Competition, Cooperation, and Corporate Culture*

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Abstract

Teamwork and cooperation between workers can be of substantial value to a firm, yet firms often differ in their level of worker cooperation. We show that these differences can be the result of competition in the labor market if workers have heterogeneous preferences and preferences are private information. In our model there are two types of workers: selfish workers who only respond to monetary incentives, and conditionally cooperative workers who might voluntarily provide team work if their co-workers do the same. We show that there is no pooling in equilibrium, and that workers self-select into firms that differ in their incentives as well as their consequential level of team work. Our model can explain why firms develop different corporate cultures in an ex-ante symmetric environment. Moreover, the results show that, contrary to first intuition, labor market competition does not destroy but may indeed foster within-firm cooperation.

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1 Introduction

Teamwork, cooperation, and helpfulness between workers can be of substantial value to a firm. There are many examples – workers with complementary skills can increase output and productivity by helping each other on individual tasks. Similarly, the sharing of information between different workers or work groups often greatly enhances the efficiency of production. While cooperation of workers is beneficial to the firm, the exertion of cooperative effort is usually costly to a worker. Moreover, it is typically hard to identify, let alone to verify, whether or not a worker has helped a co-worker or shared information. Hence, incentives for cooperation are difficult to provide. Unless workers are intrinsically motivated, firms therefore often face inefficiently low levels of worker cooperation.

Yet, empirical evidence as well as carefully designed experiments suggest that workers sometimes do cooperate and that a large part of this cooperation is driven by so-called "conditional cooperation", that is, a preference to cooperate conditional on the cooperation of others.[1] Could it be that the existence of conditional cooperators mitigates (or even solves) the above described cooperation problem within firms? The answer is not immediately clear since the same empirical evidence suggests that workers' preferences are heterogenous, where a substantial fraction of workers reveal purely selfish behavior. In case cooperation is efficient and labor markets are competitive, firms that employ cooperative workers should pay high wages due to high output. This attracts selfish types. Consequently, it has been conjectured in the literature (Lazear 1989, Kandel and Lazear 1992) that there can exist no separating equilibrium in which workers self-select into different firms if preferences are private information.[2] Moreover, labor market competition should eventually erode all cooperation, since conditionally cooperative workers no longer voluntarily exert team effort in the presence of selfish types.

[1]Cleanest evidence for conditional cooperation comes from laboratory experiments (Fischbacher, Gächter, and Fehr 2001, Gächter and Thöni 2005, Fischbacher and Gächter 2006, Kosfeld, Fehr, and Weibull 2006). Frey and Meier (2004) and Heldt (2005) provide field evidence for conditional cooperation. A recent discussion of the experimental work, also in view of policy implications, is given by Gächter (2006). Empirical studies that document conditional cooperation in real labor environments include Ichino and Maggi (2000) and Bandiera, Barankay, and Rasul (2005).

[2]Lazear (1989) argues in a tournament setting where workers can be either cooperative (doves) or selfish (hawks). He shows that types do not self-sort, concluding "that dovish firms should use personality as a hiring criterion. Hawks will attempt to pass themselves off as doves, feigning a noncompetitive personality. It is rational for dovish firm to limit the work force to genuine doves" (p571). Kandel and Lazear (1992) provide similar arguments in a profit sharing model.

While the above arguments are correct, we show in this paper that the conjecture is wrong. We prove that workers in a competitive labor market with hidden information self-select in equilibrium, thereby leading to the emergence of heterogenous corporate cultures with regard to teamwork and cooperation. The key mechanism behind our result is the fact that conditionally cooperative workers are ready to accept a slightly lower wage in order to separate themselves from selfish workers in the market.

In a nutshell, our model runs as follows. There is a competitive labor market where firms can employ teams of two workers, each worker choosing individual and team effort. Effort is costly with marginal costs in both dimensions (individual effort and team effort) being an increasing function of a worker's effort in the other dimension. Firms can provide monetary incentives for individual effort, but team effort is non-contractible. We assume that there exist two types of workers: *selfish* workers and *conditionally cooperative* workers. A selfish worker responds to monetary incentives and hence exerts individual effort only if monetary incentives are sufficiently high. Since teamwork is non-contractible, a selfish worker never exerts team effort. A conditionally cooperative worker also responds to monetary incentives with respect to individual effort. However, he might also exert team effort in case his co-worker cooperates, as well. Types are private information, and firms offer wage contracts without ex-ante information about the type of workers that are going to accept the contract. Similarly, workers do not know ex-ante the type of their co-worker who accepts the same contract. However, parties can form beliefs based on workers' observed acceptance decisions. We model competition between firms using the notion of a competitive equilibrium under adverse selection of Rothschild and Stiglitz (1976). However, we extend their equilibrium concept to account for workers' optimal behavior in firms by requiring workers to play a perfect Bayesian equilibrium.

We derive the following results. First, there is no pooling of workers in equilibrium, that is, different types of workers are never employed in the same firm. The reason is that in a pooling contract a conditional cooperator correctly believes his colleague to be selfish with strictly positive probability. It is then possible to skim off conditionally cooperative workers with a contract that specifies a slightly lower monetary payoff. Selfish workers are exclusively interested in their wage, thus they never accept this newly offered contract. Yet conditionally cooperative workers might be attracted since they can then be sure to be matched with a conditional cooperator who also exerts team effort. Hence, there can be no pooling, and workers self-select into different firms in any equilibrium. Further, we show that firms then offer two different types of contracts: *selfish contracts* and *constrained cooperative contracts*. Selfish contracts provide strong monetary incentives for individual effort and are accepted by selfish workers. No teamwork is observed in firms offering these contracts, and firms make zero profit in equilibrium. Constrained cooperative contracts are exclusively accepted by conditional cooperators, who provide team effort in equilibrium. Whether conditional cooperators also provide individual effort depends on the monetary incentives that are offered by the firm. If individual effort is relatively important to the firm, constrained cooperative contracts provide high monetary incentives and workers exert both individual and team effort. Because contracts account for the fact that individual effort is more costly for workers who also provide team effort, monetary incentives in this situation are, in fact, higher than monetary incentives for selfish workers. Yet as team work becomes more important, constrained cooperative contracts cut down monetary incentives and pay only a fixed wage, thereby inducing conditional cooperators to provide teamwork but no individual effort. The reason is that contrary to selfish workers, conditionally cooperative workers then also save on the cost of providing team effort. Independent of which case applies, in any separating equilibrium firms offering a constrained cooperative contract always have to ensure that selfish workers do not accept their contract. Depending on the situation, this may imply that a firm cannot pay out all its profits to its workers: otherwise wage payments would be so high as to attract selfish workers. In consequence, constrained cooperative contracts may yield positive profit in equilibrium.

Our results can explain a number of empirical findings. First, even within the same industry firms often develop remarkably different corporate cultures. Second, these heterogenous corporate cultures are characterized, amongst others, by differences in the degree of incentives and the level of team work that is observed within firms. Finally, firms enjoying high levels of team work are more productive than firms without or with only low levels of team work. Ichniowski, Shaw, and Prennushi (1997), for example, report substantial differences in human resource management practices (including practices concerning team work, job assignment, training, hiring, supervision, etc.) in a sample of 36 U.S. production lines all of which operate in the same steel finishing business. Furthermore, they find that lines using innovative work practices, which include high levels of team work, are significantly more productive than lines with the traditional approach where team work does not play an important role. Hamilton, Nickerson, and Owan (2003) confirm the positive impact of team work on productivity, analyzing the effects of a "cultural change" from individual to team production in a U.S. garment plant. More recently, Burks, Carpenter, and Götte (2006) provide evidence for different levels of worker cooperation in a sample of Swiss and U.S. firms from the courier industry. They elicit workers' preferences for cooperation in a field experiment and find that firms that pay for performance employ significantly less cooperative workers than firms that pay hourly wages or are organized as cooperatives. Burks *et al.* do not analyze productivity across firms. In the light of our model, these observations can be explained as a consequence of labor market competition with private information about workers' preferences for cooperation. By choosing different contracts workers in equilibrium self-select into different firms, thus leading to heterogenous corporate cultures of team work with corresponding differences in incentives and productivity.

The paper adds to several strands of research. First, our model emphasizes the role of separation and self-selection in labor markets. Other papers have analyzed the possible sorting of workers differing by skill (Kremer and Maskin 1996, Saint-Paul 2001, Grossmann 2005), liability (Dam and Perez-Castrillo 2003), or by mission (Besley and Ghatak 2005). To the best of our knowledge, our model is the first that demonstrates the endogenous separation of workers who differ with regard to their cooperative attitude. Moreover and in contrast to the papers above, firms compete under incomplete information about the type of worker accepting a particular contract.[3] Second, our paper adds to the — still rather underdeveloped — economic literature on corporate culture. Previous papers have argued that different corporate cultures are the result of coordination (Kreps 1990), shared knowledge (Crémer 1993), asymmetric equilibria in the product market (Hermalin 1994), or differences in firms' initial conditions (Rob and Zemsky 2002). We show that labor-market competition generates by itself forces sustaining the heterogeneity of different cultures in firm organization. Finally, as firms hiring conditionally cooperative workers in our model sometimes provide weaker incentives than firms that employ selfish workers, our results also offer a rationale for the potential optimality of muted incentives. Different to existing models, however (Holmstrom and Milgrom 1991, Baker, Gibbons, and Murphy 2002), muted incentives in our setting are not directly driven by workers' cost functions or by repeated interaction, but are a consequence of competition under adverse selection. The fact that workers separate according to their preference for cooperation is also related to recent experimental findings on the optimal provision of incentives for different cooperative types (Falk and Kosfeld forthcoming).

[3] A recent paper that analyzes labor market sorting in an experimental setting is Dohmen and Falk (2006). von Siemens (2005) looks at a firm's employment decision if workers have private information on their productivity and fairness considerations.

The paper is organized as follows. Section 2 sets up the model and explains the equilibrium concept used in the subsequent analysis. Section 3 contains the results. Section 4 concludes.

2 Model

Our model of a competitive labor market under adverse selection is based on Rothschild and Stiglitz's (1976) analysis of the insurance market. In addition, we account for workers' effort choices by modelling the interaction between workers within firms as a Bayesian game. There is the following sequence of actions. First, firms can simultaneously enter the market at zero costs by offering a contract to a countably infinite number of workers. Second, workers simultaneously choose among the set of offered contracts. Conditional on the contract chosen, workers are randomly matched into teams of two and are assigned a corresponding firm. In case a worker decides not to accept any offered contract or remains unmatched, he earns an outside-option utility normalized to zero. Third, workers in each team produce output by simultaneously exerting effort. Finally, wages are paid and payoffs are realized. We next fill in all the necessary details.

2.1 Workers and Firms

Let us start with team production. When matched into a team of two, worker i can produce output by exerting a two-dimensional effort $\boldsymbol{e}_i = (e_{i1}, e_{i2})$. For simplicity, we assume that effort is binary in both dimensions, $e_{i1} \in \{0, 1\}$ and $e_{i2} \in \{0, 1\}$. The effort components e_{i1} and e_{i2} differ in the kind of output they produce. Whereas effort e_{i1} generates individually attributable output, effort e_{i2} contributes to some joint production of the team. We call e_{i1} a worker's *individual effort* and e_{i2} his *team effort*.

A key assumption in our model is that it is easier for a firm to provide monetary incentives for individual effort as compared to team effort. By the very nature of team production it may be difficult to identify who is responsible for what share of the team output. This well-known free-rider problem complicates the provision of incentives. Further, team effort and cooperation might also affect a firm's performance indirectly, for example via informal communication, mutual help on individual projects, or improvements in less measurable dimensions such as quality. Following the literature on incomplete contracts, the impact of team effort on output might then perhaps be observable but hard to verify. We abstract from the underlying details regarding the incentive provision problem in this paper and simply assume that team effort is non-contractible, either because it is impossible to provide monetary incentives or because the involved agency costs are too high. Individual effort, however, is observable, verifiable, and hence contractible. A contract $\boldsymbol{w}$ then consists of two elements, a fixed wage w_f and a bonus w_b each worker gets if and only if he exerts individual effort. Fixed wage and bonus are assumed to be weakly positive. Let $\boldsymbol{\mathcal{W}}$ denote the set of all possible contracts.

Firms sell output at a price normalized to one. Given contract $\boldsymbol{w} = (w_b, w_f)$ and the workers' effort choices $(\boldsymbol{e}_i, \boldsymbol{e}_j)$ let

$$\pi\left(\boldsymbol{w}, \boldsymbol{e}_i, \boldsymbol{e}_j\right) = f(e_{i1}) + f(e_{j1}) + 2\, g(e_{i2}, e_{j2}) - \left(e_{i1} w_b + e_{j1} w_b + 2\, w_f\right) \tag{1}$$

describe the firm's profit generated by the considered team. The term in brackets captures the firm's wage payments. In addition to his fixed wage, a worker receives the bonus if and only if he exerts individual effort. The remaining three terms determine total team output. The latter consists of the individual outputs f and the joint team production g per worker. We set $f(1)$ equal to some strictly positive constant $F > 0$ and normalize $f(0)$ to zero. To model effort complementarity in team production we set g equal to some strictly positive constant $G > 0$ if and only if both workers provide team effort. For all other effort choices we normalize g to zero. Firms can hire any number of teams. To capture the idea of a common corporate culture we assume that firms offer a single contract that applies to all its teams. Firms maximize expected profit per team.

Our second 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 any team effort because effort is costly and entails no private benefits. Conditionally cooperative workers, however, might contribute team effort if they believe their team colleague to do the same. Let $\theta \in \{s, c\}$ denote a worker's type. The utility of worker i who is of type θ, chooses effort vector $\boldsymbol{e}_i = (e_{i1}, e_{i2})$, and is matched in a team with worker j who exerts effort $\boldsymbol{e}_j$ is defined as

$$u_{i\theta}(\boldsymbol{w}, \boldsymbol{e}_i, \boldsymbol{e}_j) = \begin{cases} w_b e_{i1} + w_f - \psi(e_{i1}, e_{i2}) & \text{if} \quad \theta = s, \\ w_b e_{i1} + w_f - \psi(e_{i1}, e_{i2}) + \gamma(e_{i2}, e_{j2}) & \text{if} \quad \theta = c. \end{cases} \tag{2}$$

Worker i's utility consists of up to three components. First, he enjoys utility $w_b e_{i1} + w_f$ from his wage. Second, exerting effort causes him effort costs $\psi(e_{i1}, e_{i2})$. The cost function ψ is weakly positive and strictly increasing in both effort dimensions. We assume that individual and team effort are substitutes in a worker's cost function, i.e,. marginal costs of effort in one dimension are an increasing function of effort in the other dimension. Normalizing $\psi(0, 0)$ to zero, this implies

$$\psi(1,1) > \psi(1,0) + \psi(0,1). \tag{3}$$

Third, conditionally cooperative workers enjoy some intrinsic satisfaction $\gamma(e_{i2}, e_{j2})$ from cooperation. To model conditional cooperation, we set γ equal to some strictly positive constant $\Gamma > 0$ if and only if both workers contribute team effort. For all other effort choices γ is normalized to zero. The assumption that conditionally cooperative workers enjoy some intrinsic satisfaction from joint cooperation is consistent with Rabin's (1993) model of fairness. Hamilton, Nickerson, and Owan (2003) provide empirical evidence for the hypothesis that some workers receive intrinsic satisfaction from team work. Analyzing team participation in a garment plant, they find that "some workers joined teams despite an absolute decrease in pay, suggesting that teams offer nonpecuniary benefits to workers" (p469).[4] We assume that workers' types are private information, yet it is common knowledge that they are independently distributed with each worker being conditionally cooperative with some prior probability $\lambda \in]0, 1[$. Both types of workers maximize expected utility.

Finally, we make the following assumptions with regard to the efficiency of individual effort and team effort. First, we assume that

$$F > \psi(1,1) - \psi(0,1), \tag{4}$$

which ensures that marginal output always exceeds marginal costs of individual effort. Hence, exerting individual effort is always efficient. Second, we assume that

$$\Gamma > \psi(1,1) - \psi(1,0). \tag{5}$$

Workers' benefit from exerting team effort exceeds their marginal effort costs even if individual effort is chosen. Because of the intrinsic satisfaction Γ from successful cooperation, team production is thus always efficient in a team of conditionally cooperative workers, independent of team output G.

2.2 Definition of a Competitive Equilibrium

The objective of our paper is to investigate whether labor market competition can lead to a separation of workers according to their type, whether conditionally cooperative workers cooperate in equilibrium, and whether, thus, heterogeneous corporate cultures can emerge in an ex-ante symmetric environment. To answer these questions we follow the tradition in the

[4]The assumption is also supported by numerous studies from organizational psychology. See, e.g., Tyler and Blader (2000) and Organ, Podsakoff, and MacKenzie (2006) for an overview.

literature of competition under adverse selection and analyze the equilibrium set of offered contracts, abstracting from the identity and the explicit decision making of individual firms. At the same time, we model workers' interactive behavior within firms as a Bayesian game.

As in other models of adverse selection, workers' contract choices in our setting might reveal information on their preferences. We assume that beliefs do not differ across individuals. Let $\mu(\theta|\boldsymbol{w}, \boldsymbol{W}) \in [0,1]$ denote the probability with which firms and all other workers believe a worker to be of type $\theta \in \{s, c\}$ if the latter accepts contract $\boldsymbol{w}$ out of a set of offered contracts $\boldsymbol{W}$. We require that individuals form such beliefs for all contracts $\boldsymbol{w} \in \boldsymbol{W}$ and all possible sets of offered contracts $\boldsymbol{W} \subseteq \boldsymbol{\mathcal{W}}$.

To describe workers' behavior let $a_{i\theta}(\boldsymbol{w}, \boldsymbol{W}) \in [0,1]$ denote the type-dependent probability with which worker i accepts contract $\boldsymbol{w}$ out of a set of offered contracts $\boldsymbol{W}$. Equally, let $\boldsymbol{e}_{i\theta}(\boldsymbol{w}, \boldsymbol{W}) \in \{0,1\} \times \{0,1\}$ denote worker i's type-dependent effort choice given he is assigned a team within a firm that employs contract $\boldsymbol{w}$ from a set of offered contracts $\boldsymbol{W}$. We require workers to have fully specified strategies that determine type-dependent behavior for all contracts $\boldsymbol{w} \in \boldsymbol{W}$ and all possible sets $\boldsymbol{W} \subseteq \boldsymbol{\mathcal{W}}$ of offered contracts.[5] We focus on symmetric equilibria throughout the paper where all workers share the same type-dependent equilibrium strategies, thus we skip subindices i, j in the following. In a competitive equilibrium, we require workers' strategies and beliefs to form a perfect Bayesian equilibrium given all possible sets of offered contracts $\boldsymbol{W} \subseteq \boldsymbol{\mathcal{W}}$. This is made precise in the following definition.

Definition 1 (Workers' Equilibrium Behavior) *Workers behave optimally given a set of offered contracts $\boldsymbol{W} \subseteq \boldsymbol{\mathcal{W}}$, if the corresponding beliefs μ and type-dependent strategies $\{e^*_\theta, a^*_\theta\}$ for $\theta \in \{s, c\}$ form a perfect Bayesian equilibrium, i.e.,*

(i) the type-dependent effort choice $\boldsymbol{e}^*_\theta(\boldsymbol{w}, \boldsymbol{W})$ maximizes a type-θ worker's expected utility $E_{\theta'} u_\theta\big(\boldsymbol{w}, \boldsymbol{e}^*_\theta(\boldsymbol{w}, \boldsymbol{W}), \boldsymbol{e}^*_{\theta'}(\boldsymbol{w}, \boldsymbol{W})\big)$ given the beliefs $\mu(\theta'|\boldsymbol{w}, \boldsymbol{W})$,

(ii) the type-dependent acceptance decision $a^*_\theta(\boldsymbol{w}, \boldsymbol{W})$ maximizes a type-θ worker's expected utility over the set of offered contracts $\boldsymbol{W}$ given the outcomes as implied by the behavior characterized in (i), and

(iii) the beliefs $\mu(\theta|\boldsymbol{w}, \boldsymbol{W})$ for $\theta \in \{s, c\}$ are consistent with workers' acceptance decisions $a^*_\theta(\boldsymbol{w}, \boldsymbol{W})$ and Bayes' rule, if the contract is accepted with strictly positive probability

[5] In addition, we impose the following cutoff rules: whenever a worker is indifferent between exerting and not exerting effort, he exerts effort; whenever a worker is indifferent between exerting only team effort and exerting only individual effort, he exerts only individual effort.

$a^*_\theta(\boldsymbol{w}) > 0$ by at least one type $\theta \in \{s, c\}$.

Intuitively, workers behave optimally within a firm if they maximize their expected utility given the firm's contract, the equilibrium strategies of the other workers, and the common beliefs. In a perfect Bayesian equilibrium, workers' effort choices must form a Bayesian equilibrium in every subgame and thus for all possible contracts $\boldsymbol{w}$. Based on these equilibrium outcomes each worker computes his expected utility upon accepting a particular contract and chooses the contract that maximizes his utility over the set of offered contracts. Although preferences are private information, contract choices might serve as a signal. Equilibrium beliefs are required to be consistent with worker's acceptance decisions and Bayes' rule whenever this is possible. If a contract is never accepted in equilibrium, beliefs are undetermined and can be set arbitrarily.

A competitive equilibrium is now a set of offered contracts which, given that workers behave optimally, satisfies the following requirements. First, the equilibrium set of offered contracts contains no irrelevant contracts that are never accepted in equilibrium. Second, no firm offers a contract that makes expected losses in equilibrium. Otherwise, the firm could increase its expected profit by withdrawing the offered contract. Third, competition for workers is modeled by free entry. A set of offered contract then forms an equilibrium only if no firm can enter the market by offering a new contract that attracts workers and yields non-negative expected profit. This is formally captured in Definition 2.

Definition 2 (Competitive Equilibrium) *Given that workers behave optimally for all possible sets of offered contracts, a competitive equilibrium is a set of offered contracts $\boldsymbol{W}^*$ such that*

(i) every contract $\boldsymbol{w} \in \boldsymbol{W}^*$ is accepted with strictly positive probability by at least one type of worker, i.e., $a^*_\theta(\boldsymbol{w}, \boldsymbol{W}^*) > 0$ for at least one type $\theta \in \{s, c\}$,

(ii) every contract $\boldsymbol{w} \in \boldsymbol{W}^*$ generates non-negative expected profit given the equilibrium beliefs $\mu(\theta|\boldsymbol{w}, \boldsymbol{W}^*)$ and workers' type-dependent equilibrium effort choices $\boldsymbol{e}^*_\theta(\boldsymbol{w}, \boldsymbol{W}^*)$ for both types $\theta \in \{s, c\}$, and

(iii) no contract $\boldsymbol{w'} \notin \boldsymbol{W}^*$ can attract workers, i.e., there exists no $\boldsymbol{w'} \notin \boldsymbol{W}^*$ such that $a^*_\theta(\boldsymbol{w'}, \boldsymbol{W}^* \cup \boldsymbol{w'}) > 0$ for at least one type $\theta \in \{s, c\}$ and $\boldsymbol{w'}$ yields non-negative expected profit given the beliefs $\mu(\theta|\, \boldsymbol{w'}, \boldsymbol{W}^* \cup \boldsymbol{w'})$ and workers' type-dependent effort choices $\boldsymbol{e}^*_\theta(\boldsymbol{w'}, \boldsymbol{W}^* \cup \boldsymbol{w'})$ for both types $\theta \in \{s, c\}$.

A competitive equilibrium has the following properties. Since firms can employ any number of teams, there is no rationing. Because there is an infinite number of workers, workers in a symmetric equilibrium can be sure to find a co-worker when accepting a contract that is optimally accepted with strictly positive probability. Consequently, all workers of the same type receive the same equilibrium utility. Let u^*_θ denote the equilibrium utility of a type-θ worker. We call a competitive equilibrium a *separating equilibrium* if there exists no offered contract that is accepted with strictly positive probability by both types of workers. A worker's type can then perfectly be inferred from his contract choice. In all other equilibria there exists at least one contract that is accepted by both types of workers with strictly positive probability. In this case we say that there is *pooling* in equilibrium.

2.3 Equilibrium Refinements

Whether a set $\boldsymbol{W}^*$ of contracts can be supported as a competitive equilibrium depends on workers' reaction towards a newly offered contract $\boldsymbol{w}' \notin \boldsymbol{W}^*$. 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 to find a colleague. As common in screening and signalling models, there exist multiple equilibria that are based on particular out-of-equilibrium beliefs. Further, there can arise coordination problems concerning the Bayesian equilibria within firms and workers' acceptance decisions. To rule out implausible competitive equilibria we employ the following equilibrium refinements.

Refinement 1 (Beliefs) *Consider a competitive equilibrium $\boldsymbol{W}^*$ and suppose an additional contract $\boldsymbol{w}' \notin \boldsymbol{W}^*$ is offered. Suppose further that $u^*_\theta > \max_{(\boldsymbol{e},\tilde{\boldsymbol{e}})} \left\{u_\theta(\boldsymbol{w}', \boldsymbol{e}, \tilde{\boldsymbol{e}})\right\}$ for all $(\boldsymbol{e}, \tilde{\boldsymbol{e}})$ and $u_{\theta'}(\boldsymbol{w}', \boldsymbol{e}, \tilde{\boldsymbol{e}}) \geq u^*_{\theta'}$ for some $(\boldsymbol{e}, \tilde{\boldsymbol{e}})$ with $\theta \neq \theta'$. Then $\mu(\theta | \, \boldsymbol{w}', \boldsymbol{W}^* \cup \boldsymbol{w}') = 0$.*

Refinement 1 applies Cho and Kreps's (1987) intuitive criterion to rule out the situation that workers might not accept a newly offered contract only because they then believe their co-worker to be of a certain type. Precisely, if a particular type of worker always gets strictly less than his equilibrium utility by accepting a new contract, he should never accept this contract. If this is not the case for the other type, then one should believe a worker who accepts the new contract to be of the latter type. Further, we impose the following refinement.

Refinement 2 (Coordination) *Consider a competitive equilibrium $\boldsymbol{W}^*$ and suppose an additional contract $\boldsymbol{w}' \notin \boldsymbol{W}^*$ is offered. Further, suppose that $\mu(\theta' | \boldsymbol{w}', \boldsymbol{W}^* \cup \boldsymbol{w}') = 1$ and that there exist unique equilibrium efforts $\boldsymbol{e}^*_{\theta'}$ such that $u_{\theta'}(\boldsymbol{w}', \boldsymbol{e}^*_{\theta'}, \boldsymbol{e}^*_{\theta'}) \geq u^*_{\theta'}$ given belief $\mu(\theta' | \boldsymbol{w}', \boldsymbol{W}^* \cup \boldsymbol{w}')$ and contract $\boldsymbol{w}'$. Then workers who accept contract $\boldsymbol{w}'$ choose the equilibrium efforts $\boldsymbol{e}^*_{\theta'}$.*

Workers might not accept a very attractive new contract only because they expect some unfavorable Bayesian equilibrium to be played. Yet suppose workers believe that a new contract might only be accepted by a particular type. Further suppose that even for this type it can only be optimal to accept the new contract if within the respective firm workers coordinate on a unique Bayesian equilibrium. Then workers should believe that those workers accepting the new contract are not only of the particular type, but should also expect that particular Bayesian equilibrium to be played. Finally, we make the following requirement concerning the acceptance decisions.

Refinement 3 (Acceptance) *Consider a competitive equilibrium* $\boldsymbol{W}^*$ *and suppose an additional contract* $\boldsymbol{w}' \notin \boldsymbol{W}^*$ *is offered. Given the corresponding beliefs and type-dependent equilibrium effort choices, let* $\hat{u}_\theta(\boldsymbol{w}')$ *denote the expected utility of a type-*θ *worker who accepts* $\boldsymbol{w}'$ *and is matched in a team. Then*

$$a^*_\theta(\boldsymbol{w}', \boldsymbol{W}^* \cup \boldsymbol{w}') = \begin{cases} 1 & \text{if} \quad \hat{u}_\theta(\boldsymbol{w}') > u^*_\theta, \\ \in [0,1] & \text{if} \quad \hat{u}_\theta(\boldsymbol{w}') = u^*_\theta, \ \text{and} \\ 0 & \text{if} \quad \hat{u}_\theta(\boldsymbol{w}') < u^*_\theta. \end{cases}$$

for both types $\theta \in \{s, c\}$.

A worker who is the only one to accept a particular contract cannot be matched into a team. Since he then gets his outside option of zero by assumption, a new contract might not be accepted only because each worker expects no other worker to accept this contract. Refinement 3 rules out any equilibrium that is based on this type of coordination failure.

3 Results

In this section, we proceed as follows. We first analyze the set of Bayesian equilibria within firms, that is, the set of Bayesian equilibria in all possible subgames which are defined by a particular contract and a particular belief about the co-worker's type. Based on this analysis, we then explore the competitive equilibria in our model. In particular, we show that no pooling can arise in equilibrium, we characterize the set of Pareto-efficient separating contracts, and we prove existence of a separating equilibrium. Finally, we compare our results under private information to the benchmark case where preferences are observable.

3.1 Bayesian Equilibria within Firms

Consider a Bayesian game within a firm that is characterized by a particular contract and corresponding beliefs about the co-worker's type. We restrict attention to equilibria in pure strategies. By definition of conditional cooperation, conditionally cooperative workers exert no team effort if they expect their co-worker not to exert team effort either. As we will show this behavior can generate multiple equilibria: *selfish equilibria*, in which no type of worker cooperates, and *cooperative equilibria*, in which the conditionally cooperative workers contribute team effort. Concerning selfish equilibria we get the following result.

Lemma 1 (Selfish Equilibrium) *Consider the Bayesian game given by contract* $\boldsymbol{w} \in \boldsymbol{W}$ *and beliefs* $\mu(\theta|\boldsymbol{w}, \boldsymbol{W})$ *for* $\theta \in \{s, c\}$*. There always exists a selfish equilibrium in which there is no cooperation and*

$$\boldsymbol{e}_{\theta}^{SE}(\boldsymbol{w}, \boldsymbol{W}) = \begin{cases} (0,0) & \text{if} \quad w_b < \psi(1,0) \\ (1,0) & \text{if} \quad w_b \geq \psi(1,0) \end{cases} \tag{6}$$

describes the equilibrium effort choices of both types of workers $\theta \in \{s, c\}$*.*

The simple proof is left to the reader. Since a conditionally cooperative worker in a selfish equilibrium correctly anticipates that his co-worker never contributes team effort, the same is optimal for him. Given that there is no cooperation, selfish and conditionally cooperative workers have the same utility function. Consequently, both types of workers exert individual effort if the bonus exceeds the associated increase in their effort costs. The following lemma shows that there also exists a cooperative equilibrium depending on workers' beliefs.

Lemma 2 (Cooperative Equilibrium) *Consider the Bayesian game given by contract* $\boldsymbol{w} \in \boldsymbol{W}$ *and beliefs* $\mu(\theta|\boldsymbol{w}, \boldsymbol{W})$ *for* $\theta \in \{s, c\}$*. There exists a cooperative equilibrium in which the conditionally cooperative workers exert team effort if and only if*

$$\mu(c|\boldsymbol{w}, \boldsymbol{W}) \geq \begin{cases} \psi(0,1)\,/\,\Gamma & \text{if} \quad w_b < \psi(1,0) \\ \big(\psi(0,1) + w_b - \psi(1,0)\big)\,/\,\Gamma & \text{if} \quad w_b \in \big[\psi(1,0), \psi(1,1) - \psi(0,1)\big[\\ \big(\psi(1,1) - \psi(1,0)\big)\,/\,\Gamma & \text{if} \quad w_b \geq \psi(1,1) - \psi(0,1). \end{cases} \tag{7}$$

In such a cooperative equilibrium, selfish workers choose the same efforts $\boldsymbol{e}_s^{SE}(\boldsymbol{w}, \boldsymbol{W})$ *as in the selfish equilibrium, whereas*

$$\boldsymbol{e}_{c}^{CE}(\boldsymbol{w}, \boldsymbol{W}) = \begin{cases} (0,1) & \text{if} \quad w_b < \psi(1,1) - \psi(0,1) \\ (1,1) & \text{if} \quad w_b \geq \psi(1,1) - \psi(0,1) \end{cases} \tag{8}$$

describes the equilibrium effort choices of the conditionally cooperative workers.

All the following proofs can be found in the appendix. Whether a cooperative equilibrium exists depends on the workers' belief. If a conditional cooperator believes that a conditionally cooperative colleague exerts team effort, exerting team effort increases his expected utility by $\mu(c|\boldsymbol{w}, \boldsymbol{W})\,\Gamma$. If this expected benefit of cooperation exceeds the associated effort costs, there exists a cooperative equilibrium. Yet the costs of contributing team effort depend on the individual effort choice, which in turn depends on the contract. Given a high bonus, conditionally cooperative workers exert individual effort. Since individual effort and team effort are substitutes in the worker's cost function, this makes the contribution of team effort more costly. Individual incentives thus render the conditions on the belief for the existence of a cooperative equilibrium more restrictive. In this sense, high incentives can crowd-out cooperation as in Holmstrom and Milgrom (1991).

However, team effort is efficient. Condition (5) ensures that for every contract there always exists a cooperative equilibrium if workers believe their colleagues to be conditionally cooperative with probability one. Further, workers' effort costs imply that the minimum bonus needed to implement individual effort by conditional cooperators in a cooperative equilibrium is strictly higher than the corresponding minimum bonus in a selfish equilibrium. Since conditional cooperators provide team effort in equilibrium, they need stronger incentives for individual effort than selfish workers who do not cooperate and thus save on effort costs.

3.2 Competitive Equilibrium

Having characterized the Bayesian equilibria within firms, we now introduce competition between firms. By assumptions (4) and (5) exerting both individual and team effort is efficient. Therefore, the best that can happen to a conditionally cooperative worker in a competitive equilibrium is to join a firm that implements individual effort, pays out all profit to its' workers, and attracts only conditionally cooperative workers who coordinate on the cooperative equilibrium. Lemma 2 then implies that

$$\boldsymbol{W}^c = \left\{\boldsymbol{w} \in \boldsymbol{\mathcal{W}} : \, w_b \in [\psi(1,1) - \psi(0,1), F + G\,] \text{ and } w_f = F + G - w_b\right\} \tag{9}$$

is the set of contracts that maximize a conditionally cooperative worker's utility given the above conditions. Superscript c stands for *optimal cooperative contract*. We get the following first result.

Proposition 1 (No Pooling) *Suppose workers' preferences are private information. Then in any competitive equilibrium there is no pooling.*

In general, pooling is not very attractive for conditionally cooperative workers: either the presence of selfish workers destroys cooperation, or conditionally cooperative workers do not benefit from their team effort with the probability $\mu(s|\boldsymbol{w}, \boldsymbol{W})$ with which their respective colleague is selfish. A new firm can then enter the market and skim off the conditionally cooperative workers by offering a contract that promises a slightly lower monetary payoff. Since they get less pay under the new contract, selfish workers stick to the old contract. By Refinement 1 conditionally cooperative workers can thus be sure to be among their own type when accepting the newly offered contract. Further, the new contract can be chosen such that by Refinement 2 conditionally cooperative workers coordinate on the cooperative equilibrium upon accepting the new contract. Since their team effort is now never wasted on a selfish colleague, the associated increase in their expected benefit from cooperation overcompensates their monetary loss. Consequently, firms can enter the market and attract conditionally cooperative workers. Since wages are low they thereby incur no losses.

While it is typically the conditionally cooperative type that can be attracted by a newly offered contract, we show in the proof of Proposition 1 that, in fact, there also exists a case where firms can skim off the selfish type. This happens when the pooling contract specifies an intermediate bonus and workers coordinate on the cooperative equilibrium such that only selfish workers exert individual effort. If expected team production by the conditionally cooperative workers does not cover the fixed wages, the conditionally cooperative workers are subsidized by the selfish workers in this case. New firms can then enter the market and skim off selfish workers by offering a contract which implements high individual effort, pays out all profit, and thereby grants the selfish workers the subsidy which previously went to the conditionally cooperative workers.

Proposition 1 implies that any competitive equilibrium must be a separating equilibrium. We will show that, as in other models of competition under adverse selection, our refinements ensure that the only candidate for an equilibrium is Pareto-efficient: conditional on all firms making at least zero profit, selfish workers receive contracts that maximize their utility, whereas conditionally cooperative workers receive contracts that maximize their utility without attracting selfish workers.[6]

First, consider the selfish workers. In a separating equilibrium selfish workers cannot free-ride on the cooperation of conditional cooperators. The best that can happen to a selfish worker is thus to join a firm that implements individual effort and pays out the entire profit F to

[6]We show in the formal proof that the incentive constraint of the conditionally cooperative workers can indeed be ignored.

each worker. Lemma 1 then implies that

$$\boldsymbol{W}^s = \big\{\boldsymbol{w} \in \boldsymbol{\mathcal{W}}:\ w_b \in [\psi(1,0), F] \text{ and } w_f = F - w_b\big\} \tag{10}$$

is the set of contracts that maximize a selfish worker's utility in any competitive equilibrium. Superscript s stands for *optimal selfish contract*.

Second, consider the conditionally cooperative workers. Suppose the selfish workers get at least one contract from the set $\boldsymbol{W}^s$. We want to characterize the set $\boldsymbol{W}^{cc}$ of contracts that maximize the conditionally cooperative workers' utility, given that the firms offering these contracts make at least zero profit and are not infiltrated by selfish workers. Superscript cc stands for *constrained optimal cooperative contract*. By (5), the conditionally cooperative workers' intrinsic benefit from cooperation exceeds their additional effort costs, if they can be sure that their colleague also exerts team effort. In a competitive equilibrium, they should — and we will show that they do — thus coordinate on the cooperative equilibrium. Contracts in $\boldsymbol{W}^{cc}$ must therefore satisfy the following constraints,

$$F\big(e_{c1}^{CE}(\boldsymbol{w},\boldsymbol{W})\big) + G \quad \geq \quad w_b\, e_{c1}^{CE}(\boldsymbol{w},\boldsymbol{W}) + w_f \tag{11}$$

$$F - \psi(1,0) \quad \geq \quad w_b\, e_{s1}^{SE}(\boldsymbol{w},\boldsymbol{W}) + w_f - \psi\big(e_{s1}^{SE}(\boldsymbol{w},\boldsymbol{W}),0\big). \tag{12}$$

The zero profit constraint (11) ensures that the firms make no losses in equilibrium, and (12) is the incentive constraint of the selfish workers. We get the following result.

Lemma 3 (Optimal Screening Contracts) $\boldsymbol{W}^{cc}$ *is the set of contracts such that*

(i) if $G \leq F - \psi(1,1) + \psi(0,1)$*, then* $w_b \in [\psi(1,1) - \psi(0,1),\ F]$ *and* $w_f = F - w_b$*,*

(ii) if $G \in [F - \psi(1,1) + \psi(0,1),\ F - \psi(1,0)]$*, then* $w_b < \psi(1,0)$ *and* $w_f = G$*, and*

(iii) if $G > F - \psi(1,0)$*, then* $w_b < \psi(1,0)$ *and* $w_f = F - \psi(1,0)$*.*

Moreover, suppose the above contracts are only accepted by conditionally cooperative workers and these workers coordinate on the cooperative equilibrium. Then these contracts generate a strictly positive expected profit unless $G \in [F - \psi(1,1) + \psi(0,1),\ F - \psi(1,0)]$*.*

Figure 1 illustrates the contracts in $\boldsymbol{W}^{cc}$ by mapping a conditionally cooperative worker's utility u_c^{CE} under a constrained optimal cooperative contract as a function of per-worker team output G. The latter is important as it determines whether or not the optimal screening contract implements individual effort of the conditionally cooperative types.

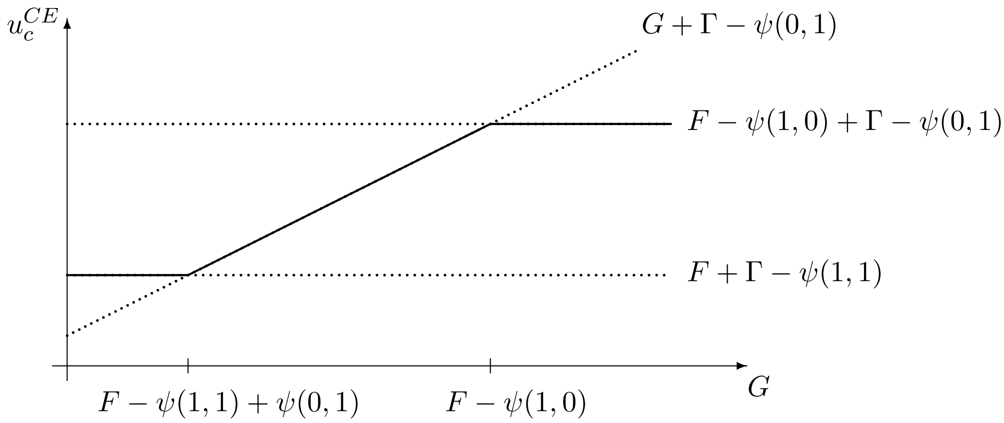

Figure 1: Optimal Screening Contracts

In general, conditionally cooperative workers want to earn a high monetary payoff. In case per-worker team output G is small, the constrained optimal cooperative contract implements individual effort as otherwise output would be too small to pay out high wages. However, conditionally cooperative workers contribute team effort to get the intrinsic benefit from cooperation. They thereby produce additional output per worker. Paying out this additional output is not incentive compatible as otherwise selfish workers are attracted by the high wages. This implies that if conditionally cooperative workers are to exert individual effort, they cannot benefit from their team effort other than by their intrinsic satisfaction from cooperation. In consequence, they earn a utility $F + \Gamma - \psi(1,1)$.

Now suppose that per-worker team output G is intermediate but still smaller than $F - \psi(1,0)$. If conditional cooperators are to exert only team effort, the firm can pay out all output to each worker without violating the selfish workers' incentive constraint. Since conditionally cooperative workers exert no individual effort, they incur no costs from individual effort. In addition, they save on their costs from cooperation. Selfish workers who infiltrate cooperative firms do not enjoy this additional cost reduction since they never exert team effort. By reducing monetary incentives, firms can thus pass on this additional cost reduction to the conditionally cooperative workers without violating the selfish workers' incentive constraint. If this additional cost reduction exceeds the loss in wages, i.e. $\psi(1,1) - \psi(0,1) > F - G$, it is optimal not to implement individual effort. Conditionally cooperative workers then provide only team effort and earn a utility $G + \Gamma - \psi(0,1)$. Finally, as per-worker team output G exceeds the threshold $F - \psi(1,0)$, the selfish workers' incentive constraint becomes binding again. Therefore, firms cannot increase wages of the conditional cooperative workers any further. The latters utility is capped at $F - \psi(1,0) + \Gamma - \psi(0,1)$.

Lemma 3 shows that firms offering contracts in $\boldsymbol{W}^{cc}$ might make strictly positive expected profit. The reason for this result is the incentive constraint: whenever it binds the respective firms cannot pay out all profit without attracting selfish workers. As seen above, the incentive constraint is binding whenever contracts in $\boldsymbol{W}^{cc}$ implement both team effort and individual effort, or when contracts in $\boldsymbol{W}^{cc}$ implement only team effort but G is sufficiently large. Building on our findings sofar, we can now present our main result.

Proposition 2 (Competitive Equilibrium) *Suppose workers' preferences are private information. Then in any competitive equilibrium* $\boldsymbol{W}^*$

(i) *workers of different types self-select into different firms,*

(ii) $\boldsymbol{W}^* \subseteq \boldsymbol{W}^s \cup \boldsymbol{W}^{cc}$ *where* $\boldsymbol{W}^*$ *contains at least one element of* $\boldsymbol{W}^s$ *and of* $\boldsymbol{W}^{cc}$*,*

(iii) *conditionally cooperative workers exert team effort, and*

(iv) *firms attracting the conditionally cooperative workers make strictly positive expected profit unless* $G \in [F - \psi(1,1) + \psi(0,1),\, F - \psi(1,0)]$.

Proposition 2 is based on the following intuition. Since there can be no pooling, workers self-select into different firms. As a consequence, contracts from the set $\boldsymbol{W}^s$ maximize the selfish workers' utility. At least one of these optimal selfish contracts must be offered in equilibrium. If this was not the case, a new firm could attract selfish workers by offering an optimal selfish contract. If this contract also specifies a high bonus, it makes at least zero profit since workers of any type exert individual effort upon acceptance. Given selfish workers get an optimal selfish contract, at least one contract from the set $\boldsymbol{W}^{cc}$ of constrained optimal cooperative contract must be offered in equilibrium. Otherwise, a firm could attract conditionally cooperative workers by offering a contract that is optimally accepted only by conditionally cooperative workers who expect to coordinate on the cooperative equilibrium. Our equilibrium refinements ensure that offering such a contract is indeed profitable and can attract workers.

At first sight it might seem puzzling that there can exist a competitive equilibrium in which some firms make strictly positive profit whereas other firms just break even. Why do those firms that make zero profit not imitate the more profitable firms? It might appear that our abstraction from firm identity and explicit profit maximization drives this result. This is not the case. If firm identity matters, workers must condition their acceptance decisions not only on the contract a firm offers, but also on the firm's identity. If a new firm offers a contract that is already offered by another firm, workers cannot increase their utility by switching to the new firm. Consequently, optimal acceptance decisions can be chosen such that the new firm cannot attract workers unless it promises them a strictly higher utility. In equilibrium, imitating the most successful firms is thus no profitable option. Yet due to asymmetric information, paying a higher wage is not possible without attracting the selfish workers and thus making losses. The same argument holds concerning firms that are already active on the market but want to change the contract they provide.

Before further commenting on the above characterized equilibrium properties, we must check whether such competitive equilibria do exist. The literature following Rothschild and Stiglitz (1976) has shown that Pareto-efficient separating equilibria in competitive markets with adverse selection might be upset by pooling contracts. Our next result demonstrates that this is not the case in our setting.

Proposition 3 (Existence) *Suppose workers' preferences are private information. Then there always exists a competitive equilibrium as characterized in Proposition 2.*

The existence result is based on the following intuition. In our model the utility a worker expects when accepting a particular contract depends on the expected effort choices of his colleague. These effort choices might depend on the colleague's type. Contrary to standard screening models, the workers' acceptance and effort decisions thus depend on their beliefs and the Bayesian equilibria they expect to be played within firms. Since by definition a pooling contract can attract both types of workers, Refinement 1 cannot restrict beliefs. Depending on the newly offered pooling contract, there are two cases.

First, the pooling contract might promise very high wages such that both types of workers are attracted, no matter what Bayesian equilibrium they expect to be played. Refinement 3 and the consistency of beliefs then implies that workers hold the prior belief upon accepting the newly offered contract. Given this belief there always exists the selfish equilibrium. Since the acceptance decision is independent of what equilibrium the workers expect to be played, Refinement 2 has no bite. Consequently, workers may coordinate on the selfish equilibrium upon accepting the newly offered contract. But then the newly offered contract must make expected losses as otherwise the conditionally cooperative workers cannot be attracted.

Second, the pooling contract might attract the conditionally cooperative workers only if they expect the cooperative equilibrium to be played. Yet suppose workers believe that only selfish workers accept the newly offered contract. Again, this belief cannot be not ruled out by our refinement, since both types of workers can be attracted in the pooling contract. Given this belief, however, only the selfish equilibrium exists. If workers expect the selfish equilibrium to be played, it is indeed optimal for only the selfish workers to accept the newly offered contract. Thus, beliefs, effort choices, and acceptance decisions are consistent. Yet, if only selfish workers accept the newly offered contract, this contract is not a pooling contract. By construction no separating contract can upset the Pareto-efficient separating equilibrium as characterized in Proposition 2.

3.3 Impact of Asymmetric Information

In order to investigate the impact of asymmetric information, we consider the benchmark case of observable preferences. If preferences are not private information, firms can target contracts at a particular type of workers. Incentive constraints can be thus ignored. This has the following consequence.

Proposition 4 (Complete Information Equilibrium) *Suppose workers' preferences are observable. Then in any competitive equilibrium* $\boldsymbol{W}^*$

(i) $\boldsymbol{W}^* \subseteq \boldsymbol{W}^s \cup \boldsymbol{W}^c$ *where* $\boldsymbol{W}^*$ *contains at least one element of* $\boldsymbol{W}^s$ *and of* $\boldsymbol{W}^c$,

(ii) conditionally cooperative workers exert team effort, and

(iii) all firms make zero profit.

The formal proof is omitted since the arguments are identical to the proof of Proposition 2. As before, conditionally cooperative workers do not want to work in firms attracting selfish workers. If workers' types are observable, the market thus splits into two, one market for each type. However, with complete information incentives do not constrain competition. Thus, selfish workers get at least one contract from $\boldsymbol{W}^s$ whereas conditionally cooperative workers get at least one contract from the set $\boldsymbol{W}^c$. Firms then make zero profit.

Proposition 4 highlights the importance of the incentive constraint. If there is asymmetric information some firms might make strictly positive profit in a competitive equilibrium. Firms would like to enter the market and attract conditionally cooperative workers by offering them a larger share of the profit they produce. Yet, this is not incentive compatible: these new firms would then also attract selfish workers. The latter never contribute team effort, thus no firm can enter the market without making expected losses. Moreover, asymmetric information can cause incentives to be muted in firms that attract the conditionally cooperative workers. Workers do not like to work, but high individual effort is efficient even though it increases the costs of cooperation. If preferences are observable, competition forces firms to pay out all profit. It is then optimal for conditionally cooperative workers to join a firm that employs very strong monetary incentives. However, if there is asymmetric information, the incentive constraint of the selfish workers might not allow firms to pay out all profit. Conditionally cooperative workers thus cannot reap all monetary benefits of their individual effort. Yet, they enjoy an additional reduction in their effort costs if firms abstain from using strong incentives. Competition ensures that firms pass on this additional cost reduction to the conditionally cooperative workers. Incentives in cooperative firms can thus be muted.

4 Conclusion

We analyze a competitive labor market with heterogeneous workers that differ with regard to their intrinsic motivation for cooperation in teams. Some workers are willing to cooperate if their co-worker cooperates as well (conditional cooperators). Other workers only follow monetary incentives and hence never cooperate (selfish workers). A worker's type is private information and firms compete for workers by offering wage contracts that can provide monetary incentives for individual effort but not for team effort. Our results show that there is no pooling in equilibrium but that workers endogenously sort into firms that differ from each other in many aspects. While selfish workers are employed in firms that offer strong monetary incentives for individual effort and do not enjoy team work, conditionally cooperative workers are employed in firms where teamwork is observed. Moreover, asymmetric information about a worker's type can cause monetary incentives to be muted in firms that employ conditional cooperators. Further, firms employing conditional cooperators can sustain positive profits in equilibrium, whereas competition for selfish workers drives down profits of the corresponding firms to zero. The reason for this – at first sight perhaps surprising – result is that in a separating equilibrium wage contracts for conditional cooperators have to be sufficiently unattractive to selfish workers. This in turn may constrain a firm in paying out its profits to the workers, since if wages were too high selfish workers would invade the firm, cooperation would be destroyed, and the firm would consequently make losses. In sum, our results show that teamwork and an intrinsic motivation for cooperation in firms can survive labor market competition. Furthermore, our model provides a theoretical rationale for the endogenous emergence and stability of different corporate cultures.

Appendix

Proof of Lemma 2

Selfish workers never exert team effort. A cooperative equilibrium thus exists if and only if it is optimal for a conditionally cooperative worker to exert team effort given he expects his conditionally cooperative colleague to exert team effort, as well. Given a contract $\boldsymbol{w} \in \boldsymbol{W}$ a worker believes with probability $\mu(c|\boldsymbol{w}, \boldsymbol{W})$ to be matched with a conditional cooperator. There are two cases.

Case A) Suppose conditionally cooperative workers also exert individual effort in equilibrium. They then get an expected utility $w_b + w_f + \mu(c|\boldsymbol{w}, \boldsymbol{W})\,\Gamma - \psi(1,1)$. Exerting team effort forms an equilibrium if there are no profitable deviations. It is not profitable to exert only team effort if and only if $w_b + w_f + \mu(c|\boldsymbol{w}, \boldsymbol{W})\,\Gamma - \psi(1,1) \geq w_f + \mu(c|\boldsymbol{w}, \boldsymbol{W})\,\Gamma - \psi(0,1)$. This condition is equivalent to $w_b \geq \psi(1,1) - \psi(0,1)$. From the remaining deviations, exerting only individual effort dominates exerting no effort at all if and only if $w_b + w_f - \psi(1,0) \geq w_f$. Due to assumption (3), this inequality is implied by the previous condition on w_b. However, exerting only individual effort is not profitable if and only if $w_b + w_f + \mu(c|\boldsymbol{w}, \boldsymbol{W})\,\Gamma - \psi(1,1) \geq w_b + w_f - \psi(1,0)$. This yields the condition on the belief $\mu(c|\boldsymbol{w}, \boldsymbol{W})$ for the case $w_b \geq \psi(1,1) - \psi(0,1)$.

Case B) Suppose conditionally cooperative workers only exert team effort in equilibrium. They then get an expected utility $w_f + \mu(c|\boldsymbol{w}, \boldsymbol{W})\,\Gamma - \psi(0,1)$. The imposed cutoff rule implies that conditionally cooperative workers do not exert both individual and team effort if and only if $w_f + \mu(c|\boldsymbol{w}, \boldsymbol{W})\,\Gamma - \psi(0,1) > w_b + w_f + \mu(c|\boldsymbol{w}, \boldsymbol{W})\,\Gamma - \psi(1,1)$. This yields the condition $w_b < \psi(1,1) - \psi(0,1)$ on the bonus. From the remaining two deviations, exerting only individual effort dominates exerting no effort at all if and only if $w_b + w_f - \psi(1,0) \geq w_f$. If $w_b \in \big[\psi(1,0), \psi(1,1) - \psi(0,1)\big[$, then the most attractive remaining deviation is to exert only individual effort. It is then not profitable to deviate if and only if $w_f + \mu(c|\boldsymbol{w}, \boldsymbol{W})\,\Gamma - \psi(0,1) \geq w_b + w_f - \psi(1,0)$. If $w_b < \psi(1,0)$, then the most attractive remaining deviation is to exert no effort at all. It is then not profitable to deviate if and only if $w_f + \mu(c|\boldsymbol{w}, \boldsymbol{W})\,\Gamma - \psi(0,1) \geq w_f$. These inequalities yield the corresponding conditions on the belief $\mu(c|\boldsymbol{w}, \boldsymbol{W})$ given the bonus w_b. *Q.E.D.*

The following Lemma is of considerable help in our subsequent analysis. For notational simplicity, we omit the dependency of a worker's effort function on the set of offered contracts whenever this is convenient.

Lemma 4 (Upsetting Equilibria) *Suppose each worker's type is private information. Consider a set of offered contracts $\boldsymbol{W}^*$ generating utilities u_c^* and u_s^* under the assumption that workers behave optimally given $\boldsymbol{W}^*$. Suppose there exists a contract $\boldsymbol{w}'$ such that*

$$u_c\big(\boldsymbol{w}', \boldsymbol{e}_c^{CE}(\boldsymbol{w}'), \boldsymbol{e}_c^{CE}(\boldsymbol{w}')\big) \;>\; u_c^* \;>\; u_c\big(\boldsymbol{w}', \boldsymbol{e}_c^{SE}(\boldsymbol{w}'), \boldsymbol{e}_c^{SE}(\boldsymbol{w}')\big), \tag{13}$$

$$u_s^* \;>\; u_s\big(\boldsymbol{w}', \boldsymbol{e}_s^{SE}(\boldsymbol{w}'), \cdot\big), \text{ and} \tag{14}$$

$$\pi\left(\boldsymbol{w}, \boldsymbol{e}_c^{CE}(\boldsymbol{w}'), \boldsymbol{e}_c^{CE}(\boldsymbol{w}')\right) \;\geq\; 0. \tag{15}$$

Then $\boldsymbol{W^*}$ cannot form a competitive equilibrium.

Proof of Lemma 4

Given any contract a selfish worker's utility depends exclusively on his own effort choice. He maximizes his utility by choosing $\boldsymbol{e}_s^{SE}$. By (14) it can thus never be optimal for selfish workers to accept contract $\boldsymbol{w}'$. Since by (13) this does not hold for conditionally cooperative worker, Refinement 1 implies that $\mu(s|\boldsymbol{w}', \boldsymbol{W}^* \cup \boldsymbol{w}') = 0$. Given this belief and contract $\boldsymbol{w}'$, the cooperative equilibrium exists by Lemma 2 and inequality (5). Refinement 2 and (13) imply that conditionally cooperative workers coordinate on the cooperative equilibrium upon accepting $\boldsymbol{w}'$. Refinement 3 with (13) and (14) then yield that $a_c^*(\boldsymbol{w}', \boldsymbol{W}^* \cup \boldsymbol{w}') = 1$ and $a_s^*(\boldsymbol{w}', \boldsymbol{W}^* \cup \boldsymbol{w}') = 0$. These acceptance decisions are consistent with beliefs, and workers accepting $\boldsymbol{w}'$ can be sure to be matched into a team. Conditionally cooperative workers can thus get more than u_c^* by accepting $\boldsymbol{w}'$. Therefore, $\boldsymbol{w}'$ cannot be element of $\boldsymbol{W}^*$ given that workers choose the utility maximizing contract among the set of offered contracts. By (15) contract $\boldsymbol{w}'$ makes non-negative expected profit given the above refined beliefs and effort choices. Since there thus exists a contract $\boldsymbol{w}' \notin \boldsymbol{W}^*$ that attracts workers while generating non-negative profit, $\boldsymbol{W}^*$ cannot form a competitive equilibrium. *Q.E.D.*

Proof of Proposition 1

Consider a competitive equilibrium $\boldsymbol{W}^*$. If there is pooling, there exists a contract $\boldsymbol{w} \in \boldsymbol{W}^*$ that is accepted by both types of workers. Contrary to selfish workers, conditionally cooperative workers might contribute team effort. As long as conditionally cooperative workers exert as much individual effort as selfish workers, they thus produce weakly more output. The latter is not the case if and only if $w_b \in [\psi(1,0), \psi(1,1) - \psi(0,1)[$ and the conditionally cooperative workers coordinate on the cooperative equilibrium. In this situation

$$\mu(c|\boldsymbol{w}, \boldsymbol{W}^*)(\,\mu(c|\boldsymbol{w}, \boldsymbol{W}^*)G - w_f) + \mu(s|\boldsymbol{w}, \boldsymbol{W}^*)(F - w_b - w_f) \tag{16}$$

describes the firm's expected profit per worker. Note that a conditionally cooperative worker produces team output only with the probability with which his colleague is also conditionally cooperative. (16) implies that selfish workers subsidize conditionally cooperative workers in a pooling equilibrium if and only if $\mu(c|\boldsymbol{w}, \boldsymbol{W}^*)\, G < w_f$ such that a conditionally cooperative worker's expected team output does not cover his fixed wage. The following proof is divided into two parts depending on whether or not selfish workers subsidize conditionally cooperative workers.

Part 1 (Skimming Off the Selfish Workers)

Suppose selfish workers subsidize conditionally cooperative workers. As argued above selfish workers then exert individual effort. Since they then get both bonus and fixed wage, they receive an equilibrium utility of $u_s^* = w_b + w_f - \psi(1, 0)$. Because conditionally cooperative workers are subsidized, $F > w_b + w_f$ must hold such that $u_s^* < F - \psi(1, 0)$.

Consider a new contract $\boldsymbol{w}'$ with $w'_f = 0$ and $w'_b = F$. First, this contract cannot make losses since it pays out F if and only if a worker exerts individual effort. Second, selfish workers who accept $\boldsymbol{w}'$ exert individual effort and get a utility of $F - \psi(1, 0)$. Since this exceeds their equilibrium utility, Refinement 3 implies that $a_s^*(\boldsymbol{w}', \boldsymbol{W}^* \cup \boldsymbol{w}') = 1$ and workers accepting $\boldsymbol{w}$ can be sure to be matched into a team. Thirdly, $\boldsymbol{w}'$ cannot be offered in equilibrium since otherwise the selfish workers' equilibrium utility must exceed u_s^*. Consequently, $\boldsymbol{W}^*$ cannot form a competitive equilibrium.

Part 2 (Skimming Off the Conditionally Cooperative Workers)

Suppose now that selfish workers do not subsidize conditionally cooperative workers. There are two subcases.

Case A) Suppose workers coordinate on the selfish equilibrium after accepting $\boldsymbol{w}$. In this case, $u_s^* = u_c^*$. Since there is no cooperation and cooperation is efficient by inequality (5), $u_c\big(\tilde{\boldsymbol{w}}, \boldsymbol{e}_c^{CE}(\tilde{\boldsymbol{w}}), \boldsymbol{e}_c^{CE}(\tilde{\boldsymbol{w}})\big) > u_c^*$ for any contract $\tilde{\boldsymbol{w}} \in \boldsymbol{W}^c$. Furthermore, suppose contract $\tilde{\boldsymbol{w}}$ is only accepted by conditionally cooperative workers who coordinate on the cooperative equilibrium. Then $\tilde{\boldsymbol{w}}$ generates zero profit as $\tilde{\boldsymbol{w}} \in \boldsymbol{W}^c$. For the final part of this proof below set $\boldsymbol{w}'$ equal to $\tilde{\boldsymbol{w}} \in \boldsymbol{W}^c$.

Case B) Suppose workers coordinate on the cooperative equilibrium after accepting $\boldsymbol{w}$. Because conditionally cooperative workers could mimic the selfish workers and thereby get the same equilibrium utility, $u_c^* \geq u_s^*$ must hold. More precisely, conditionally cooperative workers get an equilibrium utility of $u_c^* = w_b\, e_{c1}^{CE}(\boldsymbol{w}) + w_f + \mu(c|\boldsymbol{w}, \boldsymbol{W}^*)\,\Gamma - \psi\big(\boldsymbol{e}_c^{CE}(\boldsymbol{w})\big)$. Pooling implies $\mu(c|\boldsymbol{w}, \boldsymbol{W}^*) < 1$ such that $u_c\big(\boldsymbol{w}, \boldsymbol{e}_c^{CE}(\boldsymbol{w}), \boldsymbol{e}_c^{CE}(\boldsymbol{w})\big) > u_c^*$. In this part of the proof selfish workers do not subsidize conditionally cooperative workers. Thus, $\boldsymbol{w}$ generates at least zero profit if it is accepted only by conditionally cooperative workers who then coordinate on the cooperative equilibrium. For the final part of this proof set $\boldsymbol{w}'$ equal to the pooling contract $\boldsymbol{w}$.

Given contract $\boldsymbol{w}'$ as determined in Case A) and B) of this proof, consider another contract $\boldsymbol{w}''$ which specifies the same bonus as $\boldsymbol{w}'$ but pays out a fixed wage that is lower by some $\epsilon > 0$. Contract $\boldsymbol{w}''$ implements the same effort choices in the cooperative equilibrium as $\boldsymbol{w}'$ and thus generates at least zero profit if it is accepted only by conditionally cooperative workers who then coordinate on the cooperative equilibrium. Further, ϵ can be set such that

$$u_c\big(\boldsymbol{w}'', \boldsymbol{e}_c^{CE}(\boldsymbol{w}''), \boldsymbol{e}_c^{CE}(\boldsymbol{w}'')\big) > u_c^* > u_c\big(\boldsymbol{w}'', \boldsymbol{e}_c^{SE}(\boldsymbol{w}''), \boldsymbol{e}_c^{SE}(\boldsymbol{w}'')\big). \tag{17}$$

There are two cases concerning the selfish worker's equilibrium utility. If $u_c^* = u_s^*$, then the above inequality and the fact that $u_c\big(\boldsymbol{w}'', \boldsymbol{e}_c^{SE}(\boldsymbol{w}''), \cdot\big) = u_s\big(\boldsymbol{w}'', \boldsymbol{e}_s^{SE}(\boldsymbol{w}''), \cdot\big)$ yield $u_s^* > u_s\big(\boldsymbol{w}'', \boldsymbol{e}_s^{SE}(\boldsymbol{w}''), \cdot\big)$. If $u_c^* > u_s^*$, then the considered situation is as captured by Part B). Consequently, $\boldsymbol{w}' = \boldsymbol{w}$ such that $\epsilon > 0$ yields $u_s^* = u_s\big(\boldsymbol{w}', \boldsymbol{e}_s^{SE}(\boldsymbol{w}'), \cdot\big) > u_s\big(\boldsymbol{w}'', \boldsymbol{e}_s^{SE}(\boldsymbol{w}''), \cdot\big)$. In either case, Lemma 4 then implies that $\boldsymbol{W}^*$ cannot form a competitive equilibrium. *Q.E.D.*

Proof of Lemma 3

Whether or not conditionally cooperative workers are to exert individual effort in addition to team effort determines the constrained optimal contracts. There are two cases.

Case A) Suppose $\boldsymbol{w} \in \boldsymbol{W}^{cc}$ implements both individual and team effort. Then the bonus satisfies $w_b \geq \psi(1,1) - \psi(0,1)$ by Lemma 2. Furthermore, the incentive constraint (12) must be binding. The reason is the following. Suppose (12) was not binding. Then the zero profit constraint (11) must be binding, since otherwise the firm could increase the fixed wage w_f and thus the utility of the conditionally cooperative workers. Inequality $w_b \geq \psi(1,1) - \psi(0,1)$ implies that $w_b > \psi(1,0)$ by assumption (3). A selfish worker accepting $\boldsymbol{w}$ thus exerts individual effort and gets a utility $F + G - \psi(1,0)$. Since $G > 0$, this violates the incentive constraint (12). The binding incentive constraint now implies that $w_b + w_f = F$ such that $F + \Gamma - \psi(1,1)$ is the equilibrium utility of a conditionally cooperative worker.

Case B) Suppose $\boldsymbol{w} \in \boldsymbol{W}^{cc}$ implements only team effort but no individual effort. Then the bonus satisfies $w_b < \psi(1,1) - \psi(0,1)$ by Lemma 2. Since a conditionally cooperative worker exerts no individual effort, he does not benefit from the bonus. Decreasing w_b below $\psi(1,0)$ has no impact on a conditional cooperator's equilibrium utility, but softens the incentive constraint (12). It is optimal to set $w_b < \psi(1,0)$ such that a selfish worker accepting $\boldsymbol{w}$ exerts no effort at all. The incentive constraint is then equivalent to $w_f \leq F - \psi(1,0)$. A binding zero profit constraint (12) implies $w_f = G$ since the cooperative workers exert no individual effort. There are two cases. If $G \leq F - \psi(1,0)$, then the incentive constraint (12) can be ignored and only the zero profit constraint is binding. This implies $w_f = G$ such that $G + \Gamma - \psi(0,1)$ is the equilibrium utility of the conditional cooperators. If $G > F - \psi(1,0)$, then the incentive constraint is binding whereas the zero profit constraint can be ignored. This implies $w_f = F - \psi(1,0)$ such that $F - \psi(1,0) + \Gamma - \psi(0,1)$ is the equilibrium utility of the conditional cooperators.

Given the above cases, team output G determines whether the firm should implement also individual effort or not. There are two subcases. First, suppose $G > F - \psi(1,0)$. Conditional cooperators then get an equilibrium utility of $F - \psi(1,0) + \Gamma - \psi(0,1)$ if they are to exert no individual effort. Since $\psi(1,1) > \psi(1,0) + \psi(0,1)$, this equilibrium utility exceeds the respective equilibrium utility $F + \Gamma - \psi(1,1)$ if conditionally cooperative workers are to exert individual effort. It is thus always optimal not to implement individual effort if $G > F - \psi(1,0)$. Second, suppose $G \leq F - \psi(1,0)$. Conditional cooperators then get an equilibrium utility $G + \Gamma - \psi(0,1)$ if they are to exert no individual effort. If and only if $G \geq F - \psi(1,1) + \psi(0,1)$, this equilibrium utility exceeds the respective equilibrium utility $F + \Gamma - \psi(1,1)$ conditionally cooperative workers receive if they are to exert both individual and team effort. Therefore, it is optimal to implement individual effort if $G \leq F - \psi(1,1) + \psi(0,1)$, whereas it is optimal not to implement individual effort if $G \in \big[F - \psi(1,1) + \psi(0,1), F - \psi(1,0)\big]$. This interval is nonempty by inequality (3).

Note that the incentive constraint for the conditionally cooperative workers can be ignored. Since there is no cooperation, a conditionally cooperative worker who joins a firm that attracts only selfish workers gets the selfish workers' equilibrium utility $F - \psi(1,0)$. The above analysis shows that the conditionally cooperative workers' equilibrium utility is at least $F + \Gamma - \psi(1,1)$. Since cooperation is efficient by inequality (5), conditionally cooperative workers thus have no incentive to join a firm that attracts only selfish workers. *Q.E.D.*

Proof of Proposition 2

First, consider a separating equilibrium $\boldsymbol{W}^*$ that does not contain at least one element from the set $\boldsymbol{W}^s$. Then there exists a contract $\boldsymbol{w}' \notin \boldsymbol{W}^*$ with $\boldsymbol{w}' \in \boldsymbol{W}^s$ and $w_b' \geq \psi(1,1) - \psi(0,1)$. Since there is no pooling, contracts in $\boldsymbol{W}^s$ maximize a selfish worker's utility given firms make nonnegative expected profit. Thus, $u_s\big(\boldsymbol{w}', \boldsymbol{e}_s^{SE}(\boldsymbol{w}'), \cdot\big) > u_s^*$. Refinement 3 then implies $a_s^*(\boldsymbol{w}', \boldsymbol{W}^* \cup \boldsymbol{w}') = 1$ and workers who accept $\boldsymbol{w}'$ can be sure to be matched into a team. Consequently, contract $\boldsymbol{w}'$ can attract selfish workers. Moreover, any worker accepting this contract exerts individual effort since $w_b' \geq \psi(1,1) - \psi(0,1)$. Contract $\boldsymbol{w}'$ thus generates nonnegative expected profit, and $\boldsymbol{W}^*$ cannot form a competitive equilibrium.

Second, consider a separating equilibrium $\boldsymbol{W}^*$ that does not contain at least one element of $\boldsymbol{W}^{cc}$, or that the conditionally cooperative workers do not exert team effort in equilibrium. Take any contract $\boldsymbol{w}' \in \boldsymbol{W}^{cc}$. As shown above, firms offer at least one contract $\boldsymbol{w} \in \boldsymbol{W}^s$ for the selfish workers. The contracts in $\boldsymbol{W}^{cc}$ then maximize the conditionally cooperative workers' utility in any separating equilibrium, thus $u_c\big(\boldsymbol{w}', \boldsymbol{e}_c^{CE}(\boldsymbol{w}'), \boldsymbol{e}_c^{CE}(\boldsymbol{w}')\big) > u_c^*$. Consider another contract $\boldsymbol{w}''$ which specifies the same bonus as contract $\boldsymbol{w}'$ but pays out a fixed wage that is lower by some $\epsilon > 0$. Since the bonus is identical, contract $\boldsymbol{w}''$ implements the same effort choices in the cooperative equilibrium as $\boldsymbol{w}'$. Contract $\boldsymbol{w}'$ generates at least zero profit in case the contract is only accepted by conditionally cooperative workers who coordinate on the cooperative equilibrium. Since $\epsilon > 0$, the same holds for $\boldsymbol{w}''$. Further, ϵ can be chosen such that $u_c\big(\boldsymbol{w}'', \boldsymbol{e}_c^{CE}(\boldsymbol{w}''), \boldsymbol{e}_c^{CE}(\boldsymbol{w}'')\big) > u_c^* > u_c\big(\boldsymbol{w}'', \boldsymbol{e}_c^{SE}(\boldsymbol{w}''), \boldsymbol{e}_c^{SE}(\boldsymbol{w}'')\big)$. Finally, the incentive constraint (12) implies that $u_s^* \geq u_s\big(\boldsymbol{w}', \boldsymbol{e}_s^{SE}, \cdot\big)$ and consequently $u_s^* > u_s\big(\boldsymbol{w}'', \boldsymbol{e}_s^{SE}(\boldsymbol{w}''), \cdot\big)$. Lemma 4 then implies that $\boldsymbol{W}^*$ cannot form a competitive equilibrium.

Third, selfish workers receive a contract from $\boldsymbol{W}^s$ in any separating equilibrium. Consequently, no contract $\boldsymbol{w} \notin \boldsymbol{W}^s$ can yield selfish workers a utility as high as their equilibrium utility without making losses. Equally, no contract $\boldsymbol{w} \notin \boldsymbol{W}^{cc}$ can yield conditionally cooperative workers a utility as high as their equilibrium utility without making losses or attracting selfish workers. Since all contracts $\boldsymbol{w} \notin \boldsymbol{W}^s \cup \boldsymbol{W}^{cc}$ are thus strictly dominated, they cannot be element of $\boldsymbol{W}^*$. Thus, $\boldsymbol{W}^* \subseteq \boldsymbol{W}^s \cup \boldsymbol{W}^{cc}$.

Fourth, the set $\boldsymbol{W}^*$ need not contain all contracts in $\boldsymbol{W}^s$ and $\boldsymbol{W}^{cc}$. To see this consider any contract $\boldsymbol{w}' \in \boldsymbol{W}^{cc}$ with $\boldsymbol{w}' \notin \boldsymbol{W}^*$. The incentive constraint (12) implies that $u_s^* \geq u_s\big(\boldsymbol{w}', \boldsymbol{e}_s^{SE}(\boldsymbol{w}'), \cdot\big)$ and $u_c^* = u_c\big(\boldsymbol{w}', \boldsymbol{e}_c^{CE}(\boldsymbol{w}'), \boldsymbol{e}_c^{CE}(\boldsymbol{w}')\big)$ since at least one contract in

$\boldsymbol{W}^{cc}$ is already offered. Consequently, $a^*_\theta(\boldsymbol{w}', \boldsymbol{W}^* \cup \boldsymbol{w}') = 0$ for both types $\theta \in \{s, c\}$ is in line with our refinements. Yet a worker who is the only one accepting $\boldsymbol{w}'$ cannot be matched into a team and receives his outside option of zero. Since both types get a strictly positive equilibrium utility, it is therefore optimal never to accept $\boldsymbol{w}'$. The same argument holds for all contracts in $\boldsymbol{W}^s$ that are not offered in equilibrium.

Finally, Lemma 3 yields that contracts in $\boldsymbol{W}^{cc}$ that attract only conditionally cooperative workers who coordinate on the cooperative equilibrium make strictly positive profit unless $G \in [F - \psi(1,1) + \psi(0,1),\ F - \psi(1,0)]$. *Q.E.D.*

Proof of Proposition 3

By construction, the separating equilibrium in Proposition 2 cannot be upset by a separating contract that attracts only one type of workers. Therefore, consider a pooling contract $\boldsymbol{w}' \notin \boldsymbol{W}^*$ that might attract both types of workers. Since $\boldsymbol{w}'$ is a pooling contract, Refinement 1 cannot be applied to restrict beliefs. We have shown in the proof of Lemma 3 that $u^*_c \geq u^*_s$. Further, conditionally cooperative workers get a weakly higher equilibrium utility in the cooperative equilibrium as compared to the selfish equilibrium by the optimality of their effort choice. There are three cases.

Case A) Suppose that the prior probability λ for a worker to be conditionally cooperative is so low such that there only exists the selfish equilibrium given contract $\boldsymbol{w}'$. Selfish workers are offered a contract from the set $\boldsymbol{W}^s$ by Proposition 2. If contract $\boldsymbol{w}'$ is not to generate expected losses, $u^*_s \geq u_s\big(\boldsymbol{w}', \boldsymbol{e}^{SE}_s(\boldsymbol{w}'), \cdot\big)$ must hold. Refinement 3 then allows for $a^*_s(\boldsymbol{w}', \boldsymbol{W}^* \cup \boldsymbol{w}') = 0$ such that selfish workers cannot be attracted. However, a contract that attracts only one type of worker cannot upset the considered equilibrium.
Suppose for the remainder of this proof that the prior probability λ for a worker to be conditionally cooperative is sufficiently high such that there exist both the selfish and the cooperative equilibrium given contract $\boldsymbol{w}'$.

Case B) Suppose that $\boldsymbol{w}'$ can attract both types of workers no matter what equilibrium workers expect to be played. Workers can then coordinate on the selfish equilibrium upon accepting $\boldsymbol{w}'$ without violating Refinement 2. By the same argument as in Case A) above, contract $\boldsymbol{w}'$ must then generate expected losses as otherwise it cannot attract the selfish workers. Thus, contract $\boldsymbol{w}'$ cannot upset the considered equilibrium.

Case C) Suppose that $\boldsymbol{w}'$ can attract conditionally cooperative workers only if they expect the cooperative equilibrium to be played upon accepting $\boldsymbol{w}'$. Suppose, however, workers believe that only selfish workers accept $\boldsymbol{w}'$. Given this belief, only the selfish equilibrium exists. If workers expect the selfish equilibrium to be played, it is indeed optimal only for the selfish workers to accept the newly offered contract. Thus, beliefs, effort choices, and acceptance decisions are consistent. However, a contract that attracts only one type of worker cannot upset the considered equilibrium. *Q.E.D.*

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