Online Appendix for "Monitoring Team Members: Information Waste and the Transparency Trap"

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Proof of Proposition 8 . — In the high-trust benchmark (i.e., firm-preferred equilibrium), workers expect all their colleagues to work. Thus the firm solves $\min_{W} \sum E_S\left(W_i\left(S\right)|\mathbf{e}{=}\mathbf{1}\right)$ subject to $E\left(W_i\left(S\right)|\mathbf{e}{=}\mathbf{1}\right)–E\left(W_i\left(S\right)|e_i{=}0,\mathbf{e}_{-i}{=}\mathbf{1}\right)\geq c$, $\forall i\in N$, where $S=\left(S^{team},(S_i^{ind})_{i\in N}\right)$. For all $i\in N$ the optimal W_i^* must satysfy the constraint with equality. Let $W_i^1\left(S_{-j}\right):=W_i^*\left(S^{team},S_{-j}^{ind},S_j^{ind}{=}1\right)$, $W_i^0\left(S_{-j}\right):=W_i^*\left(S^{team},S_{-j}^{ind},S_j^{ind}{=}0\right)$, and define $W_i'\left(S\right):=p_jW_i^1\left(S_{-j}\right)+\left(1-p_j\right)W_i^0\left(S_{-j}\right)$, which is independent of S_j^{ind}. Note $E\left(W_i'\left(S\right)|\mathbf{e}=\mathbf{1}\right)=E\left(W_i^*\left(S\right)|\mathbf{e}=\mathbf{1}\right)$ and $E\left(W_i'\left(S\right)|e_i=0,\mathbf{e}_{-i}=\mathbf{1}\right)=E\left(W_i^*\left(S\right)|e_i=0,\mathbf{e}_{-i}=\mathbf{1}\right)$. Thus, if W_i^* respects the constraint, also W_i' does, and entails the same expected cost. As a result, the firm never needs to rely on S_{-i}^{ind} to incentivize worker i. Thus, using our analysis in Section 3 to conclude that, in equilibrium, $W_i\left(S\right)=b_i'S^{team}S_i^{ind}\left(Z\left(S\right)\right)$, where $Z\left(S\right)$ is such that $E\left(b_i'S^{team}S_i^{ind}\left(R\left(S\right)\right)|\mathbf{e}=\mathbf{1}\right)=E\left(b_iS^{team}S_i^{ind}|\mathbf{e}=\mathbf{1}\right)$. So, the power of team incentives in the contract W_i is

$$\pi^{team}\left(W_i\right):=\frac{E\left(W_i\left(S\right)|\mathbf{e}=\mathbf{1},S^{team}=1\right)}{E\left(W_i\left(S\right)|\mathbf{e}=\mathbf{1},S^{team}=1\right)+E\left(W_i\left(S\right)|\mathbf{e}=\mathbf{1},S^{team}=0\right)}=1.$$

Finally, we want to show that, under **RITW**, it is sometimes optimal to set $\pi^{team}\left(W_i\right)<1$. Consider a team of two workers, $n=2$. Under **RITW**, the firm needs to provide one worker with a salary such that

$$\min_{\mu\in[0,1]}\left(\begin{array}{c}\mu\left(E_S\left(W_i\left(S\right)|e_i=1,e_j=1\right)-E_S\left(W_i\left(S\right)|e_i=0,e_j=1\right)\right)+\\+\left(1-\mu\right)\left(E_S\left(W_i\left(S\right)|e_i=1,e_j=0\right)-E_S\left(W_i\left(S\right)|e_i=0,e_j=0\right)\right)\end{array}\right)\geq c$$

and the other with a salary such that

$$\min_{\mu\in[0,1]}\left(\left(E_S\left(W_i\left(S\right)|e_i=1,e_j=1\right)-E_S\left(W_i\left(S\right)|e_i=0,e_j=1\right)\right)\right)\geq c.$$

The second worker will be rewarded as in the firm preferred equilibrium with b_i^{both}. In the following, we are interested in the first worker.

LEMMA 1: *In the optimum no agent i is rewarded when the $S_i=0$, i.e. for all $i\in N$*

$$W_i\left(S^{team},S_i^{ind}=0,S_j^{ind}\right)=0$$

PROOF:

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To see this consider the firm's minimization problem for the first worker

$$\min_{W_i} E_S\left(W_i\left(S\right)|\mathbf{e}=\mathbf{1}\right) \qquad \text{subject to:}$$

$$\min_{\mu\in[0,1]}\left(E_{\mu,S}\left(W_i\left(S\right)|e_i=1\right)-E_{\mu,S}\left(W_i\left(S\right)|e_i=0\right)\right)\geq c,\ \text{for all } i\in N$$

i.e.

$$\min_{\mu\in[0,1]}\left(\begin{array}{c}\mu\left(E_S\left(W_i\left(S\right)|e_i=1,e_j=1\right)-E_S\left(W_i\left(S\right)|e_i=0,e_j=1\right)\right)+\\+\left(1-\mu\right)\left(E_S\left(W_i\left(S\right)|e_i=1,e_j=0\right)-E_S\left(W_i\left(S\right)|e_i=0,e_j=0\right)\right)\end{array}\right)\geq c,$$

i.e.

$$\min\left(\begin{array}{c}\left(E_S\left(W_i\left(S\right)|e_i=1,e_j=1\right)-E_S\left(W_i\left(S\right)|e_i=0,e_j=1\right)\right),\\\left(E_S\left(W_i\left(S\right)|e_i=1,e_j=0\right)-E_S\left(W_i\left(S\right)|e_i=0,e_j=0\right)\right)\end{array}\right)\geq c.$$

Suppose $W_i\left(S^{team},S_i^{ind}=0,S_j^{ind}\right)>0$ and consider W_i' such that $W_i'\left(S^{team},S_i^{ind}=0,S_j^{ind}\right)=0$ and $W_i'\left(S^{team},S_i^{ind}=1,S_j^{ind}\right)=W_i\left(S^{team},S_i^{ind}=1,S_j^{ind}\right)$. This would trivially lead to lower expected payment for the firm; so we just need to show that the constraint will still hold, which is true, indeed

$$\begin{aligned}&E_S\left(W_i'\left(S\right)|e_i=1,e_j\right)-E_S\left(W_i'\left(S\right)|e_i=0,e_j\right)\\&=\left(\begin{array}{c}p_iE_S\left(W_i'\left(S\right)|S_i^{ind}=1,e_j\right)+\left(1-p_i\right)E_S\left(W_i'\left(S\right)|S_i^{ind}=0,e_j\right)+\\-\left(\left(1-p_i\right)E_S\left(W_i'\left(S\right)|S_i^{ind}=1,e_j\right)+p_iE_S\left(W_i'\left(S\right)|S_i^{ind}=0,e_j\right)\right)\end{array}\right)\\&=\left(\begin{array}{c}p_iE_S\left(W_i\left(S\right)|S_i^{ind}=1,e_j\right)+\left(1-p_i\right)E_S\left(W_i'\left(S\right)|S_i^{ind}=0,e_j\right)+\\-\left(\left(1-p_i\right)E_S\left(W_i\left(S\right)|S_i^{ind}=1,e_j\right)+p_iE_S\left(W_i'\left(S\right)|S_i^{ind}=0,e_j\right)\right)\end{array}\right)\\&=\left(\begin{array}{c}E_S\left(W_i\left(S\right)|e_i=1,e_j\right)-E_S\left(W_i\left(S\right)|e_i=0,e_j\right)+\\+\left(1-2p_i\right)\left(E_S\left(W_i'\left(S\right)|S_i^{ind}=0,e_j\right)-E_S\left(W_i\left(S\right)|S_i^{ind}=0,e_j\right)\right)\end{array}\right)\\&>E_S\left(W_i\left(S\right)|e_i=1,e_j\right)-E_S\left(W_i\left(S\right)|e_i=0,e_j\right),\end{aligned}$$

where the last inequality follows from $p_i>\frac{1}{2}$ and the fact that, by construction, $E_S\left(W_i'\left(S\right)|S_i^{ind}=0,e_j\right)<E_S\left(W_i\left(S\right)|S_i^{ind}=0,e_j\right)$.
So we can focus on contracts where each worker i receives no bounus if $S_i^{ind}=0$.

Second, we want to show that $W_i\left(S^{team}=0,S_i^{ind}=1,S_{-i}^{ind}\right)\neq 0$ under some parameter. Indeed suppose by contraposition that we could restrict our attention to contract such that $W_i\left(S^{team}=0,S_i^{ind}=1,S_{-i}^{ind}\right)=0$, Then, in such restricted optimum, we can assume that the firm simply select bonuses $b_i:=\left(b_i^z,b_i^{jt}\right)$, where $b_i^z\geq 0$ is the bonus that the worker receive when $S^{team}=1,S_i^{ind}=1$, and $S_j^{ind}=0$, and $b_i^{jt}\geq 0$ is the bonus that the agent receives when $S^{team}=1,S_i^{ind}=1$, and $S_j^{ind}=1$. In this case we can rewrite the firm problem as

$$\min_b p_iF\left(2\right)\left(\left(1-p_j\right)b^z+p_jb^{jt}\right) \qquad \text{subject to:}$$

$$\min_{\mu_i}\left(\begin{array}{c}\mu_i\left(p_iF\left(2\right)-\left(1-p_i\right)F\left(1\right)\right)\left(\left(1-p_j\right)b^z+p_jb^{jt}\right)\\\left(1-\mu_i\right)\left(p_iF\left(1\right)-\left(1-p_i\right)F\left(0\right)\right)\left(p_jb^z+\left(1-p_j\right)b^{jt}\right)\end{array}\right)=c$$

LEMMA 2: *There exist F,p_i,p_j such that the firm prefers providing i with individual performance bonuses only, rather than setting $W_i\left(S^{team}=0,S_i^{ind}=1,S_{-i}^{ind}\right)=0$.*
PROOF:

Consider $F\left(0\right)=0,F\left(1\right)=\lim_{x\to\infty}\frac{1}{x},F\left(2\right)=1,$ and $p_i=p_j=p\in\left(\frac{1}{2},1\right)$. Then

$$\min_b p_iF\left(2\right)\left(\left(1-p_j\right)b^z+p_jb^{jt}\right) \qquad \textit{subject to:}$$

$$\min_{\mu_i\in[0,1]}\begin{pmatrix} \mu_i\left(p_iF\left(2\right)-\left(1-p_i\right)F\left(1\right)\right)\left(\left(1-p_j\right)b^z+p_jb^{jt}\right)\\ \left(1-\mu_i\right)\left(p_iF\left(1\right)-\left(1-p_i\right)F\left(0\right)\right)\left(p_jb^z+\left(1-p_j\right)b^{jt}\right)\end{pmatrix}=c$$

can be rewritten as

$$\min_b p\left(\left(1-p\right)b^z+pb^{jt}\right) \qquad \textit{subject to:}$$

$$\min\begin{pmatrix} \left(p-\left(1-p\right)\lim_{x\to\infty}\frac{1}{x}\right)\left(\left(1-p\right)b^z+pb^{jt}\right),\\ \left(p\lim_{x\to\infty}\frac{1}{x}\right)\left(pb^z+\left(1-p\right)b^{jt}\right)\end{pmatrix}=c.$$

Note that $\left(p\lim_{x\to\infty}\frac{1}{x}\right)\left(pb^z+\left(1-p\right)b^{jt}\right)<\left(p-\left(1-p\right)\lim_{x\to\infty}\frac{1}{x}\right)\left(\left(1-p\right)b^z+pb^{jt}\right)$. *Thus, either* b^z *or* b^{jt} *need to go to infinity as* $x\to\infty$, *implying that also the expected payment* $p_iF\left(2\right)\left(\left(1-p_j\right)b^z+p_jb^{jt}\right)$ *goes to infinity. As a result, the firm can be better off by inducing one of the two agents to work using individual performance bonus only. In that case, indeed, the expected payment would be* $p\frac{c}{2p-1}$ *which is less than infinity for any fixed* $p\in(0,1)$.

In light of this lemma we can conclude that setting $W_i\left(S^{team}=0,S_i^{ind}=1,S_{-i}^{ind}\right)=0$ would be suboptimal under certain parameters. Thus, under trust concerns, there exist F, p_i, and p_j such that the optimal contract structure W is characterized by

$$\pi\left(W_i\right):=\frac{E\left(W_i\left(S\right)|\mathbf{e}=\mathbf{1},S^{team}=1\right)}{E\left(W_i\left(S\right)|\mathbf{e}=\mathbf{1},S^{team}=1\right)+E\left(W_i\left(S\right)|\mathbf{e}=\mathbf{1},S^{team}=0\right)}<1.$$

■

PROOF OF PROPOSITION 10. — First, note that, due to agents risk neutrality and the restriction to additively separable contracts, IW workers receive only individual bonuses b_i^{ind} and NW workers only team bonuses b_i^{team}. We start by showing that, within NW, higher-skilled workers are ranked higher and paid more. Note that if a worker i were offered $b_i^{ind}=\frac{c}{2p_i-1}$, she would work independently of her beliefs about her colleagues. NW workers anticipate all their IW colleagues exert effort. We show that, to minimize the total expected pay while guaranteeing the effort of all workers, the firm optimally creates a ranking among these workers, offering wages that make them willing to work if and only if sufficiently many other workers do. Indeed:

1) To uniquely implement effort, the wage offered to NW workers must be such that: no s workers find it optimal to shirk when anticipating that also $s-1$ colleagues shirk: $\nexists$ s workers such that

$$c>b_i^{team\star}\left(F\left(\theta_i+\sum_{j\neq i}\theta_j\right)-F\left(\sum_{j\neq i}\theta_j\right)\right)$$

2) To minimize expected wages under these constraints, the firm offers NW workers team bonuses such that given a re-ordering $O:N\leftrightarrow N$ we have

$$b_i^{team\star}=\frac{c}{\left(F\left(\theta_{O(i)}+\sum_{j:O(j)<O(i)}\theta_j\right)-F\left(\sum_{j:O(j)<O(i)}\theta_j\right)\right)}$$

3) Note that team bonuses decrease as $O(i)$ increases, while the expected pay of IW workers is independent of O. Thus, in the optimal order, IW are placed before NW ones. Denote $\theta_{IW}:=\sum_{i\in IW}\theta_i$.

4) Thus, the firm chooses the optimal order T within NW to minimize its total expected payments

$$\min_{T:NW \leftrightarrow NW} \sum_i F\left(\sum_{i\in N} \theta_i\right) b_i^{team\star} =$$

$$= \min_T \sum_i \frac{cF(\sum_{i\in N}\theta_i)}{F\left(\theta_{IW} + \theta_{T(i)} + \sum_{j:T(j)<T(i)} \theta_j\right) - F\left(\theta_{IW} + \sum_{j:T(j)<T(i)} \theta_j\right)}$$

5) Since F is convex (due to effort complementarities), the firm optimally assigns a higher rank (lower $T(i)$) to workers with higher θ.

Finally, since all workers are assumed to have the same monitorability p and all IW workers receive the same wage and are dependable for their colleagues, the firm optimally places in IW the most skilled workers. Finally, note that higher-skilled workers (in IW) will still be paid more than their NW colleagues; otherwise, the firm could switch an extra worker from NW to IW without negatively impacting her colleagues' strategic uncertainty.