EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

University of Tübingen
Working Papers in
Economics and Finance

No. 85

# Contests vs. Piece Rates in Product Market Competition

by

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# Contests vs. Piece Rates in Product Market Competition

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July 2015

**Abstract**

We study product market competition between firm owners (principals) where workers (agents) decide on their efforts and, hence, on output levels. Two worker compensation schemes are compared: a piece rate compensation as a benchmark when workers' output performance is verifiable, and a contest-based compensation scheme with variable, revenue-based prizes when it is only verifiable who the best performing worker is, i.e., only 'contest performance' is verifiable. Without rivalry between firms, the two compensation schemes lead to the same results. In case of product market competition, however, contest-based compensation schemes lead to more employment, more production, and lower firm profits. The reduction in profits represents the cost of being only able to verify workers' contest performance instead of output performance.

Keywords: Worker compensation, piece rates, team contests, revenue sharing, strategic competition

JEL Classification: C72, L22, M52

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# 1 Introduction

Standard principal-agent models, as discussed in institutional economics, usually concentrate on a firm's internal organization and analyze compensation contracts between a single principal, the firm owner, and one or more agents, the workers (see, e.g., Laffont and Martimort 2002 or Macho-Stadler and Perez-Castrillo 1997). In industrial economics, compensation contracts are studied in a broad class of strategic competition models. However, in contrast to the standard principal-agent models, the agents in these models are usually managers but not workers (see, e.g., the survey in Sengul, Gimeno and Dial 2012). The link to the principal-(worker)agent models is the design of compensation contracts for workers in case of product market competition.

In this paper, we analyze competing firms, each consisting of one owner and several workers who decide on effort levels anticipating how these decisions affect their effort costs. The basic principal-agent framework with risk-neutral individuals is therefore extended to account for strategic interaction between owners and workers of firms on oligopolistic product markets. We compare two prominent worker-compensation schemes, one relying on piece rates and one relying on a contest-based compensation scheme with a variable, revenue-based contest prize. While piece rates are based on output performance, revenue-based contest schemes can also be implemented when worker output is not verifiable. Rather, in order to implement contest-based compensation schemes, owners only need information on workers' contest performance.

The paper combines two strands of literature. On the one hand, Gershkov, Li and Schweinzer (2009) have analyzed the design of contests within teams but neglected the relationship between worker agents and owner principals as well as product market competition. In contrast, we point out the role of the principals of rival firms in strategic competition and thus depart from the contest literature that has focused on contests in monopoly firms. On the other hand, Güth, Pull and Stadler (2015) have analyzed piece-rate and revenue-sharing contracts in the context of product market competition and vice versa. We deviate from this paper in several directions. First, we consider a contest-based compensation scheme by introducing a contest-success function. Second, we analyze the payment of an optimal fixed salary in addition to the performance-based compensation components. This allows principals to reduce the (expected) net utility of workers to a given reservation level. Third, we focus on firm profit rather than firm surplus when assessing the effects of the two compensation schemes. Due to positive reservation utilities of workers, firm profits no longer coincide with firm surpluses and hence the set-up of the optimization problems changes. Last not least, we extend both strands of literature by endogenizing the optimal number of workers employed by the firms and show that the employment levels differ according to the compensation scheme in use.

Our analysis shows the dominance of the piece-rate compensation scheme which reproduces the market performance of unitary firms. Contest-based revenue-sharing schemes unavoidably trigger strategic-competition effects, implying higher employment and output levels and lower firm profits.

The remainder of the paper is organized as follows: In Section 2 we analyze piece-rate compensation as a benchmark and show that the market performance of unitary firms is reproduced. In Section 3, we analyze a contest-based compensation scheme where the best workers' prizes depend on the firms' revenue shares, and compare the results. Section 4 concludes.

## 2 Piece-Rate Contracts

We consider a heterogeneous product market with two firms $i = 1,2$, each producing a substitute good. The firms' inverse demand functions are

$$p_i = 1 - q_i - \gamma q_j \; ; \quad i, j = 1,2, \; i \neq j \; ,$$

where $\gamma \in [0,1]$ measures the intensity of competition. In the limit case of $\gamma = 0$ the market is separated into two monopoly markets such that there is no strategic interaction between firms. In the opposite limit case of $\gamma = 1$ the products are perfect substitutes and the market is homogeneous, inducing intense competition between firms.

The single input factor of production is the effort $e_{i,k}$ of workers $k = 1,...,n_i$ in each firm $i = 1,2$, where the effort-cost function is quadratic, i.e. $c(e_{i,k}) = e_{i,k}^2/2$. The output of firm $i$ is a linear aggregation of individual effort levels and amounts to $q_i = \sum_{k=1}^{n_i} e_{i,k}$.

Each firm consists of one owner (principal) and $n_i$ workers (agents). The game has two stages: in the first stage, the owners $i = 1,2$ simultaneously write observable piece-rate contracts with their workers, specifying the fixed (positive or negative) payment $f_i$ and a (positive) piece rate $w_i$ per output unit, i.e. per unit of effort. Workers are awarded according to these contracts and suffer from effort cost of production, i.e. they realize net utilities

$$U_{i,k}(w_i, e_{i,k}) = f_i + w_i e_{i,k} - e_{i,k}^2/2 \ , \quad i = 1,2, \ k = 1,...,n_i \ .$$

In the second stage of this piece-rate (PR) compensation game, workers maximize their net utilities with respect to efforts $e_{i,k}$. The first-order conditions are

$$e_{i,k}^* = w_i \ , \quad i = 1,2, \ k = 1,...,n_i \ .$$

Since worker effort depends on the firm-specific piece rate $w_i$ only, there is neither intra- nor interfirm interaction between workers.

When the reservation utility, resulting from alternative compensation-contract offers in other markets or from unemployment benefits, is given by $\overline{U} \geq 0$, workers receive the fixed payment $f_i = \overline{U} - w_i^2/2$ such that the reduced-form profit functions of the firms can be written as

$$\begin{aligned} \pi_i(w_i, w_j, n_i, n_j) &= (1 - n_i e_i^* - \gamma n_j e_j^* - w_i) n_i e_i^* - n_i f_i \\ &= (1 - (n_i + 1/2) w_i - \gamma n_j w_j) n_i w_i - n_i \overline{U} \ , \quad i,j = 1,2, \ i \neq j \ . \end{aligned} \tag{1}$$

In the first stage, owner principals maximize profits with respect to the number of workers $n_i$ and piece rates $w_i$. The respective first-order conditions are

$$[1 - (2n_i + 1/2) w_i - \gamma n_j w_j] w_i - \overline{U} \geq 0 \tag{2}$$

and

$$[1 - (2n_i + 1) w_i - \gamma n_j w_j] n_i = 0 \ . \tag{3}$$

We distinguish two cases: one where firms are restricted with respect to the number of available workers and one with an unrestricted optimum of employed workers. In the special case of $\overline{U} = 0$, for example, firms are obviously restricted by the number of available workers, since the first-order conditions (2) and (3) imply the employment of an infinite number of workers (see Güth, Pull and Stadler 2011, 2015).

*Solution of the PR compensation game in case of a limited worker supply*

When firms are restricted by a limited market-specific worker supply, inelastically given by $2n$ workers, it follows from the first-order conditions (2) and (3) that principals prefer to employ as many workers as possible such that the symmetric equilibrium is characterized by $n_1 = n_2 = n$, i.e., the number $n$ of workers employed by each firm represents half of the market-specific worker force. The optimal piece rates and worker efforts per firm are

$$w = e^{PR} = \frac{1}{1+(2+\gamma)n} \,, \tag{4}$$

leading to the prices

$$p^{PR} = \frac{1+n}{1+(2+\gamma)n}$$

and firm profits

$$\pi^{PR} = \frac{(1+2n)n}{2[1+(2+\gamma)n]^2} - n\overline{U} \,. \tag{5}$$

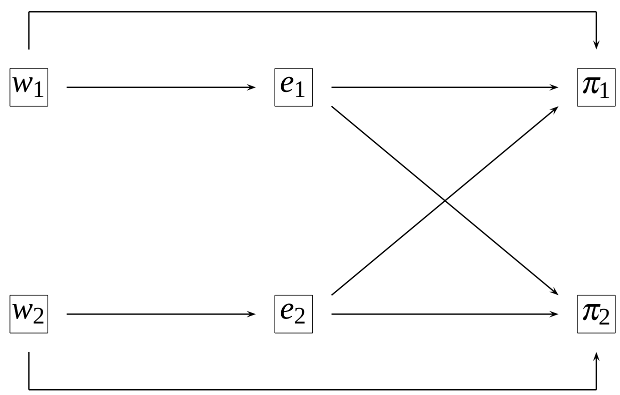
It becomes obvious that efforts, prices and firm profits are decreasing in the intensity of competition $\gamma$. Furthermore, while worker efforts and prices are decreasing in the number of employed workers, firm profits are increasing. The numerical solutions for $n = 2$ workers per firm and a common worker reservation utility of $\overline{U} = 2/900$ are presented in Table 1 for the two extreme cases of minimal ($\gamma = 0$) and maximal ($\gamma = 1$) intensities of competition.

Table 1: Results for the PR compensation game with $n = 2$ workers

| | $w$ | $e^{PR}$ | $p^{PR}$ | $\pi^{PR}$ |
|---|---|---|---|---|
| $\gamma = 0$ | 0.200 | 0.200 | 0.600 | 0.196 |
| $\gamma = 1$ | 0.143 | 0.143 | 0.429 | 0.098 |

The piece-rate compensation scheme reproduces the market performance of unitary firms. This can be seen immediately from equation (1) which coincides with the profit equation of unitary firms being able to decide directly on worker efforts. This equivalence even holds in case of product market competition since there is no strategic-competition effect of piece rates on the efforts of the rival firm's workers (see Figure 1).

Figure 1: Two-stage competition in the PR game




*Solution of the PR compensation game in case of an unlimited worker supply*

When firms are not restricted by a limited worker supply, the first-order conditions (2) and (3) give the optimal interior number of employed workers[1]

$$n^{PR} = \frac{1-\sqrt{2\overline{U}}}{(2+\gamma)\sqrt{2\overline{U}}}\,, \tag{6}$$

depending negatively on the intensity of competition $\gamma$ and the reservation utility $\overline{U}$. This leads to the piece rates and efforts

$$w = e^{PR} = \sqrt{2\overline{U}}\,, \tag{7}$$

[1]Alternatively, one could account for a decreasing marginal product of worker effort to derive an interior optimum (see, e.g., Das 1996). However, such a model would no longer be tractable for the analysis of different compensation schemes under product market competition.

prices

$$p^{PR} = \frac{1+\sqrt{2\overline{U}}}{2+\gamma} \, ,$$

and firm profits

$$\pi^{PR} = \frac{(1-\sqrt{2\overline{U}})^2}{(2+\gamma)^2} \, . \tag{8}$$

Firm profits are decreasing in the reservation utility $\overline{U}$ of workers as well as in the intensity of competition $\gamma$. Table 2 shows the numerical solutions for $\overline{U} = 2/900$ and the two extreme cases of minimal and maximal intensities of competition.

Table 2: Results for the PR compensation game with optimal numbers of workers[2]

| | $n^{PR}$ | $w^{PR}$ | $e^{PR}$ | $p^{PR}$ | $\pi^{PR}$ |
|---|---|---|---|---|---|
| $\gamma = 0$ | 7 | 0.067 | 0.067 | 0.533 | 0.218 |
| $\gamma = 1$ | 5 | 0.067 | 0.067 | 0.356 | 0.097 |

To conclude, piece-rate compensation schemes reproduce the market outcome of a unitary firm. However, piece-rate compensation schemes can only be implemented when workers' individual output units are countable and verifiable. In practice, this is often not the case. Rather, principals may only be able to measure relative performance, e.g., in the form of contest performance. Besides economizing on measurement costs, contest-based compensation schemes have many advantages, among others their ability to filter common risks. Therefore, incentive schemes where bonus payments, luxurious trips or promotions are awarded based on workers' contest performance are widespread (see, e.g., Backes-Gellner and Pull 2013).

# 3 Contest-Based Compensation Contracts

As an alternative to piece-rate compensation schemes, we analyze an incentive device where principals each decide on a revenue share $s_i \in [0,1]$ which is distributed to the

[2] The equilibrium values in case of $\gamma = 1$ are calculated by using the optimal number $n^{PR} = 4.67$, i.e. by ignoring the integer constraint.

"best" worker in terms of contest performance. Such a game is analyzed by Gershkov, Li and Schweinzer (2009) for the monopoly case only. We extend their model by investigating the influence of firm-owner principals competing in product markets, and endogenize the number of employees.

As is well known, there are several institutional set-ups appropriate to convert agents' efforts into win probabilities in contests. Such approaches can be found, e.g., in Hirshleifer and Riley (1992, Chapter 10), Fullerton and McAfee (1999), Baye and Hoppe (2003) and are summarized in Konrad (2009). These microeconomic underpinnings make a strong case for the contest success function $\mu = e_i/(\sum_{k=1}^{n_i} e_{i,k}) = e_i/q_i$.[3] The prize of winning the contest is endogenously determined by the firm owners and will depend on the firms' revenues. In this revenue-sharing (RS) game, each worker participating in the team contest expects net utility

$$
\begin{aligned}
EU_{i,k}(s_i, e_{i,k}) &= f_i + s_i(e_{i,k}/q_i)(1-q_i-\gamma q_j)q_i - e_{i,k}^2/2 \\
&= f_i + s_i e_{i,k}(1-\sum_{k=1}^{n_i} e_{i,k} - \gamma \sum_{\ell=1}^{n_j} e_{j,\ell}) - e_{i,k}^2/2 \,.
\end{aligned}
$$

In the second stage of the game, risk-neutral workers maximize their expected net utilities with respect to the efforts $e_{i,k}$. The first-order conditions are

$$
s_i(1-(n_i+1)e_i - \gamma n_j e_j) - e_i = 0 \,,
$$

where $e_{i,k} = e_i \; \forall \, k = 1,\dots,n_i$ and $e_{j,\ell} = e_j \; \forall \, \ell = 1,\dots,n_j$. The equation system is solved by the equilibrium efforts

$$
e_i^*(s_i, s_j, n_i, n_j) = \frac{s_i(1+(1+(1-\gamma)n_j)s_j)}{1+(n_i+1)s_i+(n_j+1)s_j+((1-\gamma^2)n_i n_j+n_i+n_j+1)s_i s_j} \,. \tag{9}
$$

Denoting the denominator of equation (9) by $D$, we derive the following comparative statics:

$$
\begin{aligned}
&de_i^*/ds_i = [1+(1+(1-\gamma)n_j)s_j][1+(n_j+1)s_j^2]/D^2 \; > 0 \,, \\
&de_i^*/ds_j = -\,\gamma n_j s_i[1+(1-\gamma)n_j)s_i)]/D^2 \; < 0 \,, \\
&de_i^*/dn_i = -\,s_i^2(1+(1+(1-\gamma)n_j)s_j][1+(1+(1-\gamma^2)n_j)s_j]/D^2 \; < 0 \,,
\end{aligned}
$$

[3]This is a special case of the more general Tullock contest-success function $\mu = e_i^r/(\sum_{k=1}^{n_i} e_{i,k}^r)$, where the ranking-precision parameter is normalized to $r = 1$.

$$de_i^*/dn_j = -\gamma s_i s_j[1+(1+(1-\gamma)n_i)s_i][1+s_j]/D^2 < 0 \, .$$

The derivatives show that worker efforts are monotonically decreasing in the number of workers employed by any firm. Furthermore, an increase in the revenue share offered by an owner raises the efforts of own workers but reduces the efforts of the rival's workers.

By anticipating the equilibrium worker efforts and driving workers' expected net utility down to their reservation levels such that $f_i = \overline{U} - s_i e_i(1-q_i-q_j) - e_i^2/2$, the owners face the profit function

$$\begin{aligned} \pi_i(s_i, s_j, n_i, n_j) &= (1-s_i)(1-n_i e_i^* - \gamma n_j e_j^*)n_i e_i^* - n_i f_i \\ &= (1-n_i e_i^* - \gamma n_j e_j^*)n_i e_i^* - n_i(e_i^*)^2/2 - n_i\overline{U} \, , \quad i,j=1,2\,; i \neq j \, . \end{aligned}$$

In the first stage, owner principals maximize profits with respect to the number of workers $n_i$ and revenue shares $s_i$. The respective first-order conditions are

$$d\pi_i(n_i, e_i^*(n_i), e_j^*(n_i))/dn_i = \partial\pi_i/\partial n_i + (\partial\pi_i/\partial e_i^*)(de_i^*/dn_i) + (\partial\pi_i/\partial e_j^*)(de_j^*/dn_i) \geq 0 \tag{10}$$

and

$$d\pi_i(e_i^*(s_i), e_j^*(s_i))/ds_i = (\partial\pi_i/\partial e_i^*)(de_i^*/ds_i) + (\partial\pi_i/\partial e_j^*)(de_j^*/ds_i) = 0 \, . \tag{11}$$

*Solution of the RS compensation game in case of a limited worker supply*

As in Section 2, let us first assume that firms are restricted by the number of available workers. It follows from the first-order conditions (10) and (11) that principals prefer to employ as many workers as possible. When the whole market-specific worker force is given by $2n$ workers, the symmetric equilibrium is characterized by the employment of $n_1 = n_2 = n$ workers in each firm. Furthermore, the first-order conditions (11) lead to an interior optimum for the revenue shares. Due to the partial derivatives $\partial\pi_i/\partial e_j^* = -\gamma n_i n_j e_i^* < 0$ and $de_j^*/ds_i < 0$, the strategic term has a positive sign, indicating an "overinvestment" in the revenue share devoted to the workers. Since worker efforts are strategic substitutes in the sense of Bulow, Geanakoplos and Klemperer (1985), owners choose the "top dog" strategy according to the taxonomy introduced by Fudenberg and Tirole (1984). By inserting the corresponding expressions for the partial and total derivatives in equation (11), the symmetric equilibrium revenue shares are derived as solution to the quadratic equation

$$[(1-\gamma^2)n^2+n]s^2-s-1=0\ ,$$

which has the single positive root

$$s=\frac{1+\sqrt{1+4n(1+(1-\gamma^2)n)}}{2n(1+(1-\gamma^2)n)}\ . \qquad (12)$$

The revenue share devoted to the workers as a whole is monotonically increasing in the intensity of competition from $s=1/n$ in case of no competition ($\gamma=0$) up to $s=(1+\sqrt{1+4n})/(2n)$ in case of intense competition ($\gamma=1$). In the symmetric equilibrium the worker effort equation (9) simplifies to

$$e^{RS}=\frac{s}{1+(1+(1+\gamma)n)s}\ . \qquad (13)$$

Effort levels are monotonically increasing in $\gamma$ from $e^{RS}=1/(1+2n)$ in case of no competition ($\gamma=0$) up to $e^{RS}=[1+\sqrt{1+4n}]/[1+4n+(1+2n)\sqrt{1+4n}]$ in case of intense competition ($\gamma=1$).

Given the effort levels, one obtains the prices

$$p^{RS}=1-(1+\gamma)ne^{RS}\ ,$$

and firm profits

$$\pi^{RS}=[1-(1/2+(1+\gamma)n)e^{RS}]ne^{RS}-n\overline{U}\ , \qquad (14)$$

which are decreasing in the intensity of competition $\gamma$ and the number of employed workers $n$.

The numerical solutions for $n=2$ workers per firm and a common worker reservation utility of $\overline{U}=2/900$ are presented in Table 3 for the two extreme cases of minimal ($\gamma=0$) and maximal ($\gamma=1$) intensities of competition.

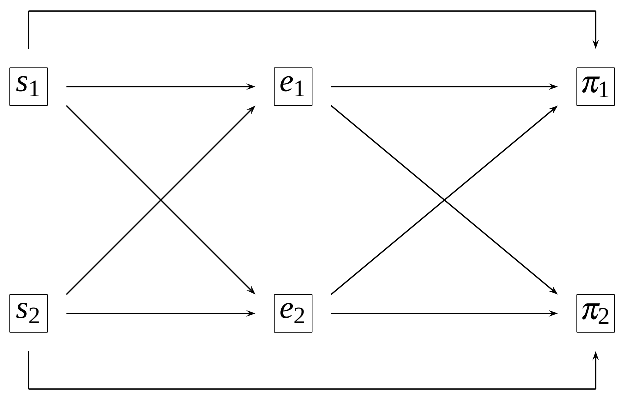
Table 3: Results for the RS compensation game with $n = 2$ workers

| | $s$ | $e^{RS}$ | $p^{RS}$ | $\pi^{RS}$ |
|---|---|---|---|---|
| $\gamma = 0$ | 0.500 | 0.200 | 0.600 | 0.196 |
| $\gamma = 1$ | 1.000 | 0.167 | 0.333 | 0.079 |

A comparison with Table 1 shows that firm profits coincide with those of the piece-rate compensation game in case of no competition ($\gamma = 0$). This would even hold true in case of competition ($\gamma > 0$) if the compensation contracts were not observable by the rivals. When observable, however, owners commit themselves in their decisions on revenue shares, thereby unavoidably inducing strategic effects (see Figure 2).

Due to these strategic effects, owners raise the revenue shares devoted to workers, thereby inducing higher effort levels, lower prices and lower firm profits. An implication of this result is that a compulsory disclosure of revenue-sharing contracts is welfare-enhancing.

Figure 2: Two-stage competition in the RS game




*Solution of the RS compensation game in case of an unlimited worker supply*

When firms are not restricted by a limited worker supply, the first-order conditions (10) hold with equality and determine an optimal interior number of employed workers per firm.

In case of separated monopolies ($\gamma = 0$), an explicit solution can be derived. The revenue-share equation (12) simplifies to $s = 1/n$, the effort equation (13) to $e^{RS}(\gamma = 0) = 1/(1+2n)$ such that the reduced-form profit equation (14) can be written as

$$\pi^{RS}(\gamma = 0) = n/(2+4n) - n\overline{U}\ .$$

The first-order condition with respect to $n$ leads to the interior optimum

$$n^{RS}(\gamma = 0) = \frac{1-\sqrt{2\overline{U}}}{2\sqrt{2\overline{U}}}\ ,$$

inducing worker effort $e^{RS}(\gamma = 0) = \sqrt{2\overline{U}}$, which coincides with the corresponding solution (7) in the piece-rate compensation game. Therefore, we can summarize that in case of $\gamma = 0$ the market outcomes of the two compensation schemes coincide with $n^{PR}(\gamma = 0) = n^{RS}(\gamma = 0)$ and $e^{PR}(\gamma = 0) = e^{RS}(\gamma = 0)$. Obviously, in this limit case (which is usually considered in traditional principal-agent models), there is no cost of verifiability of relative worker output only.

In case of product market competition, however, the two compensation schemes lead to different outcomes. Not only revenue shares but also the numbers of employed workers act as strategic variables via commitment on production quantities. Since $\partial \pi_i/\partial e_j^* = -\gamma n_i n_j e_i^* < 0$ and $de_j^*/dn_i < 0$, the strategic term in the first-order condition (10) has a positive sign, indicating an "overinvestment" in the number of employed workers, again a "top dog" strategy.

By inserting the corresponding expressions for the partial and total derivatives in the first-order condition (10), the symmetric worker employment levels are determined implicitly by

$$\begin{aligned}&[1-(1/2+(2+\gamma)n)e]e\\&+n[1-(1+(2+\gamma)n)e][(1+(1+(1-\gamma)n)s)(1+(n+1)s))]/D^2\\&+\gamma^2 n^2 es^2[(1+(1+(1-\gamma)n)s)(1+s)]/D^2-\overline{U}\ =\ 0\end{aligned} \tag{15}$$

where $e = s/[1+(1+(1+\gamma)n)]$ and $s$ resulting from equation (12). Numerical calculations show that the number of workers is generally higher as compared to the case of piece-rate compensation. In the example of $\overline{U} = 2/900$, it follows from equation (15) that the optimal number of workers per firm is given by $n^{RS} = 6$ which corresponds to the lower optimal number $n^{PR} = 5$ in case of piece-rate compensation.

Table 4 shows the numerical solutions for $\overline{U} = 2/900$ and the two extreme cases of minimal and maximal intensities of competition.

Table 4: Results for the RS compensation game with optimal numbers of workers

| | $n^{RS}$ | $s$ | $e^{RS}$ | $p^{RS}$ | $\pi^{RS}$ |
|---|---|---|---|---|---|
| $\gamma = 0$ | 7 | 0.143 | 0.067 | 0.533 | 0.218 |
| $\gamma = 1$ | 6 | 0.500 | 0.067 | 0.200 | 0.053 |

A comparison with Table 2 shows that firm profits again coincide with those of the piece-rate compensation game in case of no product market competition. This would also hold in case of product market competition if the compensation contracts were not observed by the rivals. When observable, however, owners commit themselves not only with respect to revenue shares but also with respect to the number of employed workers. Due to the strategic effects, owners employ more workers, thereby inducing a higher aggregate effort level, lower prices and lower firm profits.

To compare the performance effects of the considered compensation schemes in more detail, Table 5 presents the firm profits for the unrestricted employment optima, given by $n^{PR}(\gamma = 0) = n^{RS}(\gamma = 0) = 7$, $n^{PR}(\gamma = 1) = 5$ and $n^{RS}(\gamma = 1) = 6$ employed workers, respectively, as well as the restricted optima with an equal employment level of $n$ workers per firm.

Table 5: Firm profits depending on the number of workers per firm up to the optimal employment levels

| | $n = 1$ | $n = 2$ | $n = 3$ | $n = 4$ | $n = 5$ | $n = 6$ | $n = 7$ |
|---|---|---|---|---|---|---|---|
| $\pi(\gamma = 0)$ | 0.164 | 0.169 | 0.208 | 0.213 | 0.216 | 0.217 | 0.218 |
| $\pi^{PR}(\gamma = 1)$ | 0.092 | 0.098 | 0.098 | 0.098 | 0.097 | - | - |
| $\pi^{RS}(\gamma = 1)$ | 0.083 | 0.079 | 0.072 | 0.065 | 0.059 | 0.053 | - |

As a result of product market competition, firm profits in case of revenue sharing are dominated by those in case of piece-rate compensation. When restricted to a limited number of available workers, only revenue shares act as strategic variables, leading to higher worker efforts and lower firm profits. When unrestricted, the numbers of employed workers act as additional strategic variables, driving workers' aggregate effort further in the same direction. From the perspective of firm owners, the decline in profits can be interpreted as the cost of only observing a relative performance (winning the contest) instead of the absolute performance of individual workers. It depends on the technology and the opportunity cost of monitoring whether an alternative compensation scheme might be preferable at all. Risk-neutral workers are indifferent between the compensation schemes due to our assumption of a given reservation utility, common to all workers, which will be realized in equilibrium. Finally, consumers gain from a revenue-share compensation scheme which induces more production and thus lower prices - but only if the strategic variables are observed by the rival firms. An implication for the competition authorities is therefore that compulsory disclosure of such compensation contracts is welfare-enhancing.

# 4 Summary and Conclusion

We studied product market competition between firms where owners decide on the number of employed workers and implement a compensation scheme to which workers react by choosing efforts and, hence, output levels. Depending on the verifiability of workers' performance, owners offer a piece-rate or a variable, contest-based compensation scheme in order to maximize firm profits.

We showed the dominance of a first-best piece-rate compensation scheme when workers' output performance is verifiable. In practice, however, this might often not be the case and piece-rate contracts might not be feasible. In these cases, a second-best alternative could be a contest-based revenue-sharing compensation scheme that only relies on the verifiability of contest performance. Without product market competition, this scheme leads to the same firm performance as the piece-rate compensation scheme. Competition between firms, however, triggers strategic effects, implying higher employment and output levels and lower firm profits. This reduction in profits can be interpreted as the cost of being only able to observe workers' contest instead of their output performance.

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