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ABSTRACT

Worker Self-Selection and the Profits from Cooperation*

We investigate a competitive labor market with team production. Workers differ in their motivation to exert team effort and types are private information. We show that there can exist a separating equilibrium in which workers self-select into different firms and firms employing cooperative workers make strictly positive profits. Profit differences across firms persist because cooperation strictly increases output and worker separation requires firms employing cooperative workers to pay out weakly lower wages.

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1 Introduction

Recent evidence (see Gächter (2006) for an overview) suggests that humans differ in their motivation to cooperate in teams. Two subgroups represent the largest share of the population: *selfish types* who exhibit a propensity to shirk and free-ride, and *conditional cooperators* who reveal a preference to cooperate conditional on the cooperation of others. We analyze the interaction of these types in a competitive labor market where worker cooperation is essential for a firm to produce output. While firms in our model cannot induce selfish workers to cooperate without making losses, conditionally cooperative workers might cooperate in teams if matched with workers of their own type. Types are private information.

We show that there can exist a separating equilibrium in which selfish and conditionally cooperative workers self-select into different firms and conditionally cooperative workers cooperate. In this equilibrium selfish workers do not want to infiltrate cooperative firms as the latter pay out lower wages. Conditionally cooperative workers accept low wages since they can thus ensure to be matched with other workers of their own type. This allows them to receive their full intrinsic benefit from mutual cooperation. Cooperative firms profit from worker self-selection in two ways. First, output is higher due to worker cooperation; second, wages are lower due to screening. In consequence, cooperative firms sustain strictly larger profits in a separating equilibrium than firms employing selfish workers.

Our results offer a possible explanation for persistent profit differences across firms based on worker self-selection and team productivity. The persistence of firm-specific returns has been documented in various industries (Waring 1996). Evidence on human resource management practices shows that team work and cooperation among employees can greatly improve production efficiency (Ichniowski, Shaw, and Prennushi 1997, Hamilton, Nickerson, and Owan 2003). But team production does not work equally well within all firms and teams. In line with recent experimental evidence (Gächter and Thöni 2005) we argue that firms want to attract conditionally cooperative workers to implement sustainable worker cooperation. Our model then demonstrates that the positive effects of team work can survive labor market competition and that firms may generate additional returns as screening entails cooperative workers accepting lower wages. The resulting worker separation is consistent with field evidence demonstrating a strong link between worker motivation and labor market outcomes (Carpenter and Seki 2005).

Intuitively, the persistence of profit differences in our model is caused

by a combination of moral hazard and adverse selection. Suppose, for example, that worker cooperation was only a problem of moral hazard. All firms could then achieve the same levels of cooperation and profits by choosing optimal incentives. If cooperation requires workers with special attributes, cooperation can vary across firms as those employing non-cooperative types might be unable to induce cooperation. Yet if types are observable, firms can shut out non-cooperative workers and competition for cooperative types drives down profits to zero.¹ In our model, conditional cooperators are more productive than selfish workers only if they are matched with other workers of their own type. This particular complementarity, together with asymmetric information, allows cooperative firms to keep parts of their profits in equilibrium.

The present model extends Kosfeld and von Siemens (2007). While both models study the self-selection of workers differing in their motivation to cooperate, Kosfeld and von Siemens (2007) focus on the relationship between individual performance incentives and cooperation assuming that firms cannot provide monetary team incentives. The present paper allows firms to use team incentives.

2 Model

There is a countably infinite number of workers with total mass normalized to one. Workers who are employed by the same firm are matched into teams of two. Each team member i contributes binary effort $e_i \in \{0, 1\}$ to team production. Team output is stochastic with the team being either successful or not. If the team is successful, generated output is $G > 0$ per worker; otherwise, output is zero. The success probability π depends on the sum of workers' effort contributions where $\pi(2) > \pi(1) > \pi(0) > 0$. We assume that effort choices are non-contractible and that firms can condition wages on team output only. A contract $\mathbf{w} = (f, b, n)$ then consists of a fixed wage $f \in \mathbb{R}_+$ and a bonus $b \in \mathbb{R}$ agents receive if and only if their team is successful. To make the analysis interesting we assume that total wages must be positive, thereby generating a problem of moral hazard within firms. Contracts include the firm's identity $n \in \mathbb{N}$ as workers might have distinct preferences over firms that offer the same fixed wage and bonus. Assuming that the number of firms is countably infinite let $\mathcal{W} = \mathbb{R}_+^2 \times \mathbb{N}$ denote the contract space.

¹The same result holds true if types are private information (e.g., Delfgaauw and Dur forthcoming, von Siemens 2006).

Firms sell output at a price of one. Given contract $\mathbf{w} = (f, b, n)$ and workers' effort choices (e_i, e_j) let

$$\pi(e_i + e_j)G - [f + \pi(e_i + e_j)b] \quad (1)$$

be a firm's expected profit per worker generated by a team. Firms can hire any number of teams offering a single contract to all its teams maximizing expected profit per team.²

Our key assumption is that workers differ in their willingness to contribute team effort. There are two types: each worker is either *selfish* or *conditionally cooperative*. Selfish workers never exert costly effort unless they face sufficiently strong monetary incentives. Conditionally cooperative workers do not only respond to monetary incentives but get some additional benefit from contributing to the team if their team colleague contributes team effort, as well. Let $\theta \in \{c, s\}$ denote a worker's type. Once matched into a team with contract \mathbf{w} , the expected utility of worker i being of type θ , choosing effort e_i , and being matched with worker j who exerts effort e_j is defined as

$$u_\theta(\mathbf{w}, e_i, e_j) = \begin{cases} f + \pi(e_i + e_j)b - c(e_i) & \text{if } \theta = s, \\ f + \pi(e_i + e_j)b - c(e_i) + \gamma(e_i, e_j) & \text{if } \theta = c. \end{cases} \quad (2)$$

Worker i enjoys expected utility $f + \pi(e_i + e_j)b$ from his wage. Exerting effort causes him effort costs $c(e_i)$. We normalize $c(0)$ to zero and assume that $c(1) = C > 0$. Conditionally cooperative workers additionally enjoy intrinsic satisfaction $\gamma(e_i, e_j)$ from mutual cooperation.³ To capture the conditional aspect of cooperation we set γ equal to some positive constant Γ if and only if both workers contribute team effort and normalize γ to zero otherwise. Workers' types are private information; yet, it is common knowledge that types are independently distributed with each worker being conditionally cooperative with prior probability $\lambda \in]0, 1[$.

We make the following assumptions regarding the efficiency of team effort. Let $\Delta\bar{\pi} = \pi(2) - \pi(1)$ and $\Delta\underline{\pi} = \pi(1) - \pi(0)$. First, we assume that

²The precise sequence of actions in our model is as follows. Firms simultaneously enter the market at zero costs by offering a contract to workers. Workers simultaneously choose among all contracts offered. Depending on their choice, they enter a firm and are matched into teams of two. In case a worker rejects all offered contracts or remains unmatched, he earns an outside-option utility normalized to zero. Finally, workers produce output by simultaneously exerting effort and payoffs are realized.

³Hamilton, Nickerson, and Owan (2003) provide empirical evidence for the assumption that some workers receive non-pecuniary benefits from team cooperation.

$C > \max\{\Delta\bar{\pi}G, \Delta\underline{\pi}G\}$. Limited liability then implies that it is impossible for a firm to provide selfish workers with monetary incentives to exert high team effort without making losses.⁴ Second, we assume that $C < \Delta\bar{\pi}G + \Gamma$. Thus, exerting team effort is efficient for conditionally cooperative workers when taking their intrinsic benefit from cooperation into account.

We consider symmetric equilibria in which all workers share identical equilibrium strategies. In the following, we can thus suppress indexation for workers' identities. A worker's strategy comprises his contract acceptance choice where $a_\theta(\mathbf{w}, \mathbf{W}) \in [0, 1]$ is the probability for a type- θ worker to accept contract \mathbf{w} out of a set \mathbf{W} of offered contracts. It also specifies his effort choice where $e_\theta(\mathbf{w}, \mathbf{W}) \in \{0, 1\}$ is the effort of a type- θ worker who accepts contract \mathbf{w} from a set \mathbf{W} of offered contracts. Since workers can condition their contract choices upon their type, workers and firms rationally update their beliefs after observing workers' contract choices. Let $\mu(\theta|\mathbf{w}, \mathbf{W}) \in [0, 1]$ be the probability for firms and workers to believe a worker to be of type θ if the latter accepts contract \mathbf{w} out of a set of offered contracts \mathbf{W} .

We define a competitive equilibrium as follows. With regard to workers, we assume that equilibrium strategies and beliefs form a perfect Bayesian equilibrium given all possible sets of offered contracts. With regard to firms, we follow Rothschild and Stiglitz (1976) so that a competitive equilibrium is a finite set \mathbf{W}^* of offered contracts satisfying the following requirements given workers' equilibrium behavior. First, the equilibrium set of contracts contains no irrelevant contracts that are never accepted in equilibrium. Second, no firm offers a contract yielding expected losses in equilibrium. Third, no firm can enter the market by offering a new contract that attracts workers and yields strictly positive expected profits per team. Let u_θ^* be the equilibrium utility of workers of type θ .

Whether contracts form a competitive equilibrium depends on workers' reaction towards a new contract. This reaction in turn depends on workers' beliefs upon accepting the new contract, on the Bayesian equilibria they expect to be played within firms, and on whether they expect other workers to also accept this contract so that teams can be formed. To sharpen results we employ equilibrium refinements.⁵ These refinements impose the following intuitive restrictions. First, suppose a firm enters the market with

⁴ Our results are not affected if team effort is efficient but due to a minimum wage law the fixed wage must be so high so that firms cannot use monetary incentives to implement high team effort from selfish workers without making losses.

⁵None of the refinements is needed for our main result, i.e., the existence of a separating equilibrium with cooperation and persistent profit differences.

a contract that is not accepted by any worker. We then require that workers do not re-coordinate their behavior and choose the same acceptance and effort decisions as if the new contract had not been offered at all.⁶ Second, in the spirit of Cho and Kreps (1987) workers do not believe that a worker who accepts a new contract can be of some type if this type always gets strictly less than what he can get by keeping to his equilibrium behavior while the other type might get weakly more. Third, suppose a newly offered contract might only be accepted by a certain type, but that for this type acceptance can only be rational if a unique Bayesian equilibrium is played within the firm. We then require that workers coordinate on that equilibrium. Finally, coordinated deviations might be needed to realize potential utility gains because workers need other colleagues to be matched into a team. We require that workers do not reject an offered contract only because they think they would be alone in the firm and thus cannot be matched into a team. The formal definitions of these refinements can be found in the appendix.

3 Results

We first intuitively describe workers' equilibrium behavior within firms. The simple formal arguments are left to the reader. By assumption firms cannot induce selfish workers to exert effort without making losses. Since firms do not make losses in a competitive equilibrium, there exist at most two Bayesian equilibria in pure strategies within firms. There is always a *selfish equilibrium* in which all workers shirk. A conditionally cooperative worker who unilaterally deviates cannot get the intrinsic benefit from cooperation and therefore optimally behaves as if he was selfish. Yet, there might also exist a *cooperative equilibrium* if the combined monetary and intrinsic incentives are sufficient for conditionally cooperative workers to exert effort. In this equilibrium the conditionally cooperative workers work whereas selfish workers shirk. As $C < \Delta\bar{\pi}G + \Gamma$, there exists a cooperative equilibrium if a team consist only of conditional cooperators and the latter receive all revenues.

Given our refinements, we show below that firms use a “best separating contract” in any separating equilibrium in which conditionally cooperative workers cooperate. This contract specifies a fixed wage f and bonus b that maximizes the utility of conditionally cooperative workers who exert effort

⁶This refinement is needed to meaningfully define the other refinements.

and are matched with other conditionally cooperative workers

$$\pi(2) b + f - C + \Gamma \tag{3}$$

subject to the constraints

$$\Delta\bar{\pi} b + \Gamma - C \geq 0 \tag{4}$$

$$\pi(0) G \geq \pi(1) b + f \tag{5}$$

$$\pi(2) G - (\pi(2) b + f) \geq 0 \tag{6}$$

$$f, f + b \geq 0. \tag{7}$$

By (4) conditionally cooperative workers optimally exert effort if matched with other cooperating workers. This might require monetary incentives in addition to the intrinsic benefit from cooperation. Constraint (5) ensures that selfish workers do not want to accept a best separating contract if they can get utility $\pi(0) G$ elsewhere. By (6) firms offering a best separating contract make no losses. (7) is the limited liability constraint. We get the following result.

Lemma 1 (Best separating contract). *There exists a solution to maximization problem (3) to (7), if and only if*

$$C \leq \Gamma + \frac{\pi(0)}{\pi(1)} G \Delta\bar{\pi}. \tag{8}$$

The unique best separating contract specifies $f = 0$ and $b = G \pi(0)/\pi(1)$.

Proof. We start by showing that any best separating contract sets a fixed wage of zero. To this end we must first demonstrate that either the incentive constraint for the conditionally cooperative workers (4) or the screening constraint (5) must be binding at the optimum. Suppose both (4) and (5) are not binding. Then optimal contracts maximize (3) given (6) and (7). (6) must be binding as it is otherwise optimal to increase b . From those contracts satisfying (6) with equality, the contract with $b = G$ and $f = 0$ minimizes the r.h.s. of (5). But even this contract violates (5). At least one of the constraints (4) and (5) must thus be binding.

We can now show that any best separating contract sets a fixed wage of zero. Suppose that $f > 0$ holds at an optimum. Take changes $db > 0$ and $dw = -\pi(2) db$. By construction, these contract changes have no effect on (3) or (6). Since $db > 0$ they increase the l.h.s. of (4) and thus slacken (4). They also reduce the r.h.s. of (5) and thus slacken (5). At least one of these constraints is binding at an optimum, which allows subsequent changes that

strictly increase (3). Any solution to (3) to (7) must consequently specify a fixed wage of zero, $f = 0$.

We can next derive the condition for the existence of a best separating contract. Constraint (4) sets a lower bound on the bonus that conditionally cooperative workers must get if they are to exert effort, while (5) sets an upper bound on the bonus to ensure separation of both types of workers. Given a fixed wage of zero, both constraints are not mutually exclusive if and only if (8) holds.

Finally, any solution to the above maximization problem must have the following properties. Since $f = 0$, constraint (7) does not conflict with (3) and can be ignored. Constraint (5) implies $b \leq G \pi(0)/\pi(1) < G$ so that (6) can be ignored. The objective function and the l.h.s. of (4) are strictly increasing in b . The binding (5) then yields $b = G \pi(0)/\pi(1)$. \square

Asymmetric information implies that the maximum expected wage that can be paid out in a separating equilibrium without attracting selfish workers is limited. But since a high bonus might be needed to implement team effort, the incentive constraint (4) and the screening constraint (5) can be in conflict. Only if the non-monetary benefits from mutual cooperation are sufficiently high, then there are contracts that satisfy both constraints. The following proposition shows that there exists a separating competitive equilibrium in which conditionally cooperative workers cooperate and some firms make strictly positive profits.

Proposition 1 (Separating equilibrium). *If and only if condition (8) holds, there exists a separating competitive equilibrium in which conditionally cooperative workers cooperate. In this equilibrium firms attracting selfish workers make zero expected profits, while firms attracting conditionally cooperative workers offer best separating contracts and make strictly positive expected profits.*

Proof. We first show that condition (8) is necessary for the existence of a separating equilibrium with cooperation. We start by showing that since selfish workers shirk in any equilibrium, $u_s^* = \pi(0)G$ in any separating equilibrium. First, $u_s^* \leq \pi(0)G$ as otherwise firms attracting selfish workers make losses. Second, $u_s^* \geq \pi(0)G$ as otherwise firms can enter the market offering $f = 0$ and $b = G - \epsilon$ where $\epsilon > 0$ and $\pi(0)b > u_s^*$. This contract makes strictly positive expected profits if accepted. But not accepting violates Refinement 4 for selfish workers. Thus there is market entry.

Given $u_s^* = \pi(0)G$, the contracts accepted by conditionally cooperative workers must satisfy (4) to (7) in a separating equilibrium with cooperation.

Constraints (4) and (5) are not mutually exclusive if and only if

$$C \leq \Gamma + \frac{\pi(0)}{\pi(1)} G \Delta \bar{\pi} - \frac{f}{\pi(1)} \Delta \bar{\pi}. \quad (9)$$

As $f \geq 0$ this condition can only be satisfied if (8) holds.

We next show that in any separating equilibrium with cooperation firms attracting conditional cooperators offer the best separating contract. If (8) holds with equality, the best separating contract is the only contract that satisfies (4) and (5). If (8) is slack, there exist other contracts that satisfy (4) to (7) and we need to be more precise. Suppose cooperative workers accept one of these other contracts in equilibrium. Then a firm can enter the market offering a contract \mathbf{w} with $f = 0$ and $b = (G - \epsilon) \pi(0) / \pi(1)$ with $\epsilon > 0$. Constraints (4) to (7) hold for small ϵ . Since the best separating contract is the unique solution to program (3) to (7), $\pi(2) b - C + \Gamma > u_c^*$ for ϵ sufficiently small. Offering \mathbf{w} yields strictly positive profits in case of acceptance. Yet all workers rejecting it violates our refinements: Since $\epsilon > 0$ constraint (5) holds with strict inequality. Refinement 1 thus implies $\mu^*(s | \mathbf{w}, \mathbf{W}^* \cup \mathbf{w}) = 0$. Conditionally cooperative and selfish workers get the same utility in a selfish equilibrium. Refinement 3 therefore implies $e_c^*(\mathbf{w}, \mathbf{W}^* \cup \mathbf{w}) = 1$. Then for conditional cooperators not to accept \mathbf{w} violates Refinement 4.

We finally show that a separating equilibrium exists if (8) holds. Given the situation in Proposition 1 there cannot be profitable market entry by firms that attract only selfish types. Equally, there cannot be profitable market entry by firms that attract only conditional cooperators. Suppose thus that a firm enters the market with a pooling contract \mathbf{w} . To complete the proof we only have to show that we can then specify equilibrium worker behavior that does not violate our refinements while contract \mathbf{w} either attracts no workers or makes losses.

Before specifying workers equilibrium behavior note that $u_c^* > u_s^*$ in any separating equilibrium with cooperation, and that Refinement 2 does not restrict beliefs as by definition both types of workers might be attracted by \mathbf{w} . We now set $e_\theta^*(\mathbf{w}, \mathbf{W}^* \cup \mathbf{w}) = 0$ for $\theta \in \{c, s\}$. Since both types get the same utility in a selfish equilibrium, they get the same deviation utility $u_\theta(\mathbf{w}, 0, 0) = \hat{u}$ when accepting \mathbf{w} .

There are three cases. First, suppose $\hat{u} > u_c^* > u_s^*$. Refinement 4 then implies $a_\theta^*(\mathbf{w}, \mathbf{W}^* \cup \mathbf{w}) = 1$ for $\theta \in \{c, s\}$ so that $\mu^*(c | \mathbf{w}, \mathbf{W}^* \cup \mathbf{w}) = \lambda$. As workers are attracted even when expecting the selfish equilibrium to be played, coordinating on the selfish equilibrium does not violate Refinement 3. But then \mathbf{w} must make losses as otherwise $\hat{u} \leq u_s^*$. Second,

suppose $u_c^* \geq \hat{u} > u_s^*$. Refinement 4 yields $a_s^*(\mathbf{w}, \mathbf{W}^* \cup \mathbf{w}) = 1$ but setting $a_c^*(\mathbf{w}, \mathbf{W}^* \cup \mathbf{w}) = 0$ causes no violation. This implies $\mu^*(c|\mathbf{w}, \mathbf{W}^* \cup \mathbf{w}) = 0$. Given this belief the selfish equilibrium is the unique equilibrium. Refinement 3 thus has no bite and workers coordinate on the selfish equilibrium. Then \mathbf{w} must make losses as otherwise $\hat{u} \leq u_s^*$. Third, suppose $u_c^* > u_s^* \geq \hat{u}$. Without violating Refinement 4 we can set $a_\theta^*(\mathbf{w}, \mathbf{W}^* \cup \mathbf{w}) = 0$ for $\theta \in \{c, s\}$. Beliefs are not pinned down so that $\mu^*(c|\mathbf{w}, \mathbf{W}^* \cup \mathbf{w}) = 0$ is possible. Given this belief the selfish equilibrium is the unique equilibrium. Acceptance choices are optimal so that the firm cannot attract any workers. \square

In order to ensure separation, the screening constraint (5) sets an upper bound on wages that are paid out in cooperative firms. This implies that firms offering a best separating contract make strictly positive profits in equilibrium. Market entry and competition do not erode these profits for the following reason. If a new firm (or a selfish firm) mimics an existing cooperative firm, it does not offer conditionally cooperative workers more than what they currently earn. It is thus optimal for these workers to remain at their current employer. However, if firms offer higher wages than the best separating contract, the screening constraint (5) is violated and it draws all selfish workers. In this case conditionally cooperative workers cannot be attracted as they would then lose their intrinsic benefit from mutual cooperation.

Appendix: Refinements

Refinement 1 (No Re-Coordination). *Let \mathbf{W}^* and $\tilde{\mathbf{w}} \notin \mathbf{W}^*$ with $a_\theta^*(\tilde{\mathbf{w}}, \mathbf{W}^* \cup \tilde{\mathbf{w}}) = 0$ for $\theta \in \{c, s\}$. Then $a_\theta^*(\mathbf{w}, \mathbf{W}^* \cup \tilde{\mathbf{w}}) = a_\theta^*(\mathbf{w}, \mathbf{W}^*)$ and $e_\theta^*(\mathbf{w}, \mathbf{W}^* \cup \tilde{\mathbf{w}}) = e_\theta^*(\mathbf{w}, \mathbf{W}^*)$ for $\theta \in \{c, s\}$ and all $\mathbf{w} \in \mathbf{W}^*$.*

Refinement 2 (Reasonable Beliefs). *Let \mathbf{W}^* and $\tilde{\mathbf{w}} \notin \mathbf{W}^*$ with $a_\theta^*(\tilde{\mathbf{w}}, \mathbf{W}^* \cup \tilde{\mathbf{w}}) = 0$ for $\theta \in \{c, s\}$. Suppose $u_\theta^* > u_\theta(\tilde{\mathbf{w}}, e, \tilde{e})$ for all (e, \tilde{e}) but $u_{\theta'}(\tilde{\mathbf{w}}, e, \tilde{e}) \geq u_{\theta'}^*$ for some (e, \tilde{e}) with $\theta \neq \theta'$. Then $\mu^*(\theta|\tilde{\mathbf{w}}, \mathbf{W}^* \cup \tilde{\mathbf{w}}) = 0$.*

Refinement 3 (Coordination Effort). *Let \mathbf{W}^* and $\tilde{\mathbf{w}} \notin \mathbf{W}^*$ with $a_\theta^*(\tilde{\mathbf{w}}, \mathbf{W}^* \cup \tilde{\mathbf{w}}) = 0$ for $\theta \in \{c, s\}$. Suppose $\mu^*(\theta'|\tilde{\mathbf{w}}, \mathbf{W}^* \cup \tilde{\mathbf{w}}) = 1$ for some $\theta' \in \{c, s\}$. If there exists a unique equilibrium effort \tilde{e} such that $u_{\theta'}(\tilde{\mathbf{w}}, \tilde{e}, \tilde{e}) \geq u_{\theta'}^*$, then $e_{\theta'}^*(\tilde{\mathbf{w}}, \mathbf{W}^* \cup \tilde{\mathbf{w}}) = \tilde{e}$.*

Refinement 4 (Coordination Acceptance). *Let \mathbf{W}^* and $\tilde{\mathbf{w}} \notin \mathbf{W}^*$ with $a_\theta^*(\tilde{\mathbf{w}}, \mathbf{W}^* \cup \tilde{\mathbf{w}}) = 0$ for $\theta \in \{c, s\}$. Then $u_\theta^* \geq E_{\theta'}[u_\theta(\tilde{\mathbf{w}}, e_\theta^*(\tilde{\mathbf{w}}, \mathbf{W}^* \cup \tilde{\mathbf{w}}), e_{\theta'}^*(\tilde{\mathbf{w}}, \mathbf{W}^* \cup \tilde{\mathbf{w}}))]$ for $\theta \in \{c, s\}$.*

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