 2}}$$

for all $2n$ agents employed in the two competing firms. The profits of the principals are thus given by

$$\pi^* = (1 - s)ne^*(1 - ne^*) = \frac{ns^*(1 - s^{*2})}{[1 + (2n + 1)s^*]^2} .$$

Table 2 illustrates how the solution $(s^*, e^*, q^*, p^*, \pi^*, U^*)$ depends on the same number $n = 1, 2, \dots$ of agents employed by each duopoly seller. Again, the equilibrium revenue share s^* decreases in the number of agents as do equilibrium effort levels e^* . In order to assess the effects of selling competition on intra-firm conflicts let us compare the monopoly case with four agents to the duopoly case with each firm employing two agents: Introducing selling competition results in a higher equilibrium revenue share s^* , higher equilibrium effort levels e^* , and a higher aggregate output. At the same time, equilibrium price p^* and profits π^* are lower. Agents would thus prefer a situation where they are employed by several rather than one big firm, employing them all. The winners from antitrust policy, e.g. merger control, are thus not only the customers but also the agents, employed by these firms.

Interestingly, the profits of the principals do not converge to the Cournot-duopoly level of $1/9$ but rather to zero profits for $n \rightarrow \infty$. The reason is that our model does

not only feature the competition of principals but also that of agents. It is their competition which drives the price down to 0 when n increases to infinity.

n	$n = 1$	$n = 2$	$n = 3$	$n = 4$...	$n \rightarrow \infty$
s^*	0.333	0.290	0.261	0.240	...	0.000
e^*	0.167	0.118	0.092	0.076	...	0.000
q^*	0.167	0.237	0.276	0.304	...	0.500
p^*	0.667	0.527	0.446	0.392	...	0.000
π^*	0.074	0.088	0.091	0.090	...	0.000
U^*	0.023	0.011	0.006	0.004	...	0.000

Table 2: Solution results as depending on n , the number of agents in both firms, similarly to Table 1.

4 Conclusion

We presented a model featuring strategic interaction not only within a firm by assuming a monopoly seller, but also between firms where both, principals and agents of firms, compete with each other.

In our view, intuition based on models featuring either only intra-firm or interfirm conflict can lead us astray. So the usual intuition of the so-called LEN-models of principal-agent-theory suggests that poorly performing firms pay less to their employees although firms in distress need the best employees and therefore must pay them decently (see, e.g. Jensen, Murphy, 1990, who inspired many similar econometric studies of the pay-performance (cor)relation). Similarly, our analysis has shown that the usual results of (duopolistic) selling competition become questionable when not only principals but also also their agents compete strategically. Especially, it could be shown that it does not only matter how many agents are employed in an industry but also how they are allocated to firms.

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