E C O N O M I C S   B U L L E T I N

# Incentive Effects of Peer Pressure in Organizations

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## *Abstract*

This paper studies the effects of peer pressure on incentives. We assume that, in addition to the material payoff, each agent's utility includes the psychological payoff from peer pressure generated by a comparison of effort costs. We show that the optimal incentive schemes depend mainly on the degree of peer pressure and of the heterogeneity of agents. Furthermore, we examine the optimal organizational forms in terms of the principal's intention to make use of the effects of peer pressure.

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# 1 Introduction

This paper studies optimal incentive schemes when agents feel peer pressure. Here, peer pressure implies a psychological pressure that an agent feels when he compares his effort cost with that of his colleague's. Some literature has studied the effects of peer pressure on incentives and, most often, assumed that an agent feels peer pressure through a comparison between his actions and that of his colleague's.[1] This kind of comparison seems to be realistic and natural, so research based on this assumption is valuable in some situations. However, in other situations, it is natural to assume that the source of peer pressure is the comparison of action costs rather than the actions themselves. In particular, this aspect is crucial if we consider that agents are heterogeneous with respect to their abilities. This paper shows that peer pressure and heterogeneity have significant effects on the optimal incentive scheme even if we consider a simple situation where each agent has only two available actions: work or shirk.

We consider the following situation. There are two risk-neutral agents protected by limited liability constraints. Each agent contributes effort towards a single output. The principal can observe only the output so that the reward to each agent is contingent on this output. Two agents are heterogeneous with respect to their effort costs. In addition to the material payoff, each agent's utility includes the psychological payoff generated by a comparison between his effort cost and his colleague's. In this situation, we study optimal incentive schemes and show that such schemes depend mainly on the degree of peer pressure and that of the heterogeneity of the agents. Additionally, we study whether the principal can save the payment to the agents by making use of the effects of peer pressure. From this viewpoint, we give a brief discussion on the design of the organizational forms.

The remaining sections are organized as follows. The model is presented in the next section. Section 3 shows the principal's problem and derives the optimal incentive schemes. We compare the optimal incentives between the case with peer pressure and that without it in section 4 and examine the optimal organizational forms in section 5. Finally, conclusions are drawn in section 6.

# 2 The Model

Consider a situation in which there is a principal and two agents, denoted by $i = 1, 2$. They are assumed to be risk-neutral, but the agents are protected by limited liability constraints. Each agent chooses his effort level $e_i \in \{0, 1\}$. Let $\boldsymbol{e} = (e_1, e_2)$ denote the vector of agents' effort levels. Agent $i$ devotes his effort at cost $d_i(e_i)$. For simplicity, we assume that $d_i(1) = d_i$, $d_i(0) = 0$, and $0 < d_1 < d_2$. Thus, the heterogeneity between the agents is caused by the difference between the effort costs. Assume that agent 2 is a "less productive agent" and agent 1 is a "more productive agent". We assume that the principal knows each agent's effort

[1] See, for example, Kandel and Lazear (1992), Barron and Gjerde (1997), and Daido (2004, 2005).

costs. The realized output, $b$, depends on the effort level of the agents in the following way. The project succeeds with probability $p(\boldsymbol{e})$ and its output is $b^s$ while it fails with probability $1 - p(\boldsymbol{e})$ and its output is $b^f$. We assume $b^s = b > 0$ and $b^f = 0$. The probability $p(\boldsymbol{e})$ depends on $\boldsymbol{e}$. $p(\boldsymbol{e}) = p^h$ if both agents choose $e_i = 1$, $p(\boldsymbol{e}) = p^l$ if one agent chooses $e_i = 1$ but the other agent chooses $e_{-i} = 0$, and $p(\boldsymbol{e}) = p$ if both agents choose $e_i = 0$. We assume $0 < p < p^l < p^h < 1$. The principal can observe only this verifiable output so that the reward to each agent is contingent on the output. Thus, the principal offers agent $i$ a contract $(w_i^s, w_i^f)$ where $w_i^s$ represents the payment to agent $i$ when the project succeeds and $w_i^f$ represents the payment to agent $i$ when the project fails. Note that $w_i^n \geq 0$, for $i = 1, 2$ and $n = s, f$, because we consider the limited liability constraints.

In order to incorporate peer pressure into this model, we consider the following utility function for agent $i$.

$$u_i = p(\boldsymbol{e})w_i^s + (1 - p(\boldsymbol{e}))w_i^f - d_i(e_i) - \alpha \cdot \max\{\gamma(d_i - d_{-i}), d_{-i} - d_i\} \tag{1}$$

The final term represents a peer pressure function: the agent feels peer pressure when his effort cost differs from that of his colleague. We assume that $0 < \alpha$ and $0 < \gamma \leq 1$. $\alpha$ is the degree of peer pressure and $\gamma$ is the coefficient that represents the degree of the reduction of peer pressure when an agent's effort cost is above his colleague's, relative to the inverse case. The most significant assumption for this peer pressure function is that each agent feels peer pressure not only when his effort cost is below his colleague's level but also when it is above that level. In addition, when $\gamma < 1$, the agent feels less pressure when his effort cost is above his colleague's level than when it is below that level.[2] Because the heterogeneity of the productivity of the agents is the main feature of this paper, we assume that the source of peer pressure is the comparison of effort costs rather than effort levels.[3]

Certain assumptions in this model appear to be strict. The assumptions that peer pressure comes from the comparison of effort costs and that agents can take two actions are crucial to the results obtained the following analysis. However, we can develop a simple model under these assumptions so that we are able to interpret the optimal incentive schemes in terms of heterogeneity ($d_2/d_1$), the degree of peer pressure ($\alpha$), and the coefficient of the reduction of peer pressure ($\gamma$).

The timing is as follows. First, the principal offers a contract to the agents. Then, the agents decide simultaneously whether to accept or reject the contract. If rejected by at least one agent, the game ends and each agent receives the reservation utility, which is assumed to be zero. If accepted by both agents, the game proceeds to the next stage. Next, each agent chooses his own effort level. Finally, output is realized and the principal pays wages to the agents according to the contract.

[2]We can usually see this kind of assumption in studies on the other-regarding preferences, such as Fehr and Schmidt (1999) and Itoh (2004).

[3]Daido (2006) also studied the effects of peer pressure on incentives. He assumes that two agents feel peer pressure through comparison of effort levels and defines a quadratic peer pressure function where the agents' effort levels are continuous.

## 3 The Optimal Incentive Schemes

To begin with, we consider the case without peer pressure as the benchmark.[4] In this situation, the utility functions of agent $i$ and the principal are $u_i = p(\boldsymbol{e})w_i^s + (1 - p(\boldsymbol{e}))w_i^f - d_i(e_i)$ and $u_P = p(\boldsymbol{e})b - \sum_i \{p(\boldsymbol{e})w_i^s + (1 - p(\boldsymbol{e}))w_i^f\}$, respectively. We assume that $b$ is so large that the principal wants to implement $\boldsymbol{e} = (1, 1)$. The agent $i$'s incentive compatibility constraint and participation constraint are as follows:[5]

$$\Delta_p \Delta_i \geq d_i \tag{ICi}$$
$$w_i^f + p^h \Delta_i \geq d_i \tag{PCi}$$

where $\Delta_p \equiv p^h - p^l$ and $\Delta_i \equiv w_i^s - w_i^f$. The principal offers a contract that minimizes the payment to both agents, $\sum_i \{p(e)w_i^s + (1 - p(e))w_i^f\}$, subject to (ICi), (PCi), and the limited liability constraints.

We can readily find the optimal contract $(w_i^{s*}, w_i^{f*})$ in this case. If $(w_i^s, w_i^f)$ that (PCi) holds with equality also satisfies (ICi), then the first-best contract can be achieved. To check this, substituting $\Delta_i = (d_i - w_i^f)/p^h$ into (ICi), we obtain $(d_i - w_i^f)/p^h \geq d_i/\Delta_p$. Because $p^h > \Delta_p$, this inequality is violated even when $w_i^f = 0$. That is, the first-best contract cannot be achieved and the optimal contract is the second-best one where (ICi) binds, $\Delta_i = d_i/\Delta_p$. Then, the payment to agent $i$ is $w_i^f + p^h d_i/\Delta_p$. To minimize this payment under the limited liability constraint, $w_i^{f*} = 0$ and $w_i^{s*} = d_i/\Delta_p$. Thus, the optimal contract in the case without peer pressure is $(w_i^{s*}, w_i^{f*}) = (d_i/\Delta_p, 0)$.

Next, we consider the case with peer pressure. Each agent's incentive compatibility and participation constraints are as follows:[6]

$$w_1^f + p^h \Delta_1 - d_1 - \alpha(d_2 - d_1) \geq w_1^f + p^l \Delta_1 - \alpha d_2 \tag{IC1p}$$
$$w_2^f + p^h \Delta_2 - d_2 - \alpha\gamma(d_2 - d_1) \geq w_2^f + p^l \Delta_2 - \alpha d_1 \tag{IC2p}$$
$$w_1^f + p^h \Delta_1 - d_1 - \alpha(d_2 - d_1) \geq 0 \tag{PC1p}$$
$$w_2^f + p^h \Delta_2 - d_2 - \alpha\gamma(d_2 - d_1) \geq 0. \tag{PC2p}$$

First, consider the optimal contract for agent 2. Suppose (PC2p) binds, $\Delta_2 = \{d_2 + \alpha\gamma(d_2 - d_1) - w_2^f\}/p^h$. Substituting this equation into (IC2p), we obtain $\{d_2 + \alpha\gamma(d_2 - d_1) - w_2^f\}/p^h \geq$

[4]We can consider this case as if there is a single agent because there do not exist any correlations between two agents in the production process. Itoh (2003) is helpful in identifying optimal contracts in this case.

[5](ICi) and (PCi) represent the incentive compatibility and participation constraints for agent $i$ in the case without peer pressure, respectively.

[6](ICip) and (PCip) represent the incentive compatibility and participation constraints for agent $i$ in the case with peer pressure, respectively.

$\big[d_2 + \alpha\{\gamma d_2 - (1+\gamma)d_1\}\big]/\Delta_p$. When $w_2^f = 0$, this inequality is most feasible. Then, we have the following condition under which the first-best is achieved.

$$\frac{d_2 + \alpha\gamma(d_2 - d_1)}{p^h} \geq \frac{d_2 + \alpha\{\gamma d_2 - (1+\gamma)d_1\}}{\Delta_p} \tag{2}$$

Then, the optimal contract $(\bar{w}_2^s, \bar{w}_2^f)$ is such that (PC2p) holds with equality. In particular, $(\bar{w}_2^s, \bar{w}_2^f) = (\{d_2 + \alpha\gamma(d_2 - d_1)\}/p_h, 0)$ exists as an optimal contract.

On the other hand, if the condition (2) cannot be satisfied, the optimal contract is the second-best contract, which implies that (IC2p) binds. Then, the principal's payment to agent 2 is:

$$w_2^f + p^h\Delta_2 = w_2^f + p^h\big[d_2 + \alpha\{\gamma d_2 - (1+\gamma)d_1\}\big]/\Delta_p. \tag{3}$$

It is obvious that the principal can minimize the payment by ensuring $w_2^f = 0$. Thus, the second-best optimal contract is: $(\bar{w}_2^{s*}, \bar{w}_2^{f*}) = (\big[d_2 + \alpha\{\gamma d_2 - (1+\gamma)d_1\}\big]/\Delta_p, 0)$.

Next, consider the optimal contract for agent 1. The method of identifying such a contract is the same as for agent 2. The condition under which the first-best is achieved is as follows.

$$\frac{d_1 + \alpha(d_2 - d_1)}{p^h} \geq \frac{(1-\alpha)d_1}{\Delta_p} \tag{4}$$

Then, the optimal contract $(\bar{w}_1^s, \bar{w}_1^f)$ is such that (PC1p) holds with equality. In particular, $(\bar{w}_1^s, \bar{w}_1^f) = (\{d_1 + \alpha(d_2 - d_1)\}/p_h, 0)$ exists as an optimal contract. Note that (4) is always satisfied if $1 \leq \alpha$. On the other hand, if the condition (4) cannot be satisfied, the optimal contract is the second-best contract. Then, because (IC1p) binds, the principal's payment to agent 1 is:

$$w_1^f + p^h\Delta_1 = w_1^f + p^h(1-\alpha)d_1/\Delta_p. \tag{5}$$

Then, the second-best optimal contract is: $(\bar{w}_1^{s*}, \bar{w}_1^{f*}) = ((1-\alpha)d_1/\Delta_p, 0)$.

(2) and (4) can be represented as follows:

$$1 + \frac{\alpha - l}{(1+\alpha\gamma)l} \geq \frac{d_2}{d_1} \tag{6}$$

$$\frac{d_2}{d_1} \geq 1 + \frac{l - \alpha}{\alpha(1-l)} \tag{7}$$

where $l \equiv p^l/p^h$. Because $d_1 < d_2$, we can summarize the optimal contracts as the following proposition.

**Proposition 1.** *The optimal contracts are classified as follows.*

*(i) When $\alpha < l$, the optimal contract for agent 1 is $(\bar{w}_1^s, \bar{w}_1^f)$ when (7) is satisfied, otherwise it is $(\bar{w}_1^{s*}, \bar{w}_1^{f*})$, and the optimal contract for agent 2 is $(\bar{w}_2^{s*}, \bar{w}_2^{f*})$.*

*(ii) When $l < \alpha$, the optimal contract for agent 1 is $(\bar{w}_1^s, \bar{w}_1^f)$, and the optimal contract for agent 2 is $(\bar{w}_2^s, \bar{w}_2^f)$ when (6) is satisfied, otherwise it is $(\bar{w}_2^{s*}, \bar{w}_2^{f*})$.*

*(iii) When $\alpha = l$, the optimal contract for agent 1 is $(\bar{w}_1^s, \bar{w}_1^f)$ and the optimal contract for agent 2 is $(\bar{w}_2^{s*}, \bar{w}_2^{f*})$*

This proposition shows that the optimal incentive scheme depends on certain parameters that determine whether the incentive compatibility constraint or participation constraint binds. From (6) and (7), we can see the effects of such parameters on the incentives.

Firstly, the higher the degree of heterogeneity ($d_2/d_1$), the higher the possibility that (PC1p) rather than (IC1p), and (IC2p) rather than (PC2p) are binding. That is, when the heterogeneity is significant, the principal has no need to pay any rent to the more productive agent whereas she does have to pay rent to the less productive one. For the more productive agent, his effort cost is below his colleague's not only when he does not devote effort but also when he does. In this case, he can reduce the negative externality of peer pressure by devoting effort. This reduction is then large, as the heterogeneity is significant. As a result, he is willing to devote his effort with no rent. On the other hand, the less productive agent's effort cost is above his colleague's when he devotes effort while his effort cost is below his colleague's when he does not devote effort. Although he can also reduce negative externalities by devoting effort, this effect is relatively weak as the degree of heterogeneity is high. Consequently, the principal has to pay rent to him in order to induce him to exert effort.

Secondly, the higher the degree of the reduction of peer pressure when an agent's effort cost is above his colleague's ($\gamma$), the higher the possibility that (IC2p) rather than (PC2p) are binding. Note that $\gamma$ affects the incentive only for the less productive agent because the more productive agent's effort cost is never above the less productive agent's cost. If $\gamma$ is small, then, for the less productive agent, the negative externality of peer pressure from devoting his effort becomes small. Then, (PC2p) rather than (IC2p) tends to be binding. However, as $\gamma$ is large, the negative externality of peer pressure is significant even if he devotes effort. In this case, the principal has to provide him with incentives so that (IC2p) rather than (PC2p) becomes more stringent.

Finally, the higher the degree of peer pressure ($\alpha$), the higher the possibility that both agents' participation constraints are more effective than their incentive compatibility constraints.[7] That is, when peer pressure is significant, the principal does not need to pay any rent to both agents. We can see this result easily from the fact that the negative externality by not devoting effort is large when peer pressure is significant.

[7]Note that, for agent 2, the same effect works as $l$ decreases. For agent 1, this is true if $\alpha < 1$. As mentioned above, (PC1p) is always binding when $1 \leq \alpha$.

# 4 The Effects of Peer Pressure on Incentives

As seen previously, in contrast to the case without peer pressure, the principal no longer suffers from the agency problem in some cases with peer pressure. However, if $\alpha < l$ and $d_2/d_1 < 1 + (l - \alpha)/\alpha(1 - l)$, then both agents' incentive compatibility constraints bind. Thus, in this case, the agency problem remains even if the effects of peer pressure exist. Here, in order to study the effects of peer pressure on incentives, we compare the optimal contract in the case without peer pressure to the case with peer pressure where the agency problem remains.

With regard to agent 1, it is plain that $w_1^{s*} > \bar{w}_1^{s*}$. This result implies that the incentive for the more productive agent is less high-powered in the case with peer pressure than in the case without peer pressure. The more productive agent suffers from the negative externality of peer pressure when he devotes effort as well as when he does not, because his effort cost is below his colleague's in both cases. However, he can obviously reduce the negative externality of peer pressure if he devotes his effort. Therefore, the principal can induce the more productive agent's effort even by means of such a low-powered incentive.

On the other hand, the effect of peer pressure on the incentive for agent 2 depends on $\gamma$. If $d_2/d_1 < 1 + 1/\gamma$, the incentive for the less productive agent is also less high-powered in the case with peer pressure than in the case without ($w_2^{s*} > \bar{w}_2^{s*}$). Consequently, both agents' incentives are weakened by peer pressure if $d_2/d_1 < 1 + 1/\gamma$. However, if $d_2/d_1 \geq 1 + 1/\gamma$, the incentive for the less productive agent is more high-powered in the case with peer pressure ($w_2^{s*} \leq \bar{w}_2^{s*}$). In this way, $\gamma$ as well as heterogeneity is also crucial to the optimal incentive for him.[8] When $\gamma$ has a significant effect, the less productive agent suffers sufficiently from peer pressure even if he devotes effort. Then, the principal has to provide a more high-powered incentive to him in order to overcome the negative externality of peer pressure and induce effort. Thus, when the degree of heterogeneity is significant, the principal must adjust incentives in different directions according to the type of agent.

# 5 The Effects of Peer Pressure on Organizational Forms

This section studies whether the principal can save the payment to the agents by making use of the effects of peer pressure and we examine this issue in terms of the optimal organizational forms. Suppose that there exist two more productive agents and two less productive agents and that the principal has to divide these four agents into two groups each of which consists of exactly two agents. Then, how should the principal allocate these agents to each of the groups? In this situation, the principal can design two types of organizational forms: one is

[8] To confirm that this result is really guaranteed, we have to show that there exists the range of $d_2/d_1$ such that $1 + 1/\gamma \leq d_2/d_1 < 1 + (l - \alpha)/\alpha(1 - l)$. Then, such a range exists if $(\alpha + \alpha\gamma)/(\alpha + \gamma) < l$. There exist some $\gamma$ that satisfy this inequality when $\alpha < l$ $(< 1)$. Here, this inequality is more feasible if $\gamma$ becomes larger because $(\alpha + \alpha\gamma)/(\alpha + \gamma)$ is decreasing in $\gamma$.

that she allocates the same type of agents to a same group (Form $A$); and the other is that she allocates the different type of agents to a same group (Form $B$). Note that we can see that the latter has the form where there exist two groups with peer pressure and that the former has the form where there exist two groups without peer pressure because there is no peer pressure if two agents in the same group are homogeneous in terms of the productivity. In this section, we again focus on the case where the agency problem remains, that is, the case where $\alpha < l$ and $d_2/d_1 < 1 + (l-\alpha)/\alpha(1-l)$.

Let $W^* \equiv w_1^{s*} + w_2^{s*}$ and $\overline{W}^* \equiv \bar{w}_1^{s*} + \bar{w}_2^{s*}$. Then, we can represent $W^*$ and $\overline{W}^*$ in the following way.

$$W^* = \frac{d_1 + d_2}{\Delta_p}, \tag{8}$$

$$\overline{W}^* = \frac{d_1 + d_2 + \alpha\{\gamma d_2 - (2+\gamma)d_1\}}{\Delta_p} \tag{9}$$

The expected payment to the agents when the principal chooses Form $A$ is $2W^*$, while when she chooses Form $B$ is $2\overline{W}^*$. Therefore, we can conclude that the principal can save the payments to the agents by the effects of peer pressure if $W^* > \overline{W}^*$. This condition can be replaced with:

$$\frac{d_2}{d_1} < 1 + \frac{2}{\gamma}. \tag{10}$$

Intuitively, the principal's payment in Form $A$ is smaller than that in Form $B$ if the heterogeneity is so significant that (10) cannot hold. However, when the heterogeneity is moderate so that (10) holds, the room to save her payment appears by taking Form $B$ rather than Form $A$. Remembering the discussion in the previous section, we can understand this result when $\frac{d_2}{d_1} < 1 + \frac{1}{\gamma}$ because the principal can weaken the incentives to both types of the agents by peer pressure. In addition, (10) implies that the principal can also save the payments even when she has to give the higher-powered incentive to the less productive agents to reduce the negative externality by peer pressure. The possibility that the principal can save the payment is decreasing in $\gamma$. Thus, the principal receives more benefit from peer pressure when the agents do not feel much peer pressure, that is, when his effort cost is above his colleague's cost. This probability is also decreasing in $l$ but increasing in $\alpha$. From this point, as peer pressure and the cooperation between agents becomes significant, the principal is more likely to be better off by designing the organizational forms such that the agents feel peer pressure.

# 6 Concluding Remarks

This paper studies the effects of peer pressure on optimal incentive schemes in the situation where the heterogeneous agents receive a psychological payoff from the comparison of their effort costs. We show that optimal incentive schemes depend on parameters such as the degree of peer pressure and that of heterogeneity of agents' productivity levels. We additionally examine the possibility that the principal can be better off by making use of the effects of peer pressure when she designs the organizational forms. Although our model seems to be a simple and specific one, we can clearly illustrate the effects of peer pressure among heterogeneous agents. We hope that this paper is helpful in developing a more general model of peer pressure, or more generally, the psychological effects on incentives.

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