

Inequity Aversion and Moral Hazard with Multiple Agents

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Abstract

We analyze how inequity aversion interacts with incentive provision in an otherwise standard moral hazard model with two risk averse agents. We find that behindness aversion (suffering only when being worse off) among agents unambiguously increases agency costs of providing incentives. This holds true if agents also suffer from being better off unless they account for effort costs in their comparisons. Increased agency costs can undermine efficiency in two ways. First, inequity aversion may render equitable flat wage contracts optimal even though incentive contracts are optimal with selfish agents. Second, to avoid social comparisons the principal may employ one agent only, thereby forgoing the efficient effort provision of the second agent. Furthermore, we discuss implications for the internal organization and the boundary of the firm.

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1 Introduction

We analyze how inequity aversion (Fehr and Schmidt (1999), Bolton and Ockenfels (2000)) interacts with incentive provision in an otherwise standard moral hazard model with multiple agents. The theory of inequity aversion assumes that some but not all agents suffer a utility loss if their own material payoffs differ from the payoffs of other agents in their reference groups. The approach can explain a large variety of seemingly diverging experimental findings that often conflict with the standard assumption of pure selfishness.¹ This paper goes a step further and applies the theory of inequity aversion to the theory of incentives. If agents do not simply maximize their own material payoffs but also care for other agents' payoffs they will respond differently to incentives than predicted under the assumption of pure selfishness. Incorporating social preferences into the theory of incentives – thereby either exploiting them or paying tribute to an additional constraint – may help to understand why real world contracts often differ from those contracts found optimal by the standard theory.

In a classic contribution to the theory of incentives Holmström and Milgrom (1991, p. 24) state that “it remains a puzzle for this theory that employment contracts so often specify fixed wages and more generally that incentives within firms appear to be so muted, especially compared to those of the market.” The authors offer an explanation for the paucity of incentives based on the assumption that agents conduct multiple tasks, and that tasks are measured with varying degrees of precision.

We offer an alternative, behavioral explanation to account for the observation that incentives offered to employees within firms are generally ‘low-powered’ compared to ‘high-powered’ incentives offered to independent contractors. We assume that within firms social comparisons are pronounced whereas in the marketplace they are negligible.² We further assume that an agent suffers a utility loss if another agent conducting a similar task within the same firm receives a higher wage. We find that behindness aversion (suffering only when being worse off) unambiguously increases agency costs of providing incentives. As a consequence, behindness aversion may render equitable flat wage contracts optimal – even though incentive contracts are optimal with selfish agents. Hence, within firms where social comparisons are significant we find ‘low powered’ flat wage contracts to be optimal, whereas ‘high powered’ incentive contracts will be given to ‘unrelated agents’ in the marketplace.

¹For an overview of the literature see, for example, Fehr and Schmidt (2003) and Camerer (2003).

²Rotemberg (2002), for e.g., provides evidence for reciprocity and cooperation in the workplace.

Furthermore, we argue that our analysis can contribute to the question of the optimal size of a firm. Suppose the principal can set up different firms, but setting up a firm involves fixed costs. The principal now faces a trade-off. On the one hand, ‘integration’ of several agents within a single firm causes social comparisons and, as shown in this paper, increased agency costs of providing incentives. On the other hand, ‘separation’ of agents into different firms involves additional fixed costs. The solution to this trade-off defines, in the context of this model, the optimal degree of integration.

More specifically, in this paper we derive optimal moral hazard contracts assuming risk- and inequity averse agents that constitute each other’s reference group. The agents however do not compare themselves to the principal. Agents carry out identical tasks and regard it as unfair if their wage payments differ. We further assume that the principal is both risk neutral and selfish. To keep the analysis tractable we consider the most simple set-up with two agents, two effort levels and two possible output realizations; to receive closed form solutions we assume an explicit utility function and a linear inequity term as in Fehr and Schmidt (1999). In the appendix we however show that our results hold true (1) for any concave utility function and (2) irrespective of the functional form of disutility from inequity. Effort is taken to be non-contractible such that incentive compatible wages must condition on stochastic output realizations. Hence, agents suffer if output realizations and thus wages differ. We show that behindness aversion among agents unambiguously increases agency costs of providing incentives. This also holds true if agents, in addition, suffer from being better off unless they account for effort costs in their comparisons.

The intuition behind this finding can be seen as follows. Inequity aversion effects an utility loss if output realizations diverge. The resulting, reduced utility levels could be implemented without inequity aversion as well, simply by lowering the wages. Since these lower utility levels were not optimal without inequity aversion, they cannot be optimal now.

Increased agency costs can undermine efficiency in two ways. First, equitable flat wage contracts may become optimal even though incentive contracts are optimal with selfish agents. Second, to avoid social comparisons the principal may employ one agent only, thereby forgoing the efficient effort provision of the other agent. This second effect of inequity aversion is qualitatively different from the impact of risk aversion on optimal contracts. The principal can respond to high degrees of risk aversion only by waiving incentives and offering flat wages, whereas with inequity aversion – or more generally

with social preferences – he has an additional instrument at hand if he can control an agent’s reference group. It is possible to eliminate inequity and still provide incentives to at least one agent. We call this the ‘reference group effect’. Third, endowing the principal with the option to set up a second firm at a fixed cost allows to analyze whether ‘integration’ or ‘separation’ is optimal.

Further results are derived. Since optimal wages condition on the output realization of the respective other agent as well, the sufficient statistics result due to Holmström (1979) does not apply. We find that inequity aversion renders team contracts optimal even if output is uncorrelated. Analyzing the interaction between risk and inequity aversion, we find that the additional agency costs due to inequity aversion are higher, the higher the degree of risk aversion. With risk neutral agents inequity aversion does not impact equilibrium agency costs as long as no limited liability constraint binds. Finally, labor contracts often encompass a clause prohibiting employees to communicate their salary. At first sight, inequity aversion could serve as an explanation for this observation. We however show that secrecy of salaries only further increases the additional agency costs due to inequity aversion.

Related Literature

Itoh (2003) and Demougin and Fluet (2003) are most related to our paper. Itoh (2003) analyzes how inequity aversion among risk neutral agents changes optimal incentive contracts, assuming limited liability to be the source of moral hazard. In contrast to our results, Itoh finds that inequity aversion can never harm the principal. With risk neutrality the principal can always choose a fully equitable contract out of the set of contracts that are optimal without inequity aversion. Moreover, inequity aversion can even increase the principal’s profit. With limited liability the principal may be forced to pay the agents rents to provide incentives because there is a lower bound on agents’ wage payments. However, inequity aversion enables the principal to punish an agent harsher than paying the lowest possible wage level, simply by paying other agents more, thereby reducing agents’ rents. Demougin and Fluet (2003) also analyze a two agents moral hazard problem assuming risk neutrality and limited liability. They compare group and individual bonus schemes for behindness-averse agents and derive conditions under which either scheme implements a given effort level at least costs.

Inequity aversion between multiple agents is also analyzed by Rey Biel (2003) and Neilson and Stowe (2003). Rey Biel (2003) analyzes a setting with two inequity averse

agents and a principal in which agents' effort choices deterministically translate into output. He exogenously assumes the participation constraint to be slack and finds that the principal can always exploit inequity aversion to extract more rents from his agents. Neilson and Stowe (2003) restrict their analysis to linear piece-rate contracts and identify the conditions under which other-regarding preferences lead workers to exert more or less effort than selfish agents, and whether the optimal piece rate is higher or lower for inequity averse agents.

Englmaier and Wambach (2003) and Dur and Glaser (2004) consider comparisons between agents and principal. Englmaier and Wambach (2003) find that the sufficient statistics result does not apply and that inequity aversion causes a strong tendency towards linear sharing rules. Dur and Glaser (2004) show that inequity aversion can be a reason for high incentives, even for profit sharing, as this reduces inequity.

In Bartling and von Siemens (2004) we analyze how incentive provision in team production is affected if agents are inequity averse. In contrast to the classic result by Holmström (1982) we find that efficient effort choices can be implemented by simple budget-balancing sharing rules if agents are sufficiently inequity averse. Conditions for efficiency become less restrictive the smaller the team. This fits common observation that small teams often work well whereas larger ones suffer from free-riding.

The remainder of the paper is organized as follows. Section 2 presents the basic model. In Section 3 we derive the optimal incentive contracts for inequity averse agents. Section 4 presents our main results. Section 5 explores the implications of our results for the optimal firm size. Section 6 analyzes the case with secret salaries. In Section 7 we discuss comparison of rents, disutility from being better off, and status preferences. Section 8 concludes. In the Appendix we discuss the generality of our results.

2 The Model

2.1 Projects, Effort, and Probabilities

Suppose a principal can employ two risk averse agents. If employed, each agent manages a project with stochastic output $x \in \{x_l, x_h\}$, where $x_h > x_l$ and $\Delta x := x_h - x_l$. Each agent faces a binary effort choice. He either exerts effort, $e = 1$, or he shirks, $e = 0$. Effort costs are denoted by $\psi(1) = \psi > 0$ while shirking is assumed to be costless, $\psi(0) = 0$. If an agent exerts effort, the output of his project is x_h with probability π

and x_l with probability $1 - \pi$, where $\pi \in]0, 1[$. If an agent shirks, the output of his project is always x_l . Effort is assumed not to be contractible. The agents' projects are independent, their production outcomes are uncorrelated.

2.2 Preferences: Risk- and Inequity Aversion

We depart from the standard literature by assuming that agents are inequity averse in the sense of Fehr and Schmidt (1999).³ We assume that an agent's utility is additively separable in the following three components. First, each agent enjoys utility $u(w)$ from his wage payment w by the principal. To derive explicit results we assume this utility function to take on the specific form⁴

$$u(w) = (-1 + \sqrt{1 + 2rw})/r. \quad (1)$$

This function is strictly increasing and convex for all $w > -1/2r$. Thus, the agent is risk averse with respect to his income. The corresponding inverse function $h(x) := u^{-1}(x) = x + rx^2/2$ is well defined for all $x > -1/r$. For small w , r can be considered as the agent's approximated degree of absolute risk aversion. This approximation is correct at a zero wage: $-u''(w)/u'(w)|_{w=0} = r$. Second, an agent incurs effort costs ψ if he works; shirking is costless. Finally, an agent suffers from inequity. We assume an agent's reference group to be confined to the other agent, thus the agents do not compare themselves to the principal. Agents carry out an identical task and regard it as unfair if wage payments differ. Since the principal conducts a different 'task' his payoff is not taken to be a point of reference. The identification of an agent's relevant reference group will, however, ultimately be an empirical question.

In the body of the paper we restrict attention to 'behindness aversion'. Whenever an agent receives a lower payoff than the other agent he suffers a utility loss, but agents do not suffer if they are better off than the other agent. More formally, suppose agent $i \in \{1, 2\}$ receives wage w_i , whereas agent $j \neq i$ receives wage w_j . Agent i 's utility function can then be written as

$$v_i(w_i, w_j) = u(w_i) - \psi(e) - \alpha \cdot \max[u(w_j) - u(w_i), 0]. \quad (2)$$

³See Bolton and Ockenfels (2000) for a related formulation of inequity aversion.

⁴In the appendix we show that our results neither hinge upon this explicit utility function nor on the assumed linear formulation of inequity aversion by Fehr and Schmidt (1999). The chosen functional forms however allow to derive closed form solutions.

The parameter $\alpha \geq 0$ is a measure of behindness aversion. The higher α the more an agent suffers from inequity. Notice that the above formulation does *not* imply that agents compare utilities interpersonally, but rather that agent i suffers from the inequity between the utility he obtains from wage w_i and the utility he would enjoy when receiving the higher wage w_j himself. Both agents maximize expected utility.

Despite the evident experimental evidence on inequity aversion it is still an open question what *exactly* people compare; whether they focus, for example, on wage payments or utility from wage payments, and whether they account for differences in effort costs or not.⁵ In this paper, we assume that agents compare utility levels as this renders the principal's maximization problem well behaved.⁶ To avoid tedious case distinctions we neglect the possibility that agents account for effort costs in their comparisons. In Section 7.1 we however show that accounting for effort costs in the inequity term does not conflict with but rather reinforces the qualitative results of this paper. In Section 7.2 we show that introducing suffering from being better off, again, only reinforces our qualitative results *unless* agents account for effort costs in their comparisons.

The principal is both risk-neutral and unaffected by inequity concerns. He maximizes expected output minus expected wage payments.

3 Contracts

We focus on symmetric contracting such that the principal offers identical contracts when employing both agents. The principal has three options. He can either employ both agents and implement effort or shirking, or he can decide to employ one agent only to avoid social comparisons.⁷ In the following section we derive optimal contracts implementing these effort choices.

⁵For a more detailed discussion of inequity aversion see Fehr and Schmidt (1999, 2003).

⁶Otherwise constraints are not linear, the maximization problem not concave, and the solution not straightforwardly characterized by first-order conditions.

⁷In principle, he could also offer a 'hybrid contract': an incentive contract to one agent and a 'non-incentive contract' to the other agent. Note that due to inequity aversion such a 'non-incentive contract' would not be a flat wage contract. It can be shown that considering the 'hybrid contract' would not change the qualitative results of this paper.

3.1 Benchmark: The Single Agent Case

The principal can avoid social comparisons by employing one agent only. Recall that we have confined an agent's reference group to the respective other agent working with the same principal. With a single agent inequity aversion is thus irrelevant. The optimal contract for the employed agent (incentive or flat wage contract) then depends on the standard parameters of the model via the participation and incentive constraint. Suppose first the principal wants to implement high effort. Since effort is not verifiable wages must condition on stochastic output realizations and the classic risk-incentive trade-off arises. Define w_i as the agent's wage if his output is $i \in \{h, l\}$, and define $u_i := u(w_i)$. To render the principal's maximization problem concave, we rewrite the principal's objective function and the constraints in terms of u_h and u_l . An agents outside option is normalized to zero. The resulting first-order conditions then yield

$$u_h^* = \frac{\psi}{\pi} \quad \text{and} \quad u_l^* = 0 \quad (3)$$

as the optimal contract, and profit can be written as

$$P_1^i = \pi x_h + (1 - \pi)x_l - \left[h(\psi) + \frac{r\psi^2(1 - \pi)}{2\pi} \right] \quad (4)$$

where superscript i denotes 'incentive contract' and the subscript shows the number of agents employed. Define

$$RAC := \frac{r\psi^2(1 - \pi)}{2\pi}$$

as the 'risk-agency-costs' that have to be payed on top of the first-best cost of effort implementation $h(\psi)$ due to risk aversion.

Suppose now the principal offers a flat wage contract. The agent then never exerts effort and the participation constraint is satisfied at flat wage $w^f = 0$. The principal's profit in this case is $P_1^f = x_l$. The difference in expected profit from implementing effort as compared to paying a flat wage is given by

$$B := \pi\Delta x - h(\psi) - RAC.$$

Thus, it is optimal for the principal to implement high effort if and only if

$$B \geq 0 \quad \Leftrightarrow \quad \pi\Delta x \geq h(\psi) + RAC. \quad (5)$$

The principal offers an incentive contract whenever the expected output increase is sufficiently large relative to the first best cost of implementing effort and the RAC.

The condition is more likely to be met if effort cost and risk aversion are small and the information content of the project outcomes is high. Exerting effort is efficient if $\pi\Delta x \geq h(\psi)$ but risk aversion leads to a trade-off between insurance and efficiency and causes additional RAC. This leads to inefficient effort choices if $h(\psi) + RAC \geq \pi\Delta x \geq h(\psi)$. If $\pi\Delta x \geq h(\psi) + RAC$ the efficient effort level is implemented but risk aversion reduces the principal's expected profit.

In the next section we show that inequity aversion amplifies these effects. Inequity aversion causes additional agency costs which unambiguously rise as the level of inequity aversion rises. This further reduces the principal's expected profit, and it can lead to additional inefficiencies. Throughout the paper we therefore assume incentive condition (5) to be fulfilled. $B < 0$ is the uninteresting case since flat wage contracts would then always be optimal – even without inequity aversion.

3.2 The Two Agents Case

In this section we consider the two agents case. Both agents work within the same firm and we thus assume that they compare their wage levels. An agent suffers a utility loss in case he is behind. In contrast, we assume that an agent would not compare his wage to the wage of an agent with whom he only interacts in the market, i.e. an agent that works for another principal.

With incentive contracts inequity arises naturally as output is stochastic and incentive compatible wages must condition on output realizations. At first glance the effect of inequity aversion on agency costs is ambiguous. Behindness aversion increases incentives because exerting effort reduces the probability of being behind. At the same time agents anticipate that even if they exert high effort with positive probability they will be behind. Ex ante agents have to be compensated for this expected utility loss to ensure participation.

We show that the positive effect on incentives is always dominated by the negative effect on participation and, therefore, behindness aversion unambiguously *increases* the agency costs of providing incentives. The intuition can be seen as follows. Without inequity aversion the second-best optimal incentive contract assigns wage levels to each possible output realization such that both IC and PC are fulfilled and binding. For some output realizations (i.e. agent one is successful, agent two is not) the contract assigns diverging wage levels to the agents (agent one receives a higher wage than agent two, assuming the monotone likelihood ration to hold). If now inequity aversion

is considered, the utility of agents receiving less than others (agent two) is reduced by the amount of suffering from being behind. However, this lower utility level could have been achieved without inequity aversion as well – simply by lowering the respective wage level, which reduces the principal’s cost. As this was not optimal without inequity aversion it cannot be optimal now.

In the appendix we show that this intuition holds generally. Assuming only concavity of the utility function we show that inequity aversion renders it weakly more expensive to implement each possible effort level. However, our arguing does not hold when there is limited liability. With limited liability the lowest possible wage payment and thus the lowest possible utility level for an agent is bounded from below. To provide incentives the principle may thus be forced to leave the agents rents. In this case inequity aversion provides the principal with the possibility to reduce the lowest possible utility level. An agent can now not only be punished by paying out the lowest wage level but in addition by paying other agents a higher wage. The lowest possible utility level for an agent can thus be reduced without violating the limited liability constraint. This in turn enables the principal to reduce the agents’ rents.

Suppose first the principal does not want to implement effort. He then offers two flat wage contracts. Since there is never inequity, inequity aversion is irrelevant and the principal’s profit is simply

$$P_2^f = 2 \cdot P_1^f = 2 x_l. \quad (6)$$

Suppose now the principal wants to implement effort. We show that the principal’s expected profit is not just twice the expected profit in the single agent case but $P_2^i \leq 2 P_1^i$. As both agents are symmetric, we assume that optimal wages are symmetric in the sense that they condition on the output realizations of both projects but not on the identity of the agent. Denote by w_{ij} the wage of an agent with output i if the other agent’s output is j . Define $u_{ij} := u(w_{ij})$ as an agent’s utility from wage w_{ij} . As there are four possible states of the world, a contract determines four wage levels: w_{ll} , w_{hh} , w_{lh} , and w_{hl} , where h stands for high and l for low output. To render the principal’s maximization problem concave with linear constraints, we rewrite the principal’s objective function and the constraints in terms of u_{hh} , u_{hl} , u_{lh} , and u_{ll} .

Recall that the maximum functions in the agents’ utility functions in (2) create potential kinks. At these points, the utility functions and thus the PC and IC are not differentiable, potentially rendering it impossible to characterize optimal contracts by first-order conditions. However, the following lemma allows to avoid this problem.

Lemma 1 *The optimal incentive compatible contract for two inequity averse agents satisfies $u_{hl}^* \geq u_{lh}^*$.*

Proof: Suppose this was not the case, that is $u_{hl} < u_{lh}$ at the optimum. Then the IC and PC are given by

$$\begin{aligned} \text{(IC')} \quad & \pi^2 u_{hh} + \pi(1-\pi)[u_{hl} - \alpha(u_{lh} - u_{hl})] - \pi^2 u_{lh} - \pi(1-\pi)u_{ll} - \psi \geq 0 \\ \text{(PC')} \quad & \pi^2 u_{hh} + \pi(1-\pi)[u_{hl} - \alpha(u_{lh} - u_{hl})] + \pi(1-\pi)u_{lh} - (1-\pi)^2 u_{ll} - \psi \geq 0 \end{aligned}$$

Consider changes $du_{lh} < 0$ and $du_{hl} = -du_{lh}(1-\alpha)/(1+\alpha)$. This leaves (PC') unaffected but improves (IC'). The principal's profit increases by

$$dP_2^i = 2\pi(1-\pi) \left[h'(u_{hl}) \frac{1-\alpha}{1+\alpha} - h'(u_{lh}) \right] du_{lh},$$

which is strictly larger than zero as $(1-\alpha)/(1+\alpha) \leq 1$, $du_{lh} < 0$, $u_{hl} < u_{lh}$, and $h''(u) > 0$. q.e.d.

Notice that $du_{lh} < 0$ has a twofold effect on (PC'). On the one hand, this decreases the agent's utility if his own project fails whereas the other agent's project is successful. On the other hand, unfavorable inequity decreases if the agent himself is successful whereas the other agent is unfortunate. In the latter case the agent's utility increases. If the inequity reducing effect dominates, $\alpha > 1$, the principal may decrease both u_{hl} and u_{lh} while keeping (PC') unaffected and not impairing (IC'). In either case, the principal can increase his expected profit without violating a constraint, and $u_{hl} < u_{lh}$ cannot be optimal.

By Lemma 1 we can introduce an additional constraint, $u_{hl} - u_{lh} \geq 0$, without restricting the attainable maximum. We call this constraint the *Order Constraint* (OC). The maximum functions in the agents' utility functions are thus removed and the principal maximizes

$$P_2^i = 2 \left[x_l + \pi^2 [\Delta x - h(u_{hh})] + \pi(1-\pi)[\Delta x - h(u_{lh}) - h(u_{hl})] - (1-\pi)^2 h(u_{ll}) \right] \quad (7)$$

with respect to u_{hh} , u_{hl} , u_{lh} , and u_{ll} , where

$$\begin{aligned} \text{(IC)} \quad & \pi^2 u_{hh} + \pi(1-\pi)u_{hl} - \pi^2[u_{lh} - \alpha(u_{hl} - u_{lh})] - \pi(1-\pi)u_{ll} - \psi \geq 0 \\ \text{(PC)} \quad & \pi^2 u_{hh} + \pi(1-\pi)u_{hl} + \pi(1-\pi)[u_{lh} - \alpha(u_{hl} - u_{lh})] + (1-\pi)^2 u_{ll} - \psi \geq 0 \\ \text{(OC)} \quad & u_{hl} - u_{lh} \geq 0. \end{aligned}$$

are the constraints characterizing the principal's choice set.⁸

We begin by assuming that the OC is not, whereas the IC and PC are binding. Solving the resulting first-order conditions then yields

$$u_{hh}^* = \frac{\psi}{\pi} + \frac{\alpha(1-\pi)(1+\alpha(\pi+r\psi))}{rk} \quad (8)$$

$$u_{hl}^* = \frac{\psi}{\pi} - \frac{\alpha\pi(1+\alpha(\pi+r\psi))}{rk} \quad (9)$$

$$u_{lh}^* = \frac{\alpha(1-\pi(1+\alpha\pi)) + (1+\alpha)r\psi}{rk} \quad (10)$$

$$u_{ll}^* = -\frac{\alpha(\pi(1+\alpha(1+\pi)) - r\psi)}{rk} \quad (11)$$

where $k = 1 + \alpha\pi(2 + \alpha(1 + \pi))$. The Lagrange multipliers for the PC and IC are given by $\mu = 2(1 + r\psi[1 + \alpha(1 + \pi) + 2\pi\alpha^2] + 2\pi\alpha(1 + \pi\alpha))/k$ and $\lambda = 2(1 - \pi)(r\psi[1 + \pi\alpha + 2\pi\alpha^2] + \pi\alpha(1 + 2\pi\alpha))/\pi k$. Since these are strictly positive, both the PC and IC are indeed binding as initially assumed. We also have to check whether it holds true that the OC is slack, i.e. whether we have $u_{hl}^* \geq u_{lh}^*$. The difference is given by $(r\psi + \alpha\pi(r\pi - 1))/r\pi k$. Thus, the OC is indeed slack and the solutions (8) - (11) are valid if and only if either $r\psi \geq 1$ or $r\psi < 1$ and $\alpha < \tilde{\alpha}$ where

$$\tilde{\alpha} := r\psi/(\pi(1 - r\psi)). \quad (12)$$

Finally, since $h(u)$ is defined for $u \geq -1/r$ only, we have to verify that this always holds. Algebraic manipulations show that $u_{lh}^* \geq u_{ll}^*$. The solution is thus valid if $u_{ll}^* \geq -1/r$, or $ru_{ll}^* \geq -1$. This condition holds with equality if $r = \tilde{r} = -(1 + \alpha\pi)/(\alpha\psi)$. Differentiating ru_{ll}^* with respect to r yields $\alpha\psi/k \geq 0$. Hence, ru_{ll}^* rises in r . Since we must have $r > 0$, r always exceeds \tilde{r} , and u_{ll}^* never falls short of $-1/r$.

Suppose now that all the constraints PC, IC, and OC are binding. The binding OC forces the principal to set $u_{lh} = u_{hl}$. This restriction on the contract design eliminates inequity but comes at a cost. Solving the corresponding first-order conditions we get

$$u_{hh}^* = \frac{\psi}{\pi} + \frac{(1-\pi)\psi}{\pi} \quad (13)$$

⁸We do not consider dominant strategy implementation in this paper, i.e. we only look at contracts such that the constraints are satisfied for one agent given that the other agent behaves as expected. Even though both agents participating and exerting effort then forms a Nash equilibrium it is possibly not unique.

$$u_{hl}^* = u_{lh}^* = \frac{\psi}{\pi} - \psi = \frac{(1 - \pi)\psi}{\pi} \quad (14)$$

$$u_{ll}^* = -\psi. \quad (15)$$

The Lagrange multipliers of the PC and IC are $\mu = 2r\psi + 2$ and $\lambda = 4r\psi(1 - \pi)/\pi$. Since both are strictly positive, the PC and IC are indeed binding as initially assumed. As $h(u)$ is defined for $u \geq -1/r$ only, the above solution is valid only if $r\psi < 1$.

The overall optimal solution depends on whether the OC is binding or not, which in turn depends on r, ψ and α . This is summarized in the following proposition.

Proposition 1 (Optimal Contracts For Inequity-Averse Agents)

i) Suppose $r\psi \geq 1$. The optimal incentive compatible contract for two inequity averse agents is given by (8) - (11).

ii) Suppose $r\psi < 1$. If $\alpha < \tilde{\alpha}$, the optimal incentive compatible contract for two inequity averse agents is given by (8) - (11). If $\alpha \geq \tilde{\alpha}$, it is given by (13) - (15).

Proof: There are two cases. First, suppose $r\psi \geq 1$. Then solution (13) - (15) is not valid as $u_{ll}^* < -1/r$, whereas solution (8) - (11) is valid for all α as we always get $(r\psi + \alpha\pi(r\pi - 1))/r\pi k > 0$. Second, suppose $r\psi < 1$. Then for all $\alpha < \tilde{\alpha}$ both extreme points are candidates for the overall solution, but (8) - (11) dominates as the maximum is not restricted by the OC. For all $\alpha \geq \tilde{\alpha}$, only solution (13) - (15) is valid. q.e.d.

4 Results

4.1 Inequity Aversion Renders Team Contracts Optimal

Since we assume output to be uncorrelated an agent's output realization does not contain information about the other agent's effort choice. According to the classic result by Holmström (1979) optimal wages should only condition on sufficient statistics for effort choices. In our model wages should thus only condition on the own output realization. Nonetheless, since agents compare the utility levels from their wages optimal contracts also condition on the other agent's output realization in order to reduce inequity. Therefore, the sufficient statistics result does not apply.⁹ Define a *team con-*

⁹In the context of interdependent preferences this result naturally arises. It was first shown in Englmaier and Wambach (2003).

tract as a compensation scheme such that an agent's wage depends positively on the other agent's success. Thus, in a team contract we have $w_{hh} > w_{hl}$ and $w_{lh} > w_{ll}$. As summarized in the following proposition inequity aversion renders team contracts optimal.

Proposition 2 (Team Contracts)

The sufficient statistics result does not apply: Inequity aversion renders team contracts optimal even if output is uncorrelated.

Proof: Comparison of the relevant utility levels in Proposition 1 yields $u_{hh}^* - u_{hl}^* = \alpha(1 + \alpha(\pi + r\psi))/rk \geq 0$ and $u_{lh}^* - u_{ll}^* = \alpha(1 + \alpha(\pi + r\psi))/rk \geq 0$. q.e.d.

Since output is stochastic, agents obtain different output realizations with positive probability even though both agents exert high effort. The unfortunate agent then suffers from obtaining a lower wage than the fortunate agent. The optimal contract accounts for this effect and adjusts wage levels accordingly.

4.2 Inequity Aversion Causes Additional Agency Costs

In the benchmark case of a single agent inequity aversion is irrelevant and does not influence the principal's profit. This is also the case with flat wage contracts for two agents as there is never inequity. However, with incentive contracts for two inequity averse agents additional agency costs arise. Suppose $r\psi \geq 1$ or $r\psi < 1$ but $\alpha < \tilde{\alpha}$ such that the optimal contract is characterized by (8) - (11). Substituting optimal utility levels, the principal's maximum profit is then given by

$$P_2^i = 2 P_1^i - IAC, \tag{16}$$

where

$$IAC := \frac{\alpha(1 - \pi)(2r\psi + \pi\alpha(r\psi - 1) + \alpha r^2\psi^2)}{rk}. \tag{17}$$

denotes the 'inequity agency costs', the additional agency cost due to inequity aversion. Inequity aversion has a negative effect on the principal's maximum profit as the above solution is only valid if either $r\psi \geq 1$ or $\alpha \leq \tilde{\alpha}$ holds, and this ensures that IAC are positive. Equivalently, suppose $r\psi < 1$ and $\alpha < \tilde{\alpha}$ such that the optimal contract is characterized by (13) - (15). Substituting optimal utility levels, the principal's maximum profit is then given by

$$P_2^i = 2 P_1^i - IAC, \tag{18}$$

where

$$IAC := \frac{r\psi^2(1-\pi)}{\pi} \quad (19)$$

denotes the ‘inequity agency costs’ in this case. Again, the principal’s profit with two hard working agents is strictly less than twice the profit with only one hard working agent as the IAC are always positive. Note that in the latter case the IAC do not depend on α as the above solution is subject to the OC binding and inequity is completely eliminated. However, inequity aversion reduces the principal’s profit as it forces him to set $u_{hl}^* = u_{lh}^*$ via the binding OC. We can now derive the following result.

Proposition 3 (Additional Agency Costs)

Inequity aversion among agents causes additional agency costs of implementing effort. These agency costs weakly increase and converge as the level of inequity aversion rises.

Proof: Suppose $r\psi \geq 1$. The IAC are then given by (17) and $r\psi \geq 1$ ensures (17) > 0 . Differentiating (17) with respect to α yields

$$\frac{\partial IAC}{\partial \alpha} = \frac{2(1-\pi)(1+\alpha(r\psi+\pi))(r\psi(1+\alpha\pi)-\alpha\pi)}{rk^2}, \quad (20)$$

which is strictly positive as $r\psi \geq 1$. The limit of IAC is given by

$$\lim_{\alpha \rightarrow \infty} IAC = \frac{1-\pi}{1+\pi} \left[r\psi(2\pi+r\psi) - 1 \right], \quad (21)$$

where $r\psi \geq 1$ again ensures the expression to be positive. Suppose now $r\psi < 1$. In case $\alpha \leq \tilde{\alpha}$ the above arguments on sign of IAC and their derivative w.r.t. α apply. In case $\alpha > \tilde{\alpha}$ the IAC are given by (19) which is positive as we have $r > 0$, $\psi > 0$, and $\pi \in]0, 1[$, does not change in α , and is thus equal to the limit as $\alpha \rightarrow \infty$. q.e.d.

Proposition 3 proves that the negative effect of inequity aversion on the PC always dominates the positive effect on the IC. The negative effect of inequity is however bounded because the principal can always equate w_{hl} and w_{lh} if α becomes too large. The optimal contract then remains unchanged as α further increases. The intuition for the dominance of the effect on the PC can best be seen when approaching the problem from a different angle. Inequity aversion effects a utility loss in certain states of the world. If the resulting reduced utility level were second-best optimal, then they could be realized without inequity aversion as well – simply by lowering wage payments. As lower utility levels are not second-best optimal without inequity aversion, they cannot be optimal now. In the appendix we show that this intuition straightforwardly generalizes to less restrictive settings.

As an alternative intuition for the result consider the following. Suppose the OC is binding. To eliminate suffering from inequity aversion utility levels in case of diverging output realizations are equated. This clearly impairs incentives to exert effort. Hence, in cases with identical output realizations wage payments must become more extreme. Agents then have to bear more risk for which they must be compensated. The same reasoning holds true if the OC is not binding. In addition to the increased risk, agents then also have to be compensated for the inequity they bear despite the wage compression in case output realizations diverge. This leads to the next proposition.

Proposition 4 (Complementarity)

The more risk averse the agents, the higher the additional agency costs due to inequity aversion.

Proof: In case the OC does not bind the IAC are given by (17). Differentiating (17) with respect to r yields

$$\frac{\partial IAC}{\partial r} = \frac{(1 - \pi)\alpha^2(\pi + r^2\psi^2)}{rk^2} \tag{22}$$

which is unambiguously positive. In case the OC binds and the IAC are given by (19) the respective partial derivative is clearly positive. q.e.d.

Since contracts that account for inequity aversion lead to more risk bearing, the higher the degree of risk aversion, the higher the additional agency costs caused by inequity aversion. Risk aversion and inequity aversion thus have complementary effects.

Consider the extreme case of risk neutral agents, i.e. $u(w) = w$. The principal's expected incentive compatible wage payment per agent is then $\psi + \pi(1 - \pi)(\alpha + \beta)(w_{hl} - w_{lh})$, the sum of the first-best costs of implementing effort and compensation for inequity bearing. Notice that in the context of this model a limited liability constraint will never bind as we have normalized the success probability when shirking to zero. There is thus no rent that has to be given to the agent, i.e. the PC is binding. Since inequity aversion has an unambiguously negative effect on the PC, any amount of inequity decreases the principal's expected profit. A possible positive effect of inequity aversion on incentive provision cannot be realized since incentives can be provided at first-best costs already. With risk neutral agents (and no limited liability constraint binding) a large set of optimal contracts can implement efficient effort choices at first-best costs. With inequity aversion only a subset of these optimal contracts remains optimal, namely those contracts with $w_{hl} = w_{lh}$. The remaining subset of optimal

contracts is however non-empty. For example, the contract with $w_{hh} = \psi/\pi^2$ and $w_{hl} = w_{lh} = w_{ll} = 0$ is always possible. It provides incentives at first-best costs and eliminates all inequity. We summarize our findings in the following proposition.

Proposition 5 (Risk Neutrality)

With risk-neutral agents and no limited liability constraint binding, inequity aversion reduces the set of optimal contracts but does not impact the equilibrium outcome.

Itoh (2003) also analyzes a moral hazard setting with risk-neutral agents but assumes limited liability constraints to bind. In this case agents receive a rent. Inequity aversion provides the principal with the possibility to reduce an agent’s utility below the level that arises from paying the lowest possible wage level, simply by paying other agents more. Inequity aversion can thus reduce the principal’s rent payments in case of effort implementation, and inequity aversion can then have an impact on the equilibrium outcome.

4.3 Inequity Aversion and Efficiency

In this section we derive the conditions under which inequity aversion causes an efficiency loss similar to the efficiency loss that arises if risk aversion renders flat wage contracts optimal. There are however two qualitative differences between risk agency costs, RAC, and inequity agency costs, IAC. First, the RAC are unbounded. Therefore, an efficiency loss due to underprovision of effort always occurs if only risk aversion is sufficiently large. In contrast, the IAC are bounded. It can be that no inefficiency arises even if the degree of inequity aversion goes to infinity. The reason is that the principal can always equate wage levels in case of diverging output realizations, thereby eliminating inequity while still providing incentives. It is however not possible to provide incentives and eliminate agents’ risk. Second, if the RAC are large the principal can only offer flat wage contracts to avoid the agents’ risk exposure. In contrast, there are two means by which inequity can be avoided. As with risk aversion, the principal can either offer flat wage contracts – thereby forgoing profits from effort implementation. We call this case ‘underprovision of effort’. Or he can employ a single agent only. Then there is no reference group and thus no social comparisons and no suffering from inequity. The principal will then provide incentives to a single agent – thereby forgoing the profit from employing the second agent. We call this the ‘reference group effect’. In the following we identify the conditions under which either case arises.

4.3.1 Underprovision of Effort

Two conditions have to be met such that inequity aversion renders flat wage contracts more profitable than incentive contracts. First, the expected profit from two flat wage contracts must exceed expected profits from a single incentive contract. This condition ensures that offering two flat wage contracts is the best alternative to offering two incentive contracts. Second, for sufficiently high levels of α the IAC must exceed the difference in expected profits from two incentive contracts (without inequity aversion) and two flat wage contracts. With flat wage contracts wages never diverge and inequity aversion is irrelevant. This is summarized in the following proposition.

Proposition 6 (Underprovision of Effort)

If and only if $x_l \geq B$ and $2B < \lim_{\alpha \rightarrow \infty} IAC$, there exists a threshold level of inequity aversion $\hat{\alpha}$ such that for all $\alpha \geq \hat{\alpha}$ flat wage contracts maximize the principal's expected profit, even though incentive contracts are profit maximizing with selfish or unrelated agents.

Proof: The first condition ensures that expected profit from two flat wage contracts exceed expected profits from a single incentive contract. Formally, $P_2^f = 2x_l \geq x_l + B = P_1^i \Leftrightarrow x_l \geq B$. Consider now the second condition. P_2^i denotes the principal's expected profit when offering two incentive contracts. If $\alpha = 0$ we have $P_2^i(\alpha = 0) = 2P_1^i$. By assumption, $2P_1^i - P_2^f = 2B > 0$. Without inequity aversion the principal thus employs both agents and implements high effort. By Proposition 3, P_2^i decreases in α and converges to

$$\lim_{\alpha \rightarrow \infty} P_2^i(\alpha) = 2P_1^i - \lim_{\alpha \rightarrow \infty} IAC. \quad (23)$$

We thus have $P_2^f > \lim_{\alpha \rightarrow \infty} P_2^i$ if and only if

$$2B < \lim_{\alpha \rightarrow \infty} IAC. \quad (24)$$

From (17) and (19) we know that $\lim_{\alpha \rightarrow \infty} IAC > 0$. The parameter space for which (24) holds is thus non-empty. If $2B$, the gain of providing incentives to two agents, falls short of $\lim_{\alpha \rightarrow \infty} IAC$, the limit of the inequity agency costs of providing incentives, there exists a unique threshold level of inequity aversion $\hat{\alpha}$ such that for $\alpha < \hat{\alpha}$ two incentive contracts, and for $\alpha \geq \hat{\alpha}$ two flat wage contracts maximize the principal's expected profit. Existence and uniqueness of threshold $\hat{\alpha}$ is ensured since P_2^i is continuous and strictly decreasing in α . q.e.d.

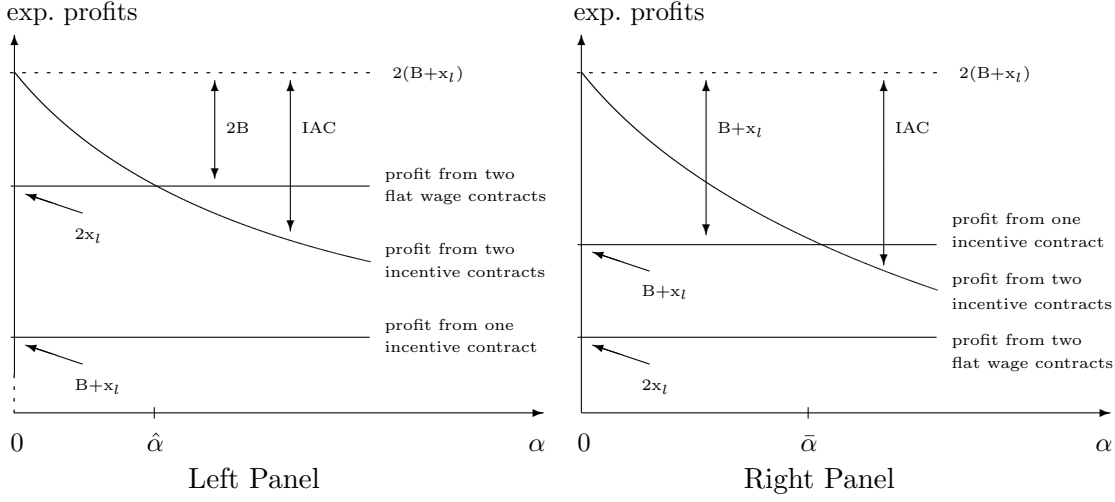


Figure 1: **Underprovision of Effort and the Reference Group Effect.**

Left Panel: Expected profit levels for $B < x_l$. In this case expected profits from two flat wage contracts exceed profits from one incentive contract. If the additional agency costs due to inequity aversion, IAC, exceed the difference in expected profits between flat wage and incentive contracts, $2B$, as α increases, then there exists a threshold level $\hat{\alpha}$ such that two flat wage contracts maximize the principal's expected profit for $\alpha \geq \hat{\alpha}$.

Right Panel: Expected profit levels for $x_l < B$. In this case expected profits from one incentive contract exceed profits from two flat wage contracts. If the additional agency costs due to inequity aversion, IAC, exceed the expected profit from an additional incentive contract absent inequity aversion, $B + x_l$, as α increases, then there exists a threshold level $\bar{\alpha}$ such that a single incentive contract maximizes the principal's expected profit for $\alpha \geq \bar{\alpha}$.

The left panel of Figure 1 provides an illustration of Proposition 6. Without inequity aversion, $\alpha = 0$, expected profits from two incentive contracts exceed expected profits from both two flat wage contracts and a single incentive contract. Condition $x_l \geq B$ ensures that the principal's best alternative to offering two incentive contracts is offering two flat wage contracts. As α increases, the IAC increase and reduce the principal's expected profit from two incentive contracts. At $\hat{\alpha}$ the IAC equal the difference in expected profits between two incentive and two flat wage contracts, $2B$. Therefore, for levels of inequity aversion exceeding $\hat{\alpha}$, two flat wage contracts maximize the principal's expected profit.

Proposition 6 is the central finding our this paper: inequity aversion can render flat wage contracts optimal even though incentive contracts are optimal with selfish agents. We interpret this as an explanation for the observed 'low powered' incentives within firms – as compared to 'high powered' incentives in the market. This interpretation

hinges upon the assumption that agents compare their wage payments within firms but not within the market. Although the determinants of an agent's reference group will ultimately be an empirical question, co-workers within a firm are a natural candidate for a reference group. However, crucial to our analysis is that there are two agents who compare their wages and dislike inequity. Our results – though not our interpretation – would hold if we assumed two principals, each of them offering an incentive contract to a single agent, and these two agents comparing wages.

4.3.2 The Reference Group Effect

Suppose now that the principal can influence an agent's reference group. Two conditions have to be met such that inequity aversion renders it more profitable for the principal to offer an incentive contract to a single agent than offering incentive contracts to two agents. When two inequity averse agents work for the principal they compare their wage levels and suffer from inequity. In contrast, with a single agent no comparisons take place, and thus no IAC arise. In Section 5 we further explore this 'reference group' or 'firm size effect' in a slightly enriched setting; for completeness we now derive the conditions that have to be met in this basic set-up. First, the expected profit from a single incentive contract must exceed expected profits from two flat wage contracts. This condition ensures that offering a single incentive contract is the best alternative to offering two incentive contracts. In contrast to the previous section, here it must hold that $x_l < B$. Second, for sufficiently high levels of α the IAC must exceed the difference in expected profits from offering two incentive contracts (without inequity aversion) and expected profits from offering a single incentive contract. With a single incentive contract inequity aversion is irrelevant as there is no reference group. This is summarized in the following proposition.

Proposition 7 (Reference Group Effect)

If and only if $x_l < B$ and $B + x_l < \lim_{\alpha \rightarrow \infty} IAC$, there exists a threshold level of inequity aversion $\bar{\alpha}$ such that for $\alpha > \bar{\alpha}$ the principal employs a single agent only to avoid social comparisons, even though employing both agents maximizes the principal's expected profit without inequity aversion.

Proof: As before, $P_2^i(\alpha = 0) = 2P_1^i$ such that without inequity aversion it maximizes the principal's expected profit to employ both agents and implement high effort. However, P_2^i decreases as α rises, and it may eventually fall short of P_1^i . As $P_1^i = P_1^f + B$

and $P_1^f = x_l$, it holds that $\lim_{\alpha \rightarrow \infty} P_2^i < P_1^i$ if and only if

$$B + x_l < \lim_{\alpha \rightarrow \infty} IAC. \quad (25)$$

From (17) and (19) we know that $\lim_{\alpha \rightarrow \infty} IAC > 0$, so the parameter space for which (25) holds true is non-empty. Whenever the base output, x_l , and the benefit from giving incentives, B , are sufficiently small, there exists a unique level of inequity aversion $\bar{\alpha}$ such that for $\alpha < \bar{\alpha}$ two incentive contracts, whereas for $\alpha \geq \bar{\alpha}$ a single incentive contract maximizes the principal's expected profit. Existence and uniqueness of threshold $\bar{\alpha}$ is ensured since P_2^i is continuous and strictly decreasing in α . q.e.d.

The right panel of Figure 1 provides an illustration of Proposition 7. Without inequity aversion, $\alpha = 0$, expected profits from two incentive contracts exceed expected profits from both two flat wage contracts and a single incentive contract. Condition $x_l < B$ ensures that the principal's best alternative to offering two incentive contracts is offering a single incentive contract. As α increases, the IAC increase and reduce the principal's expected profit from two incentive contracts – but not the expected profit from a single incentive contract as in this case no social comparisons take place. At $\bar{\alpha}$ the IAC equal the expected profit from an additional incentive contract without inequity aversion, $x_l + B$. Therefore, for levels of inequity aversion exceeding $\bar{\alpha}$, a single incentive contract maximizes the principal's expected profit.

In case neither $x_l \geq B$ and $2B < \lim_{\alpha \rightarrow \infty} IAC$, the conditions stated in Proposition 6, nor $x_l < B$ and $B + x_l < \lim_{\alpha \rightarrow \infty} IAC$, the conditions stated in Proposition 7, there is no inefficiency caused by the additional agency cost due to inequity aversion – even if the degree of inequity aversion goes to infinity. The principal is nevertheless harmed by inequity aversion since his expected profit is reduced by the amount of the IAC. In contrast, the RAC will always lead to an inefficiency if only the degree of risk aversion becomes sufficiently large.

The effect of inequity aversion in the case with ‘underprovision of effort’ is qualitatively similar to the effect of risk aversion. Providing incentives becomes more expensive as either aversion becomes more pronounced, and this may render flat wage contracts optimal for the principal. However, the ‘firm size effect’ is qualitatively different from the inefficiency that can arise due to risk aversion. The principal can respond to risk aversion only by adopting an agent's contract, whereas with inequity aversion – or more generally with social preferences – he has an additional instrument at hand as he can control the agents' reference groups. Incorporating this finding into richer

models with, for example, heterogeneous agents with respect to the degree of inequity aversion or productivity, or allowing for multi-tasking will yield deeper insights into the determinants of real world wage contracts, the optimal design of institutions, and the boundary of the firm. In the following section, while keeping the assumption of homogeneous agents, we enrich the model by allowing the principal to separate the agents into different firm at a fixed cost. We will argue that the interaction between inequity aversion and moral hazard can contribute to the old question of the nature and size of the firm.

5 The Nature and Size of the Firm

The ‘property rights approach’ of the theory of the firm – pioneered by Grossman and Hart (1986) and Hart and Moore (1990) – defines a firm as the physical assets it consists of. In contrast to the ‘transaction cost approach’ of the theory of the firm (Coase (1937), Williamson (1975, 1985)), the property rights approach can explain both, advantages and disadvantages (better incentives to invest for one, but worse incentives for the other party) of ‘integration’ within a unified framework. An optimal degree of integration, that is, an optimal firm size can thus be determined. In this section, we propose a new approach. We focus on one characteristic that distinguishes the firm from the market. The firm is seen as an economic entity within which social comparisons matter – in contrast to the market in which they are negligible.

In this section we enrich our model by endowing the principal with the option to separate the agents by setting up an additional firm. We assume that agents compare payoffs only with agents that work within the same firm but not with agents that work in distinct firms.¹⁰ Additional agency costs due to inequity aversion can thus be avoided by separating agents into different firms. If agents can be separated, that is, if social comparisons can be prevented at not cost, the purpose of this paper dissolves. The principal would then always separate the agents. However, we further assume that setting up a firm involves the expense of fixed costs, denoted by F . These fixed costs are taken to be sufficiently low such that the principal realizes positive profits when offering an incentive contract to a single agent, that is $F < P_1^i$. Alternatively, complementarities in production could be assumed such that, absent inequity aversion, it is advantageous to have agents work together.

¹⁰See, for example, Rotemberg (2002) for evidence on ‘human relations’ in the workplace.

The principal now faces a trade off. On the one hand, employing two agents within a single firm economizes on fixed costs (or enables the principal to realize complementarities in production). On the other hand, integrating the agents within a single firm provokes social comparisons that increase agency costs of providing incentives. The solution to this trade-off thus defines the optimal size of the firm, whether there is ‘integration’ of both agents within a single firm or ‘separation’ of the agents into two distinct firms. If the firm is integrated, we can have both, incentive and flat wage contracts. In case of separation, the principal will always offer incentive contracts. The following proposition identifies the conditions under which either regime is optimal.

Proposition 8 (Optimal Firm Size)

- i) If and only if $F \leq \min[\lim_{\alpha \rightarrow \infty} IAC, 2B]$ then there exists a threshold level of inequity aversion $\hat{\alpha}$ such that for $\alpha \geq \hat{\alpha}$ separation is optimal: The principal bears fixed costs F twice to set up two distinct firms, and she offers in each firm a single incentive contract. For $\alpha < \hat{\alpha}$ integration is optimal: The principal sets up a single firm and offers two incentive contracts.*
- ii) If $F > 2B$ then there is always integration, irrespective of the degree of inequity aversion α . If, in addition, $\lim_{\alpha \rightarrow \infty} IAC \leq 2B$ then integration with incentive contracts is optimal for all α . If, in addition, $\lim_{\alpha \rightarrow \infty} IAC > 2B$ then there exists a threshold level of inequity aversion $\bar{\alpha}$ such that for $\alpha \geq \bar{\alpha}$ integration with flat wage contracts is optimal, whereas for $\alpha < \bar{\alpha}$ integration with incentive contracts is optimal.*

Proof: i) If $F \leq 2B$ then it is always better to offer incentive contracts in two separated firms than to offer two flat wage contracts within a single firm. Recall that the gain of providing incentives is given by B per agent, while the cost of setting up a second firm is F . Notice that in both cases the degree of inequity aversion is irrelevant. The best alternative to offering two incentive contracts within a single firm is thus separating the agents in two firms but still offering incentive contracts. Integrating two agents with incentive contracts saves on fixed costs but provokes social comparisons, that is additional agency costs IAC . If the latter exceed the first, $F \leq IAC$, then separation becomes optimal. From Proposition 3 we know that the IAC rise with the degree of inequity aversion α ; at $\alpha = 0$ we have $IAC = 0$. If $F \leq \lim_{\alpha \rightarrow \infty} IAC$ there must thus exist a threshold level $\hat{\alpha}$ such that for $\alpha < \hat{\alpha}$ we have $F > IAC$, i.e. integration, and for $\alpha \geq \hat{\alpha}$ we have $F \leq IAC$, i.e. separation.

ii) If $F > 2B$ then, by the above arguing, the best alternative to offering two incentive contracts within a single firm is offering two flat wage contracts within a single firm. Notice that it is never optimal to offer flat wage contracts and to separate the agents. Even if the IAC become very large there is thus never separation. Absent inequity aversion the profit difference between the two regimes is $2B$. If $\lim_{\alpha \rightarrow \infty} IAC \leq 2B$ there will thus always be integration with incentive contracts. If however $\lim_{\alpha \rightarrow \infty} IAC > 2B$ then, by the above arguing, there exists a threshold $\bar{\alpha}$ such that for $\alpha < \bar{\alpha}$ integration with incentive contracts is still optimal but for $\alpha \geq \bar{\alpha}$ integration with flat wage contracts becomes optimal. q.e.d.

Figure 2 offers an illustration of Proposition 8. In all cases, at $\alpha = 0$ the expected profits from two integrated incentive contracts exceeds the expected profit either from offering separated incentive contracts or offering two integrated flat wage contracts. Notice that separated flat wage contracts can never be optimal. The left panel of Figure 2 shows expected profit levels in case $F < 2B$. This condition ensures that expected profits from two separated incentive contracts exceed profits from two integrated flat wage contracts. If the additional agency costs due to inequity aversion, IAC, exceed the cost of separation, F , as α goes to infinity, then there exists a threshold level $\hat{\alpha}$ such that expected profits from two separated incentive contracts exceed expected profits from two integrated incentive contracts for $\alpha \geq \hat{\alpha}$.

The right panel of Figure 2 shows expected profit levels in case $F > 2B$. This condition ensures that expected profits from two integrated flat wage contracts exceed profits from two separated incentive contracts. If the IAC exceed the expected profit difference between two integrated incentive contracts absent inequity aversion and two integrated flat wage contracts, $2B$, as α goes to infinity, then there exists a threshold level $\bar{\alpha}$ such that expected profits with two integrated flat wage contracts exceed expected profits with two integrated incentive contracts for $\alpha \geq \bar{\alpha}$.

In this section we have argued that social comparisons can contribute to the old question of the the optimal degree of integration. We do not claim that social comparisons can fully explain the size of the firm nor do we claim that they are the *main* determinant. However, many situation are imaginable where an employer – being indifferent otherwise – wants to separate employees to prevent social comparisons. Even though throughout the paper we did not model heterogeneity in agents’ productivity, consider the observation that many firms outsource activities very often (but certainly not exclusively) at the extreme ends of the productivity scale. There are often external

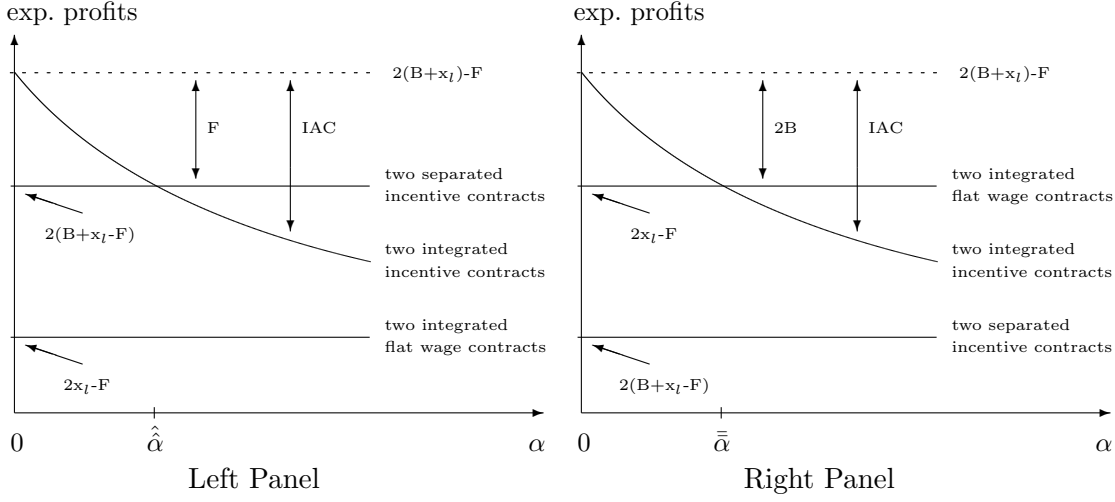


Figure 2: **The Optimal Firm Size.**

Left Panel: Expected profit levels with $F < 2B$. In this case expected profits from two separated incentive contracts exceed profits from two integrated flat wage contracts. If the additional agency costs due to inequity aversion, IAC, exceed the cost of separation, F , as α increases, then there exists a threshold level $\hat{\alpha}$ such that separated incentive contracts become optimal for $\alpha \geq \hat{\alpha}$.

Right Panel: Expected profit levels with $F > 2B$. In this case expected profits from two integrated flat wage contracts exceed profits from two separated incentive contracts. If the IAC exceed the expected profit difference between integrated incentive contracts absent inequity aversion and integrated flat wage contracts, $2B$, as α increases, then there exists a threshold level $\bar{\alpha}$ such that integrated flat wage contracts become optimal for $\alpha \geq \bar{\alpha}$.

consultants that are, in comparison to customary wage levels within the firm, relatively well paid. By the same token, employees of external cleaning companies earn relatively little. Outsourcing of these activities may thus – at least partly – be explained by the intent to maintain a balanced wage structure within the ‘core of the firm.’

An employer may not necessarily separate employees into different firms but, in case this sufficiently cuts down social comparisons, into different, say, departments of a firm. In this case our model can contribute to the literature on the internal organization of the firm. Consistent with our arguing is also the observation that within firms (or any other organization) there are often many small rungs in the job ladder, all distinguished by differentiated job titles (junior analyst, senior analyst, junior consultant, senior consultant, etc.). If employees tend to compare only to other employees on same rung of the job ladder and accept that, for example, employees ‘above them’ may earn more, then ‘separating’ agents into different ‘job categories’ may be explained by the

employer’s intent to cut down social comparisons. The determinants of employees’ relevant reference groups – be it a firm, a department, a job category, or some other attribute – will ultimately be an empirical question. However, we claim that co-workers within the same firm are a natural candidate.

6 Secrecy of Salaries

The central result of the paper states that inequity aversion among agents increases agency costs. At first sight our results could serve as an explanation for the fact that many labor contracts impose a clause that prohibits employees from communicating their salaries to their colleagues. If – by way of secret salaries – social comparisons can be prevented, the increase in agency costs can be prevented as well. In this section we show that this is not necessarily the case.

Suppose agents can be separated such that the other agent’s output realization is not observable. Suppose further that wages do not get communicated because labor contracts prohibit this but that the contracts themselves are common knowledge. We maintain the assumption that the agents’ reference group is the respective other agent that is employed with the same principal. (If agents can be separated in a way such that they do not compare themselves any longer the IAC can trivially be avoided.) We now derive the optimal incentive contract for both agents. Even though the agents cannot observe each other’s project outcome and wages, they know that their wages differ in certain states of the world because an incentive contract must condition wages on project realizations. In order not to transfer information about the other agent’s project outcome, each agent’s wage can only depend on his own output realization. Thus, there are two wage levels only. The principal therefore maximizes

$$P_2^s = 2x_l + 2\pi^2[\Delta x - h(u_h)] + 2\pi(1 - \pi)[\Delta x - h(u_h) - h(u_l)] - 2(1 - \pi)^2h(u_l) \quad (26)$$

with respect to u_h , u_l , and under the incentive and participation constraint

$$\begin{aligned} \text{(IC'')} & \quad \pi(1 + \alpha\pi)(u_h - u_l) - \psi \geq 0 \\ \text{(PC'')} & \quad \pi u_h + (1 - \pi)(u_l - \pi\alpha(u_h - u_l)) - \psi \geq 0 \end{aligned}$$

Superscript s stands for ‘secrecy contract’. Solving the resulting first-order conditions yields

$$u_h^* = \frac{\psi}{\pi} \quad \text{and} \quad u_l^* = \frac{\alpha\psi}{1 + \alpha\pi}. \quad (27)$$

At $\alpha = 0$ wages and profit equal (twice) the single agent solution. With α increasing the low wage increases in order to reduce inequity, and the principal's expected profit falls. Differentiating P_2^s with respect to α yields

$$\frac{\partial P_2^s}{\partial \alpha} = -\frac{2(1-\pi)\psi(1+\alpha(\pi+r\psi))}{(1+\alpha\pi)^3} \quad (28)$$

which is unambiguously negative. We can establish the following proposition.

Proposition 9 (Secrecy of Salaries)

Separating the agents such that project outcomes and wages are unobservable amplifies the negative effect of inequity aversion if the agents reference group remains the respective other agent and contracts are common knowledge.

Proof: Comparing (28) to (20) it can be seen that the ‘secrecy profit’ falls faster in α than the profit in the two agents case. Subtracting (28) from (20) yields $(2(1-\pi)\alpha\pi(1+\alpha(\pi+r\psi))(1+\alpha(\pi(\pi(3+\alpha\pi(3+\alpha\pi))) + (2+\alpha\pi(4+\alpha(1+2\pi)))r\psi))/(rk^2(1+\alpha\pi)^3)$ which is always positive. q.e.d.

The ‘secrecy contract’ is therefore never optimal. Covering up the respective other agent’s output realization and wage payments with intent to avoid social comparisons does not mitigate but amplifies the principal’s problem. In the ‘secrecy contract’ wage payments cannot depend on both agent’s output realizations since this would reveal the respective other agent’s outcome realization and thus wage payment. In states with diverging output realizations wages can therefore not be compressed as it was found optimal in the previous sections. This restriction on the contract design renders the ‘secrecy contract’ too costly.

7 Discussion

7.1 Rent Comparison

Suppose now that agents compare rents, that is they explicitly account for effort cost in their inequity term. Notice first that in equilibrium both agents exert effort such that effort terms cancel out in the PC. We must, however, reconsider the IC because an agent now has to account for the difference in effort costs in the inequity term when considering to shirk. The IC can now be written as

$$\begin{aligned} (\text{IC}_\psi) \quad & \pi^2 u_{hh} + \pi(1-\pi)u_{hl} - \pi^2 u_{lh} - \pi(1-\pi)\alpha(u_{hl} - u_{lh}) \\ & + \pi\alpha \max[u_{hl} - \psi - u_{lh}, 0] - \pi(1-\pi)u_{ll} - \psi \geq 0. \end{aligned}$$

Subtracting the l.h.s. of (IC_ψ) from the l.h.s. of (IC) , the IC if effort costs are not considered in the inequity term, yields

$$\pi\alpha((2 - \pi)(u_{hl} - u_{lh}) - \max[u_{hl} - \psi - u_{lh}, 0]) \quad (29)$$

which is always positive. Hence, considering effort costs in the inequity term can only increase agency costs thereby reinforcing our results. The intuition is straightforward. The expected utility when shirking increases because suffering from being behind is now lower. The difference in utility from wages is reduced by the amount of effort costs, if not cancelled. The incentive to exert effort is thus reduced.

7.2 Disutility from Being Better Off

In their original formulation of inequity aversion Fehr and Schmidt (1999) assume that inequity averse individuals dislike both unfavorable and favorable inequity. In this section we discuss the implications if suffering from being better off is incorporated in our model. It now makes a crucial difference whether effort costs enter the comparison or not.

Consider first the case in which agents compare utility from wages only. Instead of the simplified version of inequity aversion assumed in the previous sections, agents' utility function is now given by

$$v_i(w_i, w_j) = u(w_i) - \psi - \alpha \cdot \max[u(w_j) - u(w_i), 0] - \beta \cdot \max[u(w_i) - u(w_j), 0]. \quad (30)$$

If $\beta > 0$, agents suffer from receiving a higher wage than the respective other agent. Suppose the principal offers incentive contracts to both agents. Incorporating disutility from being better off into our model has two effects. First, the agents' PCs are tightened. If agents are paid different wages in case their project outcomes differ, an agent now also suffers from inequity whenever he is fortunate whereas the other agent is not. As this happens with positive probability agents have to be compensated. Second, incentive provision is impaired because suffering from being better off clearly reduces the incentive to exert effort. Recall that the results in our model are driven by the observation that the overall impact of inequity aversion on the principal's profit is negative – even when neglecting the utility loss from being better off. Incorporating this disutility adds an unambiguously negative effect and would thus only reinforce our results.

Consider now the case in which effort costs enter the inequity term. Again, the PC is tightened if $\beta > 0$. In equilibrium both agents exert effort and effort costs thus cancel in the inequity term. However, effort cost enter the IC and suffering from being better off may now *facilitate* incentive provision. To see this, assume the most extreme case, which is $\psi > u_{hl} - u_{lh}$. A shirking agent that saves on effort costs is then always better off than the other agent (who works) even if the other agent receives the higher wage in case of diverging output realizations. The IC can then be written as

$$(IC_\beta) \quad \begin{aligned} \pi^2 u_{hh} + \pi(1 - \pi)u_{hl} - \pi^2 u_{lh} - \pi(1 - \pi)u_{ll} - \psi \\ - \pi(1 - \pi)\alpha(u_{hl} - u_{lh}) + \beta[\psi - \pi(2 - \pi)(u_{hl} - u_{lh})] \geq 0. \end{aligned}$$

The positive effect of β on the IC_β may be very strong. As long as Δx is sufficiently large to ensure $B \geq 0$, ψ can become very large without violating our assumption that incentive contracts are optimal without inequity aversion. Intuitively, if an agent shirks he saves on effort costs and may thus be better off than the other agent who exerts effort. If agents suffer from being better off incentives to exert effort are increased. This effect could, in principle, be so strong that agency costs are *lowered* in comparison to the case without inequity aversion.¹¹

7.3 Status Seeking

In the previous section we have discussed the possibility that agents suffer from being better off than others. In contrast, suppose now that agents are status seekers, that is they receive *additional* utility from being better off than others. In the context, of this model this translates into $\beta < 0$. Incorporating status seeking into our model has two effects. First, the agents' participation constraints are relaxed. Whenever diverging project outcomes realize the successful agent receives additional utility from being better off than the unsuccessful agent. Second, there is an positive effect on incentives because on top of a high wage an agent receives 'status utility' whenever he is successful whereas the other agent is not. In summary, the unambiguously positive effect of status seeking on the principal's profit opposes the negative effect of inequity aversion that we have identified in this paper. Since there is no natural lower bound on β agency costs could, in principle, be reduced without bounds. Carrying this effect to the extremes, status seeking would eventually result in contracts in which agents actually pay the principal in order to be employed and sometimes receive 'status utility'.

¹¹This effect is analyzed in Bartling and von Siemens (2004).

This is only reinforced if effort costs are considered in the inequity terms. However, in this paper we focus on the more natural and more interesting case in which other-regarding preferences provoke a trade-off between the positive effect on the incentive and the negative effect on the participation constraint.

8 Conclusion

Recent insights from experimental economics have shown that many people are not fully selfish but have some kind of social preferences. This, in turn, raises the question of how other-regarding behavior interacts with incentive provision. In a moral hazard model with risk averse agents we have shown that inequity aversion among agents unambiguously *increases* agency costs unless agents compare rents *and* suffer from being better off. As a result, optimal contracts for inequity averse agents may be ‘low powered’, equitable flat wage contracts even when ‘high powered’ incentive contracts are optimal with selfish agents. Accounting for inequity aversion may thus offer an explanation for the scarcity of incentive contracts many real world situation – in which verifiable performance measures would be available but are not contracted upon.

More specifically, assuming that social comparison are pronounced within firms but less so in the market, we have argued that inequity aversion helps to understand Williamson’s (1985) observation that incentives offered to employees within firms are generally low powered as compared to ‘high powered’ incentive in markets.

Furthermore, we have argued that inequity aversion among agents and the resulting increased agency costs contribute to the old question of the boundary of the firm. In an enriched setting of the basic model, the principal could set up a second firm to separate the agents with intent to avoid social comparisons. If this involves costs, the principal faces the trade-off to either bear increased agency costs or the cost of operating the second firm. The solution to this trade-off defines an optimal size of the firm.

Incorporating our findings into richer models with, for example, heterogeneous agents with respect to the degree of inequity aversion or productivity, or allowing for multi-tasking promises to yield further insights into the determinants of real world wage contracts, the optimal design of institutions, and the boundary of the firm.

Appendix

Throughout the paper we have assumed an explicit utility function in order to obtain simple closed form solutions. As in Fehr and Schmidt (1999) we also assumed a linear inequity term. In this appendix we show that our results hold true for any concave utility function and irrespective of the functional form the inequity term. To show and illustrate the basic reasoning we, firstly, maintain the assumption that there are only two possible output realizations. Later we will drop this restriction and allow for arbitrary numbers of possible output realizations.

As benchmark, consider the single agent case. With only two possible outcome realizations, wage levels are well-defined by the incentive and participation constraints. Recall that the utility level arising from the wage payment in case of a high output realization is given by u_h , in analogy we defined u_l . From

$$\begin{aligned} (\tilde{IC}) \quad & \pi u_h + (1 - \pi)u_l - \psi \geq \pi' u_h + (1 - \pi')u_l \\ (\tilde{PC}) \quad & \pi u_h + (1 - \pi)u_l - \psi \geq 0 \end{aligned}$$

we thus get

$$u_h^* = \frac{(1 - \pi')\psi}{\pi - \pi'} \quad \text{and} \quad u_l^* = -\frac{\pi'\psi}{\pi - \pi'}. \quad (31)$$

If now a second agent is introduced and wages are contingent on the respective other agent's output realization, each agent faces an additional lottery. Suppose an agent's outcome realization is high. If the other agent works, he will also receive a high output realization with probability π , and a low output realization with probability $1 - \pi$. Recall that u_{ij} was defined as an agent's utility from wage w_{ij} , if the agent's output is i and the other agent's output is j . Absent inequity aversion we must have

$$\pi u_{hh} + (1 - \pi)u_{hl} = u_h^* \quad \text{and} \quad \pi u_{lh} + (1 - \pi)u_{ll} = u_l^* \quad (32)$$

The inverse function $h = u^{-1}$ specifies the wage payment that is necessary to generate a certain utility level. The principal minimizes wage payments $h(u_{hh})$ and $h(u_{hl})$, and $h(u_{lh})$ and $h(u_{ll})$ such that (32) holds. From the first-order condition

$$\pi h'(u_{hh}) + (1 - \pi)h'(u_{hl})(-\pi)/(1 - \pi) = 0 \quad (33)$$

and convexity of $h(\cdot)$ it follows that $u_{hh}^* = u_{hl}^* = u_h^*$ and, equivalently, $u_{lh}^* = u_{ll}^* = u_l^*$. The intuition is straightforward. The second-best utility levels that induce the agent to exert effort are given by u_h^* and u_l^* . If an agent's wages depend on the other agent's

output realization, in expectation he should nevertheless receive u_h^* and u_l^* . Incentives are thus not affected but contingent wages introduce an additional lottery, and agents must be compensated for the associated risk. Absent inequity aversion, wages will thus be independent of the other agent's output realization.

Consider now inequity averse agents. The second-best optimal utility levels in case of high and low output realizations are still given by u_h^* and u_l^* , respectively. However, in case of diverging output realizations there is now a utility loss arising from the inequity. In analogy to (32) wage levels must now be such that

$$\pi u_{hh} + (1 - \pi)(u_{hl} - \alpha \max[u_{lh} - u_{hl}, 0]) = u_h^*, \quad \text{and} \quad (34)$$

$$\pi(u_{lh} - \alpha \max[u_{hl} - u_{lh}, 0]) + (1 - \pi)u_{ll} = u_l^*. \quad (35)$$

It can be seen that the cost of providing the second-best optimal utility level are weakly increasing in the level of inequity aversion α . Consider the following reasoning.

1. Fix u_{hl} at some level.
2. Consider the set of (u_{lh}, u_{ll}) such that an agent with a low output realization receives an expected utility level of u_l^* .
3. Given any u_{lh} , the level of u_{ll} to yield u_l^* is given by

$$u_{ll} = \frac{u_l^* - \pi u_{lh} + \pi \alpha \max[u_{hl} - u_{lh}, 0]}{1 - \pi} \quad (36)$$

4. Hence, the cost to implement u_l^* weakly increases in α .

The reasoning for u_h^* is analogous.

Figure 3 illustrates the above reasoning and shows how inequity aversion tightens the constraints subject to which the principal minimizes costs. The decreasing, parallel lines depict combinations of u_{hh} and u_{hl} , and u_{lh} and u_{ll} that lead to expected utility levels of u_h^* and u_l^* , respectively. The total differential of (32) at constant utility levels yields their slope with $-(1 - \pi)/\pi$. The iso-cost curves in the case without inequity aversion are tangent at $u_{hh}^* = u_{hl}^* = u_h^*$, and $u_{lh}^* = u_{ll}^* = u_l^*$, as argued above. Consider now the case with inequity aversion. Algebraically, the combinations of u_{hh} and u_{hl} , and u_{lh} and u_{ll} that lead to expected utility levels of u_h^* and u_l^* are now given by (34) and (35), respectively. The total differential of (34) while setting $du_h = 0$ yields

$$\frac{du_{hh}}{du_{hl}} = -\frac{(1 - \pi)(1 + \alpha)}{\pi}, \quad (37)$$

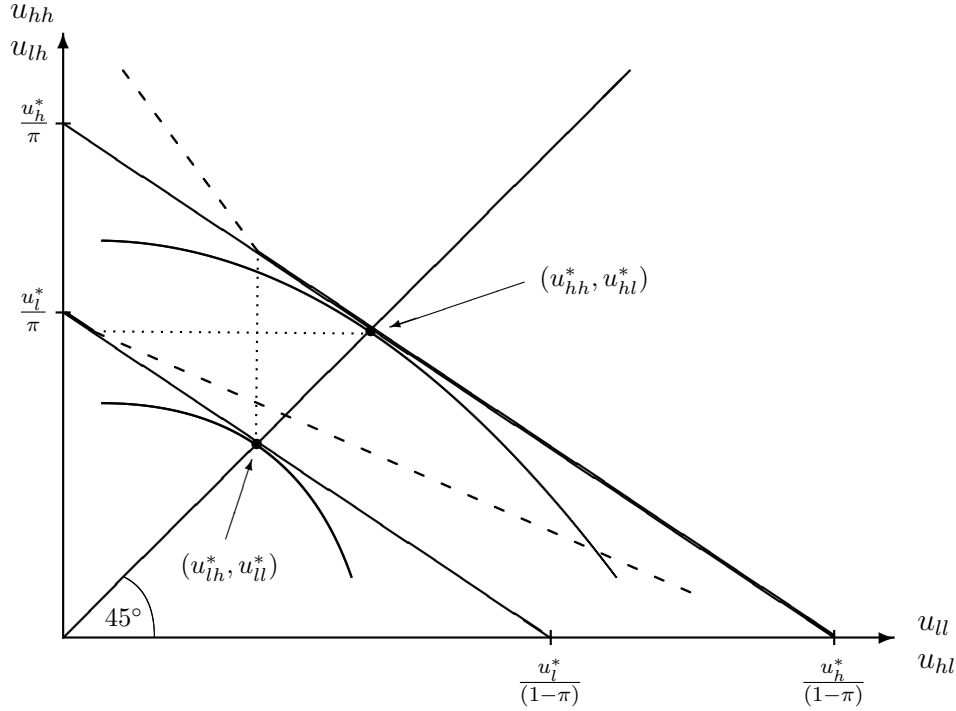


Figure 3: **Inequity aversion increases agency costs.**

The negatively sloped, parallel lines depict the constraints subject to which the principal minimizes wages. Without inequity aversion, the lowest iso-cost curves that satisfy the restrictions are tangent where $u_{hh} = u_{hl}$ and $u_{lh} = u_{ll}$. With inequity aversion, the constraints become weakly more restrictive, depicted by the dashed lines. Utility combinations that satisfy the constraints cannot lie on lower iso-cost curves.

if we have $u_{lh} > u_{hl}$. For $u_{lh} \leq u_{hl}$ we get $-(1 - \pi)/\pi$. Graphically, with inequity aversion, the dashed line depicting the combinations of u_{hh} and u_{hl} such that the agents receives an expected utility level of u_h^* is *steeper* for $u_{lh} > u_{hl}$ and has the same slope otherwise. Equivalently, the total differential of (35) while setting $du_l = 0$ yields

$$\frac{du_{lh}}{du_{ll}} = -\frac{(1 - \pi)}{\pi(1 + \alpha)}, \quad (38)$$

if we have $u_{lh} < u_{hl}$, and $-(1 - \pi)/\pi$ otherwise. The dashed line depicting the combinations of u_{lh} and u_{ll} such that the agents receives an expected utility level of u_l^* is *flatter* for $u_{lh} < u_{hl}$ and has the same slope otherwise. Hence, the constraints subject to which the principals minimizes wage payments thus become (weakly) more restrictive.

The above reasoning generalizes straightforwardly to the case where one agent has N and the other agent has M possible output realizations. Now, the solution to the principal's profit maximization problem is not determined by IC and PC alone any

longer. The principal first derives the contract that implements each action at the least cost. She then implements the action that maximizes her profit. Incentive and participation constraint for agent i in case the principal wants to implement a_h can now be written as

$$\begin{aligned}
(\hat{IC}) \quad & \sum_{n=1}^N \sum_{m=1}^M U_i(x_n, x_m) f(x_n, x_m \mid a_h, a_h) - \psi \geq 0 \\
(\hat{PC}) \quad & \sum_{n=1}^N \sum_{m=1}^M U_i(x_n, x_m) [f(x_n, x_m \mid a_h, a_h) - f(x_n, x_m \mid a_l, a_h)] - \psi \geq 0
\end{aligned}$$

where $f(\cdot)$ denotes the conditional joint density function over output realizations, and $U_i(x_n, x_m)$ is given by

$$U_i(x_n, x_m) = u_i(x_n, x_m) - \alpha \max[u_j(x_n, x_m) - u_i(x_n, x_m), 0]. \quad (39)$$

$u_i(x_n, x_m)$ denotes the utility that arises from the wage payment in case the own output realization is x_n and the other agent's output realization is x_m . $U_i(x_n, x_m)$ denotes the utility level in this case net of a possible utility loss due to suffering from inequity aversion. Equivalently for agent j . Denote by \mathcal{U} the set of all $U_i(x_n, x_m)$ and $U_j(x_n, x_m)$ such that (\hat{IC}) and (\hat{PC}) are binding,

$$\mathcal{U} := \{U_i(\cdot), U_j(\cdot) \mid (\hat{IC}) \text{ and } (\hat{PC}) \text{ binding}\}. \quad (40)$$

The principal chooses those $U_i(x_n, x_m)$ and $U_j(x_n, x_m)$ from \mathcal{U} that minimize her cost. The wage cost $w(\cdot)$ of providing the respective utility levels is given by

$$w(U_i(x_n, x_m)) = h(u_i(x_n, x_m)) = w_{nm}. \quad (41)$$

Recall that $h(\cdot) = u^{-1}$. As can be seen from equation (39), for any strictly positive level of α , the utility from wage to attain any fixed level of 'net utility' U must be higher whenever $u_j(x_n, x_m) > u_i(x_n, x_m)$. Since $h'(\cdot) \geq 0$, the wage payment w_{nm} must be higher. Hence, if the principal wants to implement the high effort choice a_h her costs are weakly increased by inequity aversion. If the principal want to implement a_l , she will pay a fixed wage and inequity aversion is thus irrelevant. With additional expenses on notation, this reasoning generalizes to the cases with any finite number of possible effort levels and more than two agents.

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