OTHER REGARDING PRINCIPAL AND MORAL HAZARD WITH MULTIPLE AGENTS[♠]

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Abstract:

We analyze a principal multi-agent interaction where the agents are other-regarding vis-à-vis themselves and the principal is other-regarding vis-à-vis the agents. We show that when projects are 'not highly controllable' both team contracts and relative performance contracts can be optimal if the principal is 'status seeking' or 'not too inequity-averse'. But an extreme independent contract is optimal when the principal is sufficiently inequity averse. Similar results hold when the projects of the agents are correlated as well. Also the agents are generally (weakly) better-off under a 'sufficiently inequity averse' principal compared to a 'status seeking' or 'moderately inequity-averse' principal. With a 'fair' principal, ceteris paribus, team contracts are more likely over relative performance contracts compared to the standard 'other-regarding' principal.

Keywords: *Other regarding preferences, self regarding preferences, inequity-averse, status- seeking, optimal contract.*

JEL: D86, D63, M52.

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1. Introduction:

It is now well known that economic agents are not always motivated by self-interest. People do care about others and react in fair, altruistic ways or may have a feeling of envy or spite if others do well compared to her. From the 'ultimatum game' experiment of Guth, Schmittberger & Schwarze (1982) to the recent social experiments by Camerer (2003) show the existence of other-regarding preferences in behavioural decision making[1]. Since people's attitude towards other's wellbeing is crucial for incentive design, relaxing the self-regarding hypothesis is crucial in the theory of contracts for a better understanding of optimal incentive design. Several papers (we will discuss those below) have analyzed optimal incentive design in a multi agent framework with other-regarding agents, but none with other-regarding principal. This paper is a small step in plugging that gap where we analyze the optimal contract design of an other-regarding principal interacting with multiple other-regarding agents using the framework proposed in Itoh (2004). Specifically we have an other regarding principal who is other regarding vis-a-vis the agents. The principal can be 'inequity-averse' or 'status-seeking'. To keep things simple and reasonably tractable we assume the agents to be ex-ante symmetric, therefore the nature and extent of other-regardingness of the principal is similar towards both the agents. We assume the principal to be 'never behind' the agents. The agents are also other-regarding but among themselves. They are not other regarding vis-a-vis the principal. This particular assumption stems from a large body of sociological literature which proposes that people are more likely to compare themselves with persons who are similar in terms of personal characteristics and similar in positions/hierarchy in an organization. Although technically the agents might care

[1] For more see Fehr and Schmidt (2003).

about the principal's wellbeing but it is more likely that agents will go for 'lateral' comparison compared to a 'vertical' one (Baron 1998) and we assume that the agents are other regarding vis-à-vis themselves. Also since the principal doesn't have anyone 'lateral' in our model, she is assumed to be other-regarding vis-a-vis the agents.

Given the above structure we show that with 'not so high inequity-averse' or 'status seeking' agents, a moderately inequity averse or status seeking principal will optimally offer an 'extreme relative performance contract', whereas she will offer an 'extreme team contract' if the agents are 'sufficiently inequity averse'. These optimal contracts mentioned above are very similar to what we get in Itoh (2004) with self-regarding principal. The interesting change comes where the principal is 'sufficiently in-equity averse'. In that case the principal will optimally offer an 'extreme' independent contract that minimizes her ex-ante welfare loss from being ahead, at the same time keeping the work incentives intact. Therefore with other regarding principal, along with team contracts and relative performance contracts, an independent contract can also be optimal which were not the case in Itoh (2004) and other papers in multi agent framework with other-regarding agents and self-regarding principal. This alerts us to the importance of the social preferences that the principal might have and its impact on the optimal incentive design within organizations. In fact as we will see similar results hold if we assume the project outcomes of both the agents to be correlated. Finally we extend our analysis and consider the case of a 'fair' principal who experiences a reduction in utility when the agents get different wages. We get that team contracts are more likely compared to relative performance contracts under a 'fair' principal compared to the standard case where the principal is other-regarding vis-a-vis the agents. We also get that relative performance contracts are never optimal when a fair principal interacts with a self-regarding agent.

Quite a few papers have analyzed optimal incentive design in a multi agent framework with other-regarding agents. Itoh (2004) analyzed the interaction of a self-regarding principal with two other-regarding agents. The agents can be inequity averse or status seeking. He shows that the principal can exploit the other-regarding nature of the agents by designing appropriate interdependent contracts, viz. team and relative performance contracts. He also considers the case where the agents' projects are affected by a common shock, i.e. when the projects are correlated and show that team contracts can be optimal under certain situations.

Apart from Itoh (2004) various other papers have addressed optimal incentive design with other-regarding agents in multi-agent situations but with self-regarding principal. Grund and Sliwka (2005) study rank-order tournaments among inequity-averse agents and show that inequity-averse agents exert more effort compared to self-regarding agents for a given contract. They also show that first best effort is not implementable if prizes are endogenous. Bartling and Siemens (2010) analyze the impact of envy on optimal incentive contracts in a standard moral hazard model but with a fairly general structure. They show that with risk-averse agents and without limited liability, envy leads to a tendency towards offering flat wage contracts within firms. Dur and Sol (2010) construct a principal agent model where agents in addition to productive activities also engage in social interaction that leads to co-worker altruism. They examine how both team incentives and relative performance incentives help in creating a good work climate. Englmaier and Wambach (2010) has a small section with multiple agents where they show that for inequity averse agents team incentives can be optimal even if the tasks that the agents perform are technologically independent. Bartling (2011) use a principal-multi agent model where agents can be both inequity-averse or status seeking. He shows that team contracts can be optimal even if the agents' performance measures are positively correlated. The paper also shows that optimal incentive contracts for other-regarding agents can be low-powered as compared to contracts offered to purely self-regarding agents. Other papers that address the effect of social comparison in multi agent setting are Dernougin and Fluet (2006), Goel and Thakor (2006), Neilson and Stowe (2010) and Rey Biel (2008). Whereas Dernougin and Fluet (2006) and Neilson and Stowe (2010) assume risk neutral agents, Goel and Thakor (2006) considers risk averse agents. Neilson and Stowe (2010) focus on piece rate contracts only and show conditions under which inequity-aversion leads to higher optimal effort exerted by workers and firms set lower piece rates than they would otherwise. Goel and Thakor (2006) show that envy among agents can lead to low-powered optimal team incentives. Rey Biel (2008) in a multi agent framework show that even with contractible effort inequity-aversion of workers can justify the optimality of team production. But all the above mentioned papers assume principal to be self regarding whereas this paper specifically focuses on an other-regarding principal and her interaction with agents who are other-regarding among themselves.

This paper can be regarded as a multi agent extension of Banerjee and Sarkar (2017) and a generalization of Itoh (2004)'s multi agent model with other regarding agents. Banerjee and Sarkar (2017) analyzed optimal incentive design when an other-regarding principal interacts first with a self-regarding and then an other-regarding agent. This paper focused on a principal-single agent interaction whereas here we have multiple (two) agents.

Itoh (2004)'s multi agent model can be viewed as a special case of our model. Put differently this paper generalizes Itoh (2004) with an other-regarding principal.

Two comments on the modeling choice that we employ a la Itoh (2004) are warranted. First, the structure is simple and brings out the principal-agent interactions and the impact of the interdependent preferences on optimal incentive design clearly. Second, almost all existing results and more can be generated using this parsimonious structure. Therefore, additional complication of the analytical structure will come at a cost which might outweigh its advantage.

The rest of the paper is organized as follows: In section 2 we examine the interaction of an other-regarding principal and two other-regarding agents where the project outcomes are independent. In section 3 we analyze optimal contracts when the project outcomes of the agents are correlated. Section 4 provides an alternative specification. In section 5 we re-interpret other-regarding principal as a 'fair' principal who hates inequity among agents and analyze optimal contracts. Finally section 6 provides concluding remarks and throws some light on possible future works.

2. Other Regarding Principal and Other-Regarding Agents:

2.1: The Model:

Assume an other-regarding principal who hires two other-regarding agents 1 and 2. The principal is other-regarding with respect to the agents but the agents are other-regarding among themselves. Thus for the time being we assume that the principal doesn't belong to the agents' reference group. This is in line with Itoh (2004). Therefore currently each agent cares about the payoff of the other agent. Both the principal and agents are assumed to be risk-neutral. Each agent engages in a project separately. The agents can choose either high or low effort denoted by e_1 and e_0 respectively where $e_1 > e_0$[2]. Effort is unobservable and hence non-verifiable. Cost of putting e_1 is d and 0 for e_0. Each project can either succeed or fail. Each project returns b in case of success and 0 in case of failure which are verifiable. In case the agent puts e_i the project succeeds with probability p_i, $i = 0,1$ and it is assumed that $1 > p_1 > p_0 > 0$. Denote $\Delta p = p_1 - p_0$. For the time being we assume that there is no correlation. The timing of the game is as follows: the principal simultaneously offers a contract to both the agents which are defined below. The agents simultaneously decide whether to accept or reject the contract. If rejected by at least one agent the game ends and each agent receives her reservation utility which is normalized to zero. If both agents accept the contract, they choose actions simultaneously. The outcomes of the projects are realized and transfers are made according to the terms of the contract. Since our paper follows the structure of Itoh (2004) we follow Itoh's notation henceforth.

Let w^n_{jk} be the payment scheme offered to agent n where the outcome of his project is j and the outcome of the other agent's project is k, $j,k = s,f$. Thus for agent n the feasible set of contract looks like $w^n = \{w^n_{ss}, w^n_{sf}, w^n_{fs}, w^n_{ff}\}$ where the following limited liability constraint is satisfied

$$w^n_{jk} \geq 0, \quad j,k = s,f,\ n = 1,2. \tag{1}$$

The utility function of agent n is given as

$$U_n = \begin{cases} w^n_{jk} - d_i - \alpha_n \gamma_n v_n (w^n_{jk} - w^m_{kj}); & when\ \ w^n_{jk} \geq w^m_{kj} \quad (Agent\ n\ ahead) \\ w^n_{jk} - d_i - \alpha_n v_n (w^m_{kj} - w^n_{jk}); & when\ \ w^n_{jk} \leq w^m_{kj} \quad (Agent\ n\ behind) \end{cases} \tag{2}$$

[2] Our intuition goes through even with continuum of effort choices.

where $i = 0,1$, $j,k = s,f$, $n,m = 1,2$ and $n \neq m$.

$\alpha_n \geq 0$ is the other-regarding parameter. $\alpha_n = 0$ implies that the agents are self-regarding among themselves. We also make the standard assumption that $v_n'(z) > 0 \quad \forall z$ and $v_n(0) = 0$. The constant γ_n captures situations where the n^{th} agent is 'inequity averse' or 'status seeking'. If $\gamma_n < 0$, the agent is 'status seeking'[3] whereas when $\gamma_n > 0$ the agent is 'inequity averse'. Also when an agent is behind then she is always 'inequity averse'. Again in line with Fehr and Schmidt (1999) and Itoh (2004) we assume that $|\gamma_n| < 1$ implying that 'inequity-averse agent dislikes inequity at least as much when he is behind as when he is ahead' (Fehr and Schmidt (1999)). For a status seeking agent this implies that a 'status-seeking agent likes to be ahead no better than he likes to avoid being ahead' (Itoh (2004)).

We assume b to be sufficiently high so that the principal would like to implement high effort from both the agents. Now the principal is other regarding vis-à-vis both the agents. To fix ideas we assume that the principal is always ahead (at least weakly) of the agents. In line with Fehr and Schmidt (1999) we assume the principal's utility function with respect to agent n to be of the following form:

$$U^P = b_j - w_{jk}^n - \pi\rho f(b_j - 2w_{jk}^n); \quad \sin ce\ b_j - w_{jk}^n \geq w_{jk}^n \tag{3}$$

where the outcome of the n^{th} agent is j and of the other agent is k.

The parameter $\pi > 0$, a constant, captures the extent to which the principal cares about any agent's material payoff. $\pi = 0$ implies that the principal is self-regarding. ρ, another constant, captures situations where the principal is either 'inequity averse' or 'status seeking'. If $\rho < 0$, the principal prefers to increase the difference in payoffs vis-à-vis an

[3] This terminology is due to Neilson and Stowe (2003).

agent when he is ahead, i.e. the principal is 'status seeking'[4]. If $\rho > 0$, the principal's utility is decreasing in the difference in payoffs between the principal and the agent and therefore the principal is said to be 'inequity averse', even if he is ahead. Along with this we make the standard assumptions that $f(0) = 0$ and $f'(z) > 0$ for $z > 0$.

Again to keep things simple and tractable we make the following simplifying assumptions (similar to Itoh (2004)):

Assumption 1:

(a). We assume the agents to be symmetric, i.e. $\alpha_1 = \alpha_2 = \alpha$, $\gamma_1 = \gamma_2 = \gamma$ *and* $v_1(.) = v_2(.) = v(.)$.

(b). We assume $v(.)$ *to be linear, i.e.* $v(z) = z, \forall z \geq 0$.

(c). We assume $f(.)$ *to be linear, i.e.* $f(z) = z, \forall z \geq 0$.

(d). We focus on symmetric contracts, i.e. $w^1 = w^2$.

(e). $\alpha\gamma \leq 1$.

(f). $\pi\rho \leq 1$.

For tractability of our model we focus on symmetric agents. In assumption 1(b) and 1(c) we assume agents and the principal to be linearly other regarding. This is in line with Fehr and Schmidt (1999)'s original specification. Since agents are assumed to be symmetric, without loss of generality we focus on symmetric contracts (assumption 1(d)). Finally assumption 1(e) rules out the case that the agent who is ahead and inequity averse transfers some of his income to the other agent who is behind which seems implausible. 1(f) rules out the trivial

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[4] This terminology is due to Neilson and Stowe (2003).

case of an inequity-averse principal transferring some of her income to the agents who are behind such that payoff differences are eliminated always.

Given above, the principal will maximize her expected utility subject to the participation constraint and the Nash incentive compatibility constraints of the agents. Since we focus on symmetric contracts, henceforth, we will suppress the superscripts. Again in line with Itoh (2004) without loss of generality we focus on contracts where the limited liability binds, i. e. $w_{fs} = w_{ff} = 0$. The expected utility of the principal can be written as

$$E(U^P) = 2p_1^2[b - w_{ss} - \pi\rho(b - 2w_{ss})] + 2p_1(1 - p_1)[b - w_{sf} - \pi\rho(b - 2w_{sf})] \quad \text{since } b_j - w_j \geq w_j \tag{4}$$

The principal will maximize above subject the following Nash incentive compatibility constraint

$$p_1 w_{ss} + (1 - p_1)w_{sf} + [p_1 - (1 - p_1)\gamma]\alpha w_{sf} \geq \frac{d}{\Delta p} \tag{5}$$

And the following participation constraint

$$p_1 w_{ss} + (1 - p_1)w_{sf} - (1 - p_1)\alpha(1 + \gamma)w_{sf} \geq \frac{d}{p_1} \tag{6}$$

Definition: *A contract w is a 'team contract' if $w_{ss} > w_{sf}$. If $w_{ss} < w_{sf}$ then w is a 'relative performance contract'. If $w_{ss} = w_{sf}$ then w is referred to as an 'independent contract'.*

Before we proceed we re-iterate that the principal is always ahead (at least weakly) implies that b is sufficiently high such that it is optimal for the principal to elicit high effort from both the agents and $\frac{b}{2}$ will exceed both the extreme team and the relative performance wages. As we proceed we will put forward a technical exposition once we define extreme team and relative performance wages.

Similar to Itoh (2004) one can easily state the following benchmark result:

Result 1 (Itoh 2004)**:**

For self regarding principal and agents the independent contract $w_{ss} = w_{sf} = d / \Delta p$ *is an optimal contract.*

At the optimum the incentive compatibility constraint will bind and if $\alpha = 0$ and $\pi = 0$ then the binding incentive constraint becomes $p_1 w_{ss} + (1 - p_1) w_{sf} = \frac{d}{\Delta p}$. One can easily check that $w_{ss} = w_{sf} = \frac{d}{\Delta p}$ solves the incentive constraint and also satisfies the participation constraint and therefore the above contract is an optimal contract. Needless to point out that one can find other multiple optimal contracts as well which satisfies both the incentive compatibility and the participation constraint with $\alpha = 0$ and $\pi = 0$. Next we explore optimal contracts with other regarding principal and agents.

2.2: Analysis of Optimal Contracts:

To fix ideas we start by analyzing the behavior of an inequity-averse principal, i.e. $\rho > 0$. One can rewrite the principal's objective function given in (6) in the following way:

$$E(U^P) = 2 p_1 b(1 - \pi\rho) - 2 p_1 (1 - 2\pi\rho)\left[p_1 w_{ss} + (1 - p_1) w_{sf}\right] \qquad \text{(6a)}$$

If $\pi\rho < \frac{1}{2}$ implying that the principal is not sufficiently inequity-averse, the principal is effectively minimizing her expected payment and therefore is better-off paying lower wages. Thus taking into account the binding Nash incentive compatibility for other-regarding agents (given in (4)) re-written as $p_1 w_{ss} + (1-p_1)w_{sf} \geq \frac{d}{\Delta p} + [(1-p_1)\gamma - p_1]\alpha w_{sf}$, if $(1-p_1)\gamma > p_1$ implying $p_1 < \frac{\gamma}{1+\gamma}$ the principal will optimally set $w_{ss} > 0$ and $w_{sf} = 0$. Otherwise when $(1-p_1)\gamma < p_1$ holds implying $p_1 > \frac{\gamma}{1+\gamma}$ the principal will optimally set $w_{sf} > 0$ and $w_{ss} = 0$. In line with Itoh (2004) we define the extreme team wage $\hat{w}_{ss}$ and the extreme relative performance wage $\hat{w}_{sf}$ as follows:

$$\hat{w}_{ss} = \frac{d}{\Delta p} \cdot \frac{1}{p_1} \tag{7}$$

$$\hat{w}_{sf} = \frac{d}{\Delta p} \cdot \frac{1}{(1-p_1) + \alpha[p_1 - (1-p_1)\gamma]} \tag{8}$$

$\hat{w}_{ss}$ is found by putting $w_{sf} = 0$ in (4) and $\hat{w}_{sf}$ is found by replacing $w_{ss} = 0$ in (4). Also we define the team wage and the relative performance wage when both (4) and (5) binds and is given below:

$$\overline{w}_{ss} = \frac{d}{\Delta p} \cdot \frac{p_0(1-p_1)}{p_1^{\ 2}} \left[\frac{p_1 / p_0}{(1-p_1)/(1-p_0)} - \frac{1-\alpha\gamma}{\alpha} \right] \tag{9}$$

$$\overline{w}_{sf} = \frac{d}{\Delta p} \cdot \frac{p_0}{\alpha p_1} \tag{10}$$

Given that we have defined the extreme team wage and the extreme relative performance wage we clarify the following technical point. Since the principal is always ahead (at least weakly) this implies that $\frac{b}{2} > \frac{d}{\Delta p} \cdot \frac{1}{p_1}$ and $\frac{b}{2} > \frac{d}{\Delta p} \cdot \frac{1}{(1-p_1) + \alpha[p_1 - (1-p_1)\gamma]}$ holds. One can make specific assumptions on the relative magnitude of $\hat{w}_{ss}$ and $\hat{w}_{sf}$, in that case only one condition is needed which is not necessary at this stage. It can be shown that the previous conditions automatically imply that the principal will optimally implement high effort from both the agents and therefore we do not need any additional restriction on b.

Given above we state our next proposition which is in some sense a generalization of Itoh (2004).

Proposition 1:

If the Principal is inequity averse ($\rho > 0$ *) and* $\pi\rho < \frac{1}{2}$ *holds then*

(i). The extreme team contract $(\hat{w}_{ss}, 0)$ *is optimal if* $(1 - p_1)\gamma > p_1 \Rightarrow p_1 < \frac{\gamma}{1+\gamma}$ *holds. The principal's payoff is independent of the agents' other-regardingness.*

(ii).The extreme relative performance contract $\{0, \hat{w}_{sf}\}$ *is optimal if both* $(1 - p_1)\gamma < p_1 \Rightarrow p_1 > \frac{\gamma}{1+\gamma}$ *and* $\frac{p_1 / p_0}{(1 - p_1)/(1 - p_0)} \leq \frac{1 - \alpha\gamma}{\alpha}$ *holds. The principal benefits the more other regarding the agents are.*

(iii). $\{\overline{w}_{ss}, \overline{w}_{sf}\}$ *is optimal if both* $p_1 > \frac{\gamma}{1+\gamma}$ *and* $\frac{p_1 / p_0}{(1 - p_1)/(1 - p_0)} > \frac{1 - \alpha\gamma}{\alpha}$ *holds. The principal is better-off dealing with more other-regarding the agents.*

(iv). If $\rho > 0$ and $\pi\rho = \frac{1}{2}$ *holds then any contract that satisfies equation (5) is optimal.*

Proof:

We proceed in line with Itoh (2004).

(i). If $(1-p_1)\gamma > p_1$ (implying $p_1 < \frac{\gamma}{1+\gamma}$) the incentive compatibility constraint binds at $\{\hat{w}_{ss}, 0\}$. Also since $p > \Delta p$, $\{\hat{w}_{ss}, 0\}$ satisfies the participation constraint (given in (5)) and therefore is an optimal contract. Assumption 3 ensures that $E(U^P) > 0$ under $\{\hat{w}_{ss}, 0\}$.

(ii). If $(1-p_1)\gamma < p_1$ (implying $p_1^* > p_1 > \frac{\gamma}{1+\gamma}$) holds, then incentive compatibility constraint binds at $\{0, \hat{w}_{sf}\}$. For $\{0, \hat{w}_{sf}\}$ to satisfy the participation constraint we need $\frac{d}{\Delta_P}\frac{(1-p_1)[1-\alpha(1+\gamma)]}{(1-p_1)+\alpha[p_1-(1-p_1)\gamma]} \geq \frac{d}{p_1}$ to hold which can be calculated as $\frac{p_1/p_0}{(1-p_1)/(1-p_0)} \leq \frac{1-\alpha\gamma}{\alpha}$. Also $E(U^P) > 0$ under $\{0, \hat{w}_{sf}\}$ if $b > \frac{d}{\Delta p}.\frac{(1-2\pi\rho)}{(1-\pi\rho)}.\frac{1}{1+\alpha[p_1-(1-p_1)\gamma]/(1-p_1)}$ holds which is ensured since $\frac{b}{2} > \frac{d}{\Delta p}.\frac{1}{(1-p_1)+\alpha[p_1-(1-p_1)\gamma]}$ and $(1-p_1)\gamma < p_1$ holds.

(iii). If $(1-p_1)\gamma < p_1$ and $\frac{p_1/p_0}{(1-p_1)/(1-p_0)} > \frac{1-\alpha\gamma}{\alpha}$ holds then both the incentive compatibility and the participation constraints bind with equality and solving those we get $\{\overline{w}_{ss}, \overline{w}_{sf}\}$ as the optimal contract.

(iv). When $\pi\rho = \frac{1}{2}$ holds then the principal needs to ensure that the agents put in high effort and any wage profile that will ensure this happens will be optimal. **QED**

The principal has the following two incentive effects. First, if the principal pays a reduced wage she is better-off through the 'direct' effect. But since the principal is inequity averse and also is ahead, she suffers from being ahead and experiences a reduction in utility and therefore would optimally want to reduce wage inequality by paying an increased wage. This is the 'indirect' effect. If the principal is not sufficiently 'inequity-averse' the direct effect dominates the indirect effect and therefore the principal would like to pay as less as possible. Put differently the principal effectively minimizes her expected wage payment and we get back the Itoh (2004) case. Suppose the principal is 'not sufficiently inequity-averse'. Given this we consider the incentive effects of the agents. Note that the agents are other regarding vis-à-vis themselves and not the principal. An agent falls behind if she fails and the other agent succeeds. If she is behind she is inequity averse and therefore suffers a utility loss. Therefore the agent will try and reduce the probability of falling behind and this is a 'positive incentive effect'. But if she is successful and the other agent fails she is ahead. Now if she is 'inequity averse' ($\gamma > 0$) then she suffers from being ahead and would again suffer a utility loss and would like to reduce her probability of success. This acts as a 'negative incentive effect' for 'inequity-averse' agents. If $(1-p_1)\gamma > p_1$ holds implying γ (the inequity aversion switch) is sufficiently high then the 'negative incentive effect' dominates and therefore the optimal wage scheme offered by the principal have to be such that the impact of inequity-aversion is minimized and this is done through the extreme 'team contract'. This is stated in part (i) of proposition 1. Under the team contract both agents always get the same amount and therefore is 'fair' in some sense. Because of this feature the principal's payoff is independent of the extent to which the agents are other-regarding towards each other.

When $(1-p_1)\gamma < p_1$ holds, i.e. γ is sufficiently low, the first 'positive incentive effect' dominates the 'negative' one. Here the principal will optimally adopt the relative performance contract and will thus generate the possibility of inequity. When the participation constraint does not bind then the principal will optimally offer a tournament-type extreme relative performance contract thus exploiting the positive incentive effect. This is part (ii) of proposition (1). Note that when the agents are status seeking while ahead, both the incentive effects are 'positive' and therefore an extreme relative performance contract will be optimum.

When both $(1-p_1)\gamma < p_1$ and $\frac{p_1/p_0}{(1-p_1)/(1-p_0)} > \frac{1-\alpha\gamma}{\alpha}$ holds implying that the project outcomes are sufficiently informative in terms of effort choice and the agents are sufficiently other-regarding implying high α the participation constraint binds and the principal will optimally offer wages such that both the participation constraint and the incentive compatibility constraint binds. Put differently positive amounts will be paid to the agents irrespective of whether the project succeeds or fails. The principal will not offer the extreme relative performance contract anymore. Finally when $\pi\rho = \frac{1}{2}$ holds the principal's payoff becomes independent of the wages that she pays. In that case she only needs to ensure that the agents put in high effort. Thus any wage combination that satisfies the Nash incentive compatibility will be optimum. The previous analysis is done for a 'moderately inequity' averse principal. The following result talks about a 'status seeking' principal.

Result 2: *If the principal is status seeking, i.e.* $\rho < 0$ *holds then the optimal contracts characterized in (i), (ii) and (iii) in proposition 1 are optimal.*

The intuition of the above result is not difficult to comprehend. Since a status seeking principal always wants to be ahead, she is better off paying as less as possible and therefore will pay enough such that the incentive compatibility constraint of the agents are satisfied. In other words the principal will be minimizing expected wage payment and given the incentive effects of the agents as discussed above are present, similar intuition (as above) suggests that the optimal contracts given in (i), (ii), and (iii) of proposition1 depending on the parametric ranges will be optimal.

Next we consider the case where the principal is sufficiently inequity averse. The result is stated in the next proposition:

Proposition 2:

(A). If the principal is sufficiently inequity averse ($\rho > 0$) in the sense that $\pi\rho > \frac{1}{2}$ holds then the extreme independent contract $w_{ss} = w_{sf} = \frac{b}{2}$ is optimal and unique. This holds irrespective of the degree of other-regardingness of the agents.

The feasibility and optimality of the extreme independent contract is ensured by the assumption that the principal is never behind, implying both $\frac{b}{2} > \frac{d}{\Delta p} . \frac{1}{p_1}$ and $\frac{b}{2} > \frac{d}{\Delta p} . \frac{1}{(1 - p_1) + \alpha[p_1 - (1 - p_1)\gamma]}$. One can again explain the above result through the interaction of the 'direct' and the 'indirect' effects. If the principal pays less then she is better off through the 'direct effect' of paying less. But at the same time remember that she is ahead and being 'inequity-averse' she hates to be ahead. Therefore if she pays less she is worse off since she is now 'more ahead' which she hates. This second 'indirect effect' dominates if the principal is sufficiently 'inequity-averse' and therefore the principal will optimally increase the wage such that at the optimum no inequity remains. Therefore if $\pi\rho > \frac{1}{2}$, irrespective of the parametric ranges, the principal will offer $w_{ss} = w_{sf} = \frac{b}{2}$ which is nothing but an 'elevated' independent contract. Interestingly this contract is also unique and the above result is different to what we get in Itoh (2004) with self regarding principal and other-regarding agents.

3. Correlated Outcomes:

We now extend our analysis to the case where the project returns are correlated. It is pretty well known in the standard principal-agent literature that with purely self-interested principal and agents relative performance evaluation is optimal when the agents' performances are positively correlated (Holmstrom (1982), Mookherjee (1984)). But the analysis of the previous section points to the fact that team contracts or even independent contracts might turn out to be optimum in the correlated environment. This motivates us to examine the case where the agents' projects are correlated. Specifically, now the project outcomes of each agent not only depend on their respective efforts and the idiosyncratic shock, but also on a common shock that affects the outcome of both projects. The common shock is good with probability q and bad with probability $(1-q)$. If the common shock is good then both projects succeed irrespective of the agents actions. If the common shock is bad then the project outcome depends on the agents' actions and the idiosyncratic shock, i.e. each agents' project succeeds with probability p_1 if she puts high effort and succeeds with probability p_0 if she puts in low effort. Taking everything together now effectively each agent's project succeeds with probability $q+(1-q)p_1$.[5] The principal is other regarding according to the previous section. Internalizing the binding limited liability constraints one can write the expected utility function of the principal as

$$E(U^P) = 2q[b - w_{ss} - \pi\rho(b-2w_{ss})] + (1-q)[2p_1^2(b - w_{ss} - \pi\rho(b-2w_{ss})) + 2p_1(1-p_1)(b - w_{sf} - \pi\rho(b-2w_{sf}))] \tag{11}$$

$\sin ce\, b_j - w_j \geq w_j$ holds.

Now the above expected payoff can also be expressed as

$$E(U^P) = 2b(1-\pi\rho)[q+(1-q)p_1] - 2(1-2\pi\rho)[qw_{ss} + (1-q)p_1(p_1 w_{ss} + (1-p_1)w_{sf})] \tag{12}$$

The principal will maximize the above expected payoff subject to the following incentive compatibility and the participation constraints given as (similar to Itoh (2004)) follows:

$$(1-q)[p_1 w_{ss} + (1-p_1)w_{sf} + (p_1 - (1-p_1)\gamma)\alpha w_{sf}] \geq \frac{d}{\Delta p} \tag{NIC2}$$

$$(1-q)[p_1 w_{ss} + (1-p_1)w_{sf} - (1-p_1)\alpha(1+\gamma)w_{sf}] \geq \frac{d - qw_{ss}}{p_1} \tag{PC2}$$

Similar to the previous section one can define the extreme team wage w'_{ss} and the extreme relative performance wage w'_{sf} as

$$w'_{ss} = \frac{d}{\Delta p} \cdot \frac{1}{(1-q)p_1} \tag{13}$$

$$w'_{sf} = \frac{d}{\Delta p} \cdot \frac{1}{(1-q)[(1-p_1) + \alpha(p_1 - (1-p_1)\gamma)]} \tag{14}$$

[5] Given this framework, Che and Yoo (2001) with self-regarding principal and agents show that the extreme relative performance contract is optimal.

Thus $\{w'_{ss}, 0\}$ and $\{0, w'_{sf}\}$ will be the extreme team and relative performance contracts such that the above incentive compatibility constraint (IC2) binds. Given this we can therefore state the following proposition that corresponds to this correlated environment:

Proposition 3:

(A). If the Principal is status-seeking ($\rho < 0$) or inequity averse ($\rho > 0$) with $\pi\rho < \frac{1}{2}$ then

(i). The extreme team contract $\{w'_{ss}, 0\}$ is optimal if $\gamma > \frac{p_1}{(1-p_1)} \Rightarrow p_1 < \frac{\gamma}{1+\gamma}$ holds.

(ii).The extreme relative performance contract $\{0, w'_{sf}\}$ is optimal if both $p_1 > \frac{\gamma}{1+\gamma}$ and $\frac{p_1 / p_0}{(1-p_1)/(1-p_0)} \leq \frac{1-\alpha\gamma}{\alpha}$ holds.

(iii). $\{\overline{\overline{w}}_{ss}, \overline{\overline{w}}_{sf}\}$ is optimal if both $\gamma < \frac{p_1}{(1-p_1)} \Rightarrow p_1 > \frac{\gamma}{1+\gamma}$ and $\frac{p_1 / p_0}{(1-p_1)/(1-p_0)} > \frac{1-\alpha\gamma}{\alpha}$ holds.

(B). If the principal is sufficiently inequity averse ($\rho > 0$) in the sense that $\pi\rho > \frac{1}{2}$ holds then the independent contract $w_{ss} = w_{sf} = \frac{b}{2}$ is optimal.

(C). If $\rho > 0$ and $\pi\rho = \frac{1}{2}$ holds then any contract that satisfies (IC2) are optimal.

In the above proposition $\{\overline{\overline{w}}_{ss}, \overline{\overline{w}}_{sf}\}$ are the team and the relative performance wages such that (IC2) and (PC2) binds. Note that the principal's expected payment is independent of the common shock when she offers the relative performance contract, i.e. the principal is able to filter out the common shock through the relative performance contract as in

Holmstrom (1982). The team contract is still optimum even with a small but positive shock. The intuition of the above proposition will be similar to that of proposition 1 and 2.

Interestingly when the principal is sufficiently inequity averse then the 'extreme' independent contract is still optimal in the correlated environment as well. This is different from what we get in Holmstrom (1982), Mookherjee (1984) and Che and Yoo (2001) with self-regarding preferences and with Itoh (2004) with other regarding preferences. In this situation the expected payment of the principal does depend on the common shock.

4. Alternative Specification:

One can extend the previous analysis by assuming that the principal and the agents compare their payoffs net of the cost of effort. The agents might be able to observe their actions (if they work closely) and the principal might be able to monitor the agents and judge each agents actions correctly and therefore both the principal and agents might take into account effort costs while comparing payoff differences. Given above the nth agents' payoff function will look like

$$U_n = \begin{cases} w_{jk}^n - d_i - \alpha_n \gamma_n v_n (w_{jk}^n - d_i - w_{kj}^m + d_h); & when \;\; w_{jk}^n - d_i \geq w_{kj}^m - d_h \;\; (Agent\; n\; ahead) \\ w_{jk}^n - d_i - \alpha_n v_n (w_{kj}^m - d_h - w_{jk}^n + d_i); & when \;\; w_{jk}^n - d_i \leq w_{kj}^m - d_h \;\; (Agent\; n\; behind) \end{cases} \tag{15}$$

where $h, i = 0,1$, $j,k = s, f$, $n,m = 1,2$ and i and h are the index of agent n^{th} and m^{th} actions respectively, given $n \neq m$.

Again the principal's payoff function with respect to the n^{th} agent will be

$$U^P = b_j - w_{jk}^n - \pi\rho(b_j - 2w_{jk}^n + d_i); \quad \sin ce\; b_j - w_{jk}^n \geq w_{jk}^n - d_i$$

where d_i is the effort cost of the n^{th} agent. Once again the principal will be ahead if we take into account the agents' effort cost. Imposing symmetry and assuming $d_i = d$ for $e = e_1$ and $d_i = 0$ for $e = e_0$ the principal's expected payoff can be written as

$$E(U^P) = 2p_1 b(1-\pi\rho) - 2p_1(1-2\pi\rho)\left[p_1 w_{ss} + (1-p_1)w_{sf}\right] - 2\pi\rho\, d$$

A necessary condition for an optimal contract to exist under this changed specification is $p_1 b(1-\pi\rho) > \pi\rho\, d$ i.e. $b > \frac{\pi\rho}{(1-\pi\rho)}\frac{d}{p_1}$. Similar to our previous approach we analyze the case where $\pi\rho < \frac{1}{2}$ and the principal is effectively minimizing expected payment. Following Itoh (2004) one can write the incentive compatibility conditions of the agents (under symmetric contracts) as:

$$p_1 w_{ss} + (1-p_1)w_{sf} + \left[p_1 - (1-p_1)\gamma\right]\alpha w_{sf} \geq (1-\alpha\gamma)\frac{d}{\Delta p} + (1-p_0)p_1\alpha(1+\gamma)\frac{w_{sf}}{\Delta p} \quad \text{if } w_{sf} < d$$

(NIC3a)

$$p_1 w_{ss} + (1-p_1)w_{sf} + \left[p_1 - (1-p_1)\gamma\right]\alpha w_{sf} \geq \left[1-\alpha\gamma + (1-p_0)p_1\alpha(1+\gamma)\right]\frac{d}{\Delta p} \qquad \text{if } w_{sf} \geq d$$

(NIC3b)

The participation constraint of the agents remain the same as in the original specification. We follow the approach by Itoh for $\pi\rho < \frac{1}{2}$. Under the extreme team contract $(w_{ss},0)$, since $w_{sf} < d$, equation (NIC3a) will apply and the simplified incentive compatibility becomes $p_1 w_{ss} \geq (1-\alpha\gamma)\frac{d}{\Delta p}$. Under $(w_{ss},0)$ if an agent is sticking to e_1 the other agent becomes ahead by d if she deviates from e_1 to e_0. Now when the deviating agent is status seeking she will enjoy this deviation whereas when she is 'inequity-averse' she will not enjoy this deviation. Thus the principal needs to provide stronger incentive for a status-seeking agent compared to an inequity-averse agent. For an inequity-averse agent, the principal is better-off the more inequity-averse the agent is (the expected payment falls with increased α) and therefore in this changed specification with the extreme team contract the principal's expected payoff depends on the extent of other-regardingness of the agents, which was not the case under the original specification. Also note that if α is sufficiently high in the sense $\alpha\gamma > p_0 / p_1$, then $\frac{d}{p_1} > (1-\alpha\gamma)\frac{d}{\Delta p}$ implying that at the optimum under the extreme contract the participation constraint will bind and the incentive compatibility will not bind. Thus if $\alpha\gamma > p_0 / p_1$ holds then the extreme team wage will be $\tilde{w}_{ss} = d / p_1^2$ participation constraint will bind and the incentive compatibility will not bind, otherwise $\hat{w}_{ss} = (1-\alpha\gamma)\frac{d}{p_1 \Delta p}$.

When $\pi\rho > \frac{1}{2}$ holds then the independent contract $w_{ss} = w_{sf} = \frac{b+d}{2}$ will be optimal. If $\pi\rho = \frac{1}{2}$ holds then any contract that satisfies (NIC3a) and (NIC3b) will be optimal if $w_{sf} < d$ and $w_{sf} \geq d$ holds respectively.

5. The Case of 'Fair' Principal:

We extend our previous analysis and consider the case of a 'fair' principal who experiences a reduction in utility when the agents get different wages. Put differently the principal is 'inequity averse' in the sense that she hates inequity among agents. Specifically we assume that the principal's utility function to be:

$$U^P = b_j - w_{jk}^n - \pi \left| w_{jk}^n - w_{kj}^m \right|, \text{ where } n \neq m$$

where $\pi > 0$ is the inequity-aversion parameter. The agents are assumed to be other-regarding among themselves in the sense of equation (2). Given above the principal will maximize her expected payoff

$$E(U^P) = p_1^2[2b - 2w_{ss}] + 2p_1(1 - p_1)\left[b - w_{sf} - \pi w_{sf}\right] \quad (16)$$

$$= 2p_1\left[b - p_1 w_{ss} - (1 - p_1)(1 + \pi)w_{sf}\right]$$

subject to the Nash-Incentive compatibility given in (5) and the participation constraint given in (6). Maximizing above is effectively minimizing $[p_1 w_{ss} + (1 - p_1)(1 + \pi)w_{sf}]$ subject to (5) and (6). At the optimum the incentive compatibility (given in (5)) will bind and therefore replacing $p_1 w_{ss} + (1 - p_1)w_{sf} + [p_1 - (1 - p_1)\gamma]\alpha w_{sf} = \frac{d}{\Delta p}$ in $[p_1 w_{ss} + (1 - p_1)(1 + \pi)w_{sf}]$ the problem effective becomes minimization of $\frac{d}{\Delta p} + [(1 - p_1)(\alpha\gamma + \pi) - p_1\alpha]w_{sf}$. If $[(1 - p_1)(\alpha\gamma + \pi) - p_1\alpha] \geq 0$ then minimization requires $w_{sf} = 0$, otherwise $w_{sf} > 0$. Therefore we can characterize the optimal contracts as follows:

Proposition 4:

(i). The extreme team contract $\{\hat{w}_{ss}, 0\}$ *is optimal if* $p_1 < \frac{\alpha\gamma + \pi}{\alpha\gamma + \pi + \alpha}$ *holds. The principal's payoff is independent of the agents' other-regardingness.*

(ii).The extreme relative performance contract $\{0, \hat{w}_{sf}\}$ *is optimal if both* $p_1 > \dfrac{\alpha\gamma + \pi}{\alpha\gamma + \pi + \alpha}$ *and* $\dfrac{p_1 / p_0}{(1 - p_1)/(1 - p_0)} \le \dfrac{1 - \alpha\gamma}{\alpha}$ *holds. The principal benefits the more other regarding the agents are.*

(iii). $\{\overline{w}_{ss}, \overline{w}_{sf}\}$ *is optimal if both* $p_1 > \dfrac{\alpha\gamma + \pi}{\alpha\gamma + \pi + \alpha}$ *and* $\dfrac{p_1 / p_0}{(1 - p_1)/(1 - p_0)} > \dfrac{1 - \alpha\gamma}{\alpha}$ *holds. The principal is better-off dealing with more other-regarding agents.*

(iv). When agents are self-regarding ($\alpha = 0$)*, the extreme relative performance contract is never optimal.*

(v). The independent contract $w_{ss} = w_{sf} = \dfrac{b}{2}$ *is never optimal.*

Note that $\dfrac{\alpha\gamma + \pi}{\alpha\gamma + \pi + \alpha} > \dfrac{\gamma}{1 + \gamma}$ for $\pi > 0$ and therefore under a 'fair' principal the range for which team contract is optimal expands and therefore a 'team contract' is more likely under a 'fair' principal compared to the original specification.

Under a 'fair' principal when agents are self-regarding, i.e. when $\alpha = 0$, $\dfrac{\alpha\gamma + \pi}{\alpha\gamma + \pi + \alpha} = 1$ and therefore $\{\hat{w}_{ss}, 0\}$ is optimal for all $p_1 < 1$ and the extreme relative performance contract $\{0, \hat{w}_{sf}\}$ is never optimal. But even if the principal is 'fair', with other-regarding agents the extreme relative performance contract can be optimal since the principal can benefit from the tournament type relative performance contract when agents are other-regarding, especially when agents are status-seeking. With an increase in α the critical value $\dfrac{\alpha\gamma + \pi}{\alpha\gamma + \pi + \alpha}$ falls implying that with more other-regarding agents, ceteris paribus, team contract is less likely. Again with a fall in γ (from positive to negative) the critical value $\frac{\alpha\gamma+\pi}{\alpha\gamma+\pi+\alpha}$ falls and therefore for status seeking agents the range for which team contract is optimal shrinks and relative performance contract becomes more likely. But with self-regarding agents, the relative performance contract is never optimal since with self-regarding agents the principal doesn't benefit from the tournament type relative performance contract and 'fairness' is the only concern. Finally, the independent contract $w_{ss} = w_{sf} = \frac{b}{2}$, although 'fair', is not optimal since the expected payoff of the principal will be strictly lower under such an 'elevated' independent contract.

6. Conclusion:

This paper analyzes optimal contracts when an other-regarding principal interacts with two other-regarding agents. The principal is other-regarding vis-a-vis the agents whereas the agents are other-regarding vis-à-vis each other. We analyze both independent production technology and correlated project outcomes. We find that with 'status seeking' and 'not so high inequity-averse' agents, a moderately inequity averse or a status seeking principal will offer an 'extreme relative performance contract', whereas she will offer an 'extreme team contract' if the agents are 'sufficiently inequity averse' and this is similar to what we get in Itoh (2004) with self-regarding principal. Contrary to this a 'sufficiently in-equity averse' principal will offer an 'extreme' independent contract that minimizes her ex-ante expected payoff loss from being ahead keeping the work incentives intact. This is contrary to what we get in Itoh (2004) and other papers in multi agent framework with other-regarding agents and self-regarding principal. Similar results hold in essence when the projects of the agents are correlated as well. In addition to this we consider the case of a 'fair' principal who experiences a reduction in utility when the agents get different wages. We show that relative performance contracts are never optimal when a fair principal interacts with a self-regarding agent. Also team contract is more likely under a 'fair' principal compared to the standard case where the principal is other-regarding vis-a-vis the agents.

Overall this paper can be viewed as a generalization of Itoh (2004) with other-regarding principal and a multi agent extension of Banerjee and Sarkar (2017). In the future we plan to extend our analysis in the continuous effort framework where agents work on different and/or a single joint project. It will be interesting to look at the optimal incentive design under such situations when the principal and the agents have social preferences and these have implications for optimal organizational design.

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