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A Model for Team managers with Self-serving Workers

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ABSTRACT

We develop a model of team formation in which workers learn about their level of ability. We show that insufficient cooperation may arise as workers learn positively about their own skills. We then build a model for team managers and establish that their objectivity in assessing coworkers' abilities may facilitate cooperation among agents. This is the case because managers are able to design team contracts based on workers' true performances. Our work provides a motive for the existence of team managers in the absence of asymmetry of information.

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Abstract

We develop a model of team formation in which workers learn about their level of ability, and we show that insufficient cooperation may arise as workers learn positively about their own skills. We then build a model for team managers and establish that their objectivity in assessing co-workers' abilities may facilitate cooperation among agents. This is the case because managers are able to design team contracts based on workers' true performances. Our work provides a motive for the existence of team managers in the absence of asymmetry of information.

1 Introduction

Teamwork has become increasingly popular in organizations since the beginning of the nineties (Dumaine 1990, Osterman 1994, Lawler, Morhman and Ledford 1995, Ichniowski, Shaw and Prennushi 1997) and, consequently, understanding the factors leading to team success has become decisive (Stewart 2006). In this paper, we provide a psychological approach to the issue of

team formation and team management. In particular, we develop a model in which individuals suffer from self-serving biases. Self-serving biases imply that workers tend to learn positively about their own skills. There is widespread evidence in psychology literature that people learn optimistically about themselves by taking credit for successes while denying responsibility for failures (Bradley 1978, Miller and Ross 1975, Zuckerman 1979). Individuals are inclined to process information distortedly so as to build a positive self-image (Fiske and Taylor 1991, Nisbett and Ross 1980). Researchers have found that positive personality information is efficiently processed whereas negative personality information is poorly processed (Kuiper and Derry 1982, Kuiper and McDonald 1982, Kuiper et al. 1985). In addition, there is extensive evidence that people recall their successes better than their failures (Korner 1950, Silverman 1964, Mischel, Ebbesen and Zeiss 1976). This causes individuals to hold excessively positive beliefs about themselves (Greenwald 1980, Svenson 1981 and Cooper, Woo and Dunkelberg 1988). Psychology literature has mostly interpreted biases in inference and attribution as motivational biases, with agents considered to feel better-off when learning positively about themselves. In this work, we account for these motivational biases by assuming that workers are likely to process bad signals about their abilities as if they were good signals.

Various researchers have studied the role of behavioral factors in the context of teams, focusing on finding possible solutions to the free riding that arises in teams when efforts of its members are not observable.[1] Rotemberg (1994) demonstrates how altruism can improve workers' cooperation and welfare when complementarities exist among team members. Kandel and Lazear (1992) show how peer pressure can increase cooperation among workers by stressing how workers can reduce the negative effects of peer pressure by exerting higher levels of efforts.

[1] Free riding issues in teams have been studied in numerous papers such as Holmstrom (1982), Itoh (1991) or Che and Yoo (2001).

Gervais and Goldstein (2006) find that workers' biased self-perception facilitates cooperation among agents. They show that an overconfident agent overestimating his marginal product of effort will lead co-workers to exert more effort in the team. The authors show that both self-confident as well as rational workers can benefit from overconfidence.

To analyze team formation we consider a two-period model in which workers jointly decide whether to form a team or to work alone. It is assumed that workers' abilities are unknown, and agents update their beliefs about abilities after receiving a signal at the end of the first period. We show that when workers suffer from self-serving attribution, cooperation among agents is undermined.[2] The negative impact of self-serving biases on team formation is referred to as the *teams inefficiency result*.

Subsequently considering how hiring a team manager can improve cooperation among self-serving workers helps us to shed light on the debate on the efficiency of self-managed teams (Dumaine 1990, Goodman, Devadas and Hughson 1998, Stewart and Barrick 2000). We show that in equilibrium team managers who are capable of observing workers' performances objectively can help improve cooperation among agents. This is because these managers are able to design team contracts based on true workers' performances, and will permit workers to learn more objectively about their own abilities. In our model, managers are able to learn correctly about workers' performances since they are not involved in the production process. If managers are involved in the production process they may tend to blame workers for insufficient performances rather than challenging the production system that they decided to implement (Repenning and Sterman 2002). Also, team workers may mistakenly attribute successes and failures of teams to their leader's personal traits (Weber et al. 2001).

[2] This model is first considered in Corgnet (2005).

We also show that managers are hired even if observing workers' performances is costly. Asymmetries of information are not necessary in our model to show that team managers can be hired in equilibrium. The manager considered in this paper is not a teamwork supervisor as described in Alchian and Demsetz (1972) and Holmstrom (1982). These authors emphasize that in the presence of moral hazard in teams, a supervisor holding a residual claim on the team outcome can lead workers to exert their optimal level of effort. In our framework, workers' performances are mutually observable. Our analysis differs from the ones previously mentioned since it eliminates free riding issues by assuming the observability of co-workers' actions. We consider the most favorable case of their cooperation by focusing on teams with a sufficiently close level of collaboration such that agents are able to observe each other's performances and actions. In our model, asymmetry of information arises as a consequence of self-serving biases because learning biases imply that workers learn differently about their ability and that of their partner.

Our approach implies that the manager has an informational rent since he is able to observe workers' performances objectively. In the subsequent model, the manager has private information about individuals' abilities given that workers do not correctly assess their own performances.

This paper is structured as follows. In Section 2 we present the model of team formation and establish the teams inefficiency result, followed by a third section in which a model for managers is developed. Section 4 contains the results and emphasizes the empirical implications of our model.

2 Team formation and self-serving biases

2.1 The team formation framework

We consider the case of two workers deciding whether to complete an individual or a team project. Examples of such decisions are found in the academia when researchers decide whether to write a single-authored or a coauthored paper. Workers may also be confronted with decisions to form teams in their organizations as in the case of the Koret Corporation described by Hamilton, Nickerson and Owan (2003). We propose to model team formation in a two-period game described as follows. At $t = 0$, the two co-workers decide simultaneously whether to undertake the individual or the group project. The team project is undertaken only if both workers agree to do so. At the end of the first period the outcome of the project chosen at $t = 0$ is observed by both workers. At $t = 1$, agents decide whether to continue with the project undertaken in the first period. The outcome associated to the project performed in the second period is observed at $t = 2$. Team members do not know neither their own ability to undertake the task nor the ability of their co-worker. Workers update their beliefs about abilities at the end of the first period after observing the outcome of the project chosen in the first period. We assume agents are risk neutral so that they select their projects by maximizing expected payoffs. An agent $i \in \{1; 2\}$ when working alone undertakes a project that is a success [failure] with probability q_i $[1-q_i]$ and delivers a payoff $X_{i,t} \equiv G$ $(B < G)$, where q_i is defined as Worker i's ability. The subscript t corresponds to time where $t \in \{0; 1; 2\}$. We assume a Beta prior distribution for individual abilities: $q_i \sim Beta(\alpha, \beta)$ and we denote $q^* = \frac{\alpha}{\alpha+\beta}$ the mean of this

distribution.[3-4] The outcomes of the two individual projects are assumed to be independent. If workers choose to form a team, they are involved in a project that delivers the following payoff $\gamma\left(X_{1,t}+X_{2,t}\right), \forall t \in \{1;2\}$. The total outcome of the group project is shared according to an allocation rule $\eta \in [0,1]$ so that Workers 1 and 2 get respectively payoffs $\eta\gamma\left(X_{1,t}+X_{2,t}\right)$ and $(1-\eta)\gamma\left(X_{1,t}+X_{2,t}\right)$. The parameter γ represents synergies obtained for working in a team and the absence of synergies corresponds to $\gamma = 1$. We assume that γ is known by workers at $t = 0$. In that case the total outcome of the team project is the sum of the individual projects outcomes. In addition, we assume the existence of a learning by doing effect such that if workers repeat a project (a team or an individual project) the expected payoffs associated to that project are multiplied by $\phi \geq 1$. We consider no discount factors; the effect of discounting would be to reduce the role of learning about workers' abilities at $t = 1$.[5] The sequence of decisions as well as the payoffs of the individual and team projects are represented in Figure 1, where q^* stands for the prior expected ability of workers. We discuss the assumptions of our model of team formation as well as possible extensions in Appendix A.

2.2 The benchmark case: the absence of self-serving biases

We consider an allocation rule under which the share of the group outcome obtained by an individual is equal to his relative ability. The relative ability of Worker i is defined as $\frac{\hat{q}_{i,t}}{\hat{q}_{i,t}+\hat{q}_{j,t}}$, $i \neq j, \forall (i,j) \in \{1;2\}, \forall t \in \{0;1\}$. We denote $\hat{q}_{i,t}$ the level of ability of Worker i as updated by a Bayesian inferrer given information up to time t. Under this allocation rule, Worker i's

[3] The beta prior assumption is convenient since the beta distribution is a conjugate prior for the binomial problem considered here (Box and Tiao 1973). In addition, beta distributions can approximate any reasonably smooth unimodal distribution on $[0,1]$ (Lee 1997).

[4] Similar results are obtained if we consider workers with different prior abilities.

[5] A low discount factor would not be consistent with our aim since we want to consider projects for which learning and then self-attribution biases matter.

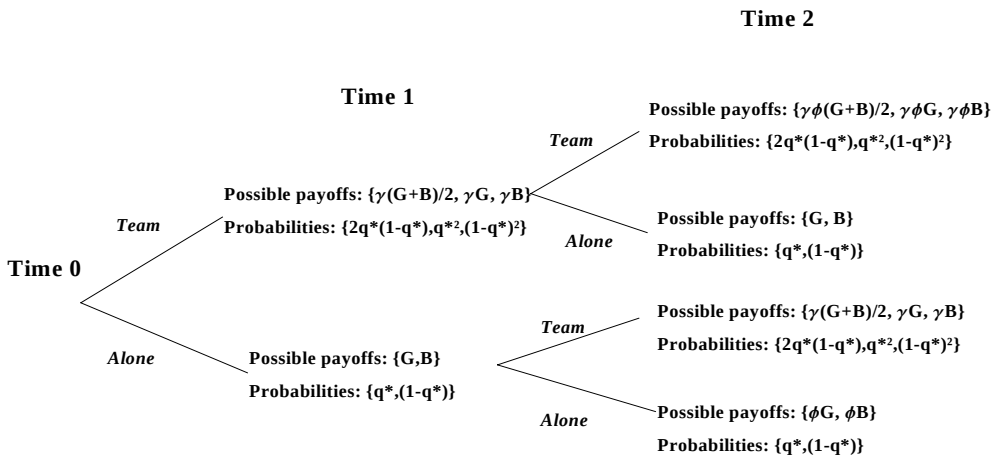

Figure 1: Timeline and payoffs for $\eta = \frac{1}{2}$

expected payoffs for a team project undertaken for the first time is $\gamma\hat{q}_{i,t}$. The next proposition shows that, in this case, workers form teams at $t = 0$ whenever $\gamma \geq 1$.[6] This result still holds if coworkers' prior abilities are different as long as both workers agree on the priors.

Proposition 1. Under the relative ability allocation rule and in the absence of self-serving biases, teams are formed at $t = 0$ whenever $\gamma \geq 1$.

Our proposition shows that by selecting a splitting rule that depends on updated workers' ability, the maximum level of workers' cooperation is attained. As a result, we show that the efficient teams outcome (ETO) is attainable in the absence of self-serving biases, where the ETO corresponds to the payoffs obtained by team members when teams are formed at $t = 0$ and continued at $t = 1$ whenever $\gamma \geq 1$. We call efficient teams equilibrium (ETE) an equilibrium that implements the ETO. We refer to a team as being efficient if $\gamma \geq 1$.

[6] In addition to the subgame-perfect Nash equilibrium considered in Proposition 1, we can derive by backward induction the following subgame-perfect equilibria. 1) No workers form teams at $t = 1$ and teams are formed for $\gamma \geq \phi$ at $t = 0$. 2) No workers form teams at $t = 0$ and at $t = 1$. 3) Teams are formed at $t = 1$ and no teams are formed at $t = 0$. These equilibria involve weakly dominated strategies. In addition they involve strategies that prevent any cooperation in at least one of the two periods.

2.3 The teams inefficiency result

In this section we consider that workers suffer from biases in their learning process. We model self-serving attribution as Bayesian learning with imperfect processing of negative signals. We introduce inference biases by assuming that, with probability p, workers process bad signals about their ability as if they were good signals. Our assumption implies a different treatment of bad and good signals. This asymmetry in the learning process is what we call biased self-attribution or self-serving learning. Workers are tempted to distort bad signals about their abilities in order to build a positive self-image. Through time, above average effects arise leading workers to see themselves as more talented than their co-workers. The latter effects generate a dispersion in coworkers' beliefs about their own ability and the ability of their coworker. Differences in perceptions about abilities will lead agents to break teams. The learning process that is considered in this section is described in Assumption 1. Workers are assumed to suffer from self-serving biases by mistakenly interpreting bad signals about their abilities.[7] We consider that agents are aware of their incentives to process information with biases.[8] Also, we assume that workers update others' abilities using Bayesian inference. We take p_G $[p_B]$ to be the expected probability given information at $t = 0$ that $X_{i,1} = G$ $[X_{i,1} = B]$, $\forall i \in \{1; 2\}$.

Assumption 1 (Self-serving Learning)

We denote σ_{ij} Worker i's perception of Worker j's performance at $t = 1, \forall (i, j) \in \{1; 2\}^2$.

We assume that, with probability p, a Worker i perceives his bad performance at $t = 1$ $(X_{i,1} = B)$ as if it was a good performance $(\sigma_{ii} = G)$, $\forall i \in \{1; 2\}$.[9] The updating rule

[7] Learning biases can be modeled as a result of errors in information processing or as memory imperfections. However, this distinction between the different origins of learning biases is not central to our results and to their implications.

[8] Bénabou and Tirole (2002) refer to this assumption as metacognition.

[9] Workers' biases are assumed to be independent.

at $t = 1$ is described as follows, $\forall i \in \{1; 2\}$.

$$\left[\begin{array}{c} E_{i,S}\left[q_i \mid \sigma_{ii} = B\right] \equiv q_B \equiv E\left[q_i \mid X_{i,1} = B\right] \\ E_{i,S}\left[q_i \mid \sigma_{ii} = G\right] \equiv \hat{q}_G \equiv \frac{pp_B}{pp_B + p_G} E\left[q_i \mid X_{i,1} = B\right] + \frac{p_G}{pp_B + p_G} E\left[q_i \mid X_{i,1} = G\right] \end{array}\right.$$

A worker updates his coworker's ability using Bayesian inference and correct information processing, that is $\sigma_{ij} = X_{j,1}$, $\forall i \neq j$ and $(i, j) \in \{1, 2\}^2$.

We denote $E_{i,S}$ the expectation of workers suffering from self-serving biases p.[10] We introduce a subscript i for the expectation of Worker i since when learning biases are present co-workers' expectations may not coincide. We assume that the two co-workers suffer from learning biases. According to our learning process, workers update differently beliefs about their own ability and beliefs about others' abilities. Agents are considered to behave as Bayesian inferers when updating others' abilities but they are assumed to suffer from self-serving biases when updating their own ability. There is evidence in the psychology literature that individuals see themselves more positively than others see them. For example, Lewinsohn et al. (1980) compared the ratings made by observers and by college students themselves about personality characteristics like friendliness, warmth and assertiveness of students involved in a group interaction task. They found that self-ratings were significantly more positive than observers' ratings. In this paper, we consider that team workers do not suffer from learning biases in assessing their coworker's ability.

The self-serving learning process is assumed to be common knowledge. As it appears in Assumption 1, we consider that workers are aware of their incentives to be biased. This means that workers perceiving themselves as good performers at $t = 1$ are aware that this positive self-perception may be the result of their self-serving biases.

[10] Alternatively, we can consider the case of two agents with different degrees of self-serving attribution: $p_1 \neq p_2$. The results derived below continue to hold taking $p \equiv Max\{p_1; p_2\}$.

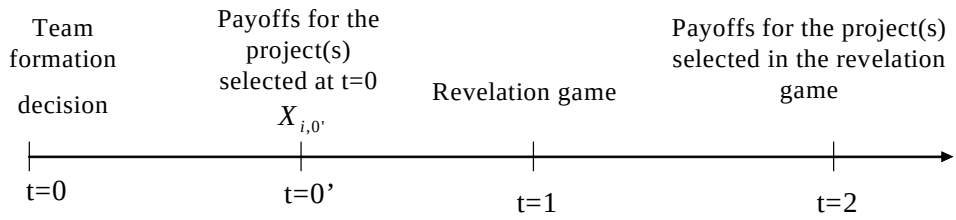

Figure 2: Timeline for the team formation model with self-serving workers.

Workers will try to overcome their biases by recovering the correct signals about their abilities.

We define a contract as the share of the group outcome η_i distributed to Worker i at $t = 1, \forall i \in \{1; 2\}$.[11] The set of contracts analyzed are budget balanced, that is the group outcome is distributed in its totality to workers ($\eta_1 + \eta_2 = 1$). We consider contracts that can be contingent on co-workers' performances received at $t = 1$. The difficulty is that workers' suffering from self-serving biases may disagree about the signals received at $t = 1$. To tackle this issue we consider that contracts are contingent on the signals revealed by the agents rather than on the signals effectively observed. We then modify the initial framework by introducing a revelation game at $t = 1$ after workers have observed their performances on the first period project (Figure 2).[12] Workers are interested in communicating about their perceived abilities since they know that their co-worker is an objective observer of their performances. On aggregate workers have complete information about abilities since Worker 1 [2] knows Worker 2 [1] ability level at $t = 1$.

The structure of the revelation game played at $t = 1$ is as follows.

[11] The share of the group outcome given to Worker 1 in the first period is not considered further since $\eta_1 = \frac{1}{2}$ ensures team formation at $t = 0$ if team formation is obtained at $t = 1$.

[12] We assume that performances are not verifiable by the court. If performances were verifiable by the court, workers could reach the *ETO* by asking the court to reveal workers' performances. Evidently, such a process can be costly to workers.

At $t = 1$ each worker chooses an action $a_i \equiv (a_{i1}, a_{i2})$ $\forall i \in \{1, 2\}$, where a_i is a vector of messages that belongs to the set S of possible signals observed at $t = 0^{'}$. The set S is actually the set of possible workers' types. This is the case since the perception of performances by the agents constitutes their private information.[13]

At $t = 1^{'}$ where $1^{'} \in]1, 2[$, workers decide either to continue with the project selected at $t = 0$ or to undertake the other project. We denote $b_i \in B \equiv \{T; NT\}$, Worker i's action at $t = 1^{'}$, $\forall i \in \{1; 2\}$, where $T\,[NT]$ stands for forming a team [working alone].

The actions of the two agents will determine the share of the group outcome given to the first co-worker (η) as a function of the revealed signals, that is $\eta \equiv \eta_1\,(a_{11}, a_{12}, a_{21}, a_{22})$.[14] We denote $V_i\,(a_i, a_j, b_i, b_j)$ the expected payoffs obtained by Worker i when undertaking the second period project, $\forall i \neq j$ and $(i, j) \in \{1; 2\}^2$.

Given that workers assess each other's ability as Bayesian inferers, we may wonder if allowing workers to communicate will lead agents to eliminate their learning biases and cooperate efficiently.[15] The result captured in Proposition 2 shows that such conjecture is not verified, an ETE being impossible to achieve.

Definition 1. Under Assumption 1, a PBE of the revelation game is $A^* \equiv (a_1^*, a_2^*, b_1^*, b_2^*)$ that solves (1) and (2):

(1) $\max\limits_{a_i \in S} V_i \left(a_i, a_j^*, b_1^*, b_2^*\right), \forall i \neq j,\ (i, j) \in \{1; 2\}^2.$

(2) $\max\limits_{b_i \in B} V_i \left(a_1^*, a_2^*, b_i, b_j^*\right), \forall i \neq j,\ (i, j) \in \{1; 2\}^2.$

Where $V_i \equiv 1_{NT} E_{i,S}\left[q_i |\, \sigma_{ii}, a_j\right] + 1_T E_{i,S}\left[\eta_i\left(a_i, a_j\right)\left(q_i + q_j\right) \mid X_{j,1}, \sigma_{ii}, a_j\right]$

[13] The set of possible messages being the set of types, we can use the Revelation Principle and conclude that our results continue to hold for any message space. The Revelation Principle can be applied to our model since it can be represented as a normal form game of a static Bayesian game.

[14] We denote $\eta_i\,(a_{11}, a_{12}, a_{21}, a_{22})$ the share of the group outcome obtained by Worker i.

[15] This would be the case if teams are formed whenever $\gamma \geq 1$.

We denote 1_T $[1_{NT}]$ the indicator function that takes value one for $b_1 = b_2 = T$ $[(b_1, b_2) \neq (T, T)]$.

A PBE is defined for a given contract function $\eta : x \mapsto \eta(x)$, where $x \in \{B; G\}^4$ and $\eta(x) \in [0, 1]$.

Proposition 2. There exist no Perfect Bayesian Equilibria (PBE) that implement the ETO.

Workers are unable to reach the ETO because they have an incentive to reveal themselves as being high-ability workers in order to obtain a higher share of the group outcome. These incentives to lie imply that truthful telling is costly to achieve. Indeed, workers tell the truth in equilibrium only if the allocation rule of the group outcome is a fixed rule that is not contingent on (a_1, a_2), i.e. $\eta(a_1, a_2) = \hat{\eta}$. However, fixed allocation rules do not provide the adequate incentives for workers to form teams since then high-performance workers will perceive their team rewards as being insufficient. In the case of fixed allocation rules the ETO is not attainable even in the presence of complete information.[16]

3 Team managers

3.1 A model for team managers

We consider a situation in which a third agent called a manager has the possibility to observe workers' performances. The manager is assumed to update workers' abilities without biases. This assumption is in agreement with the motivational explanation underlying biased self-attribution that is discussed in the introduction.[17]

[16] The proof of this result is trivial and is available upon request.

[17] Agents are considered to feel better-off when learning positively about themselves. In the model considered in this section, the manager does not learn about himself since he is not involved in team production.

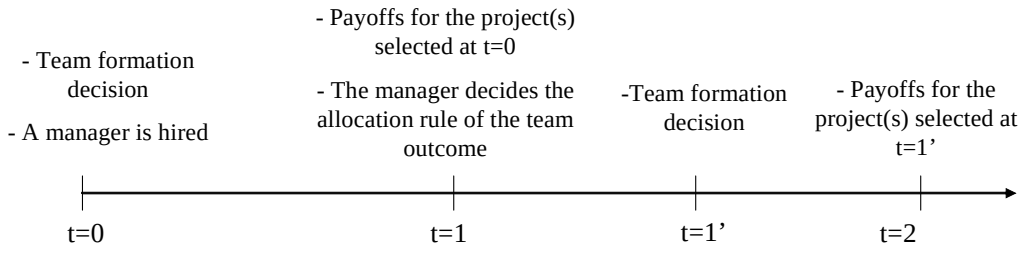

Figure 3: Timeline for the manager's game when a manager is hired at $t = 0$.

Definition 2. A manager is an agent who is able to observe team workers' performances without biases given that he is not involved in team production.

The manager is assumed to observe workers' performances without costs.

The manager is paid a proportion ($\xi > 0$) of the total payoffs of coworkers' projects in the second period. The timing of the game is described as follows and represented in Figure 3.

At $t = 0$, workers decide simultaneously whether to be involved in an individual or a team project rewarded according to equal splitting. They decide as well whether to hire a manager or not. If workers decide to hire a manager and the manager accepts the offer, the game continues as follows. At $t = 1$, workers receive the payoffs of the first period project and the manager decides the allocation rule for the team project undertaken in the second period. This is equivalent to say that the manager has the full bargaining power. At $t = 1^{'} > 1$, workers decide whether to continue with the first period project or undertake another project. If workers decide not to hire a manager, the game becomes the one presented in Section 2. It is straightforward to see that if no bribery is possible, an ETE is attainable in this game.[18] In the absence of bribery, the following strategies define a truthful telling PBE: a manager

[18] Bribery is possible if a worker is able to offer side payments to the manager in order to change his choice for the allocation rule of the group outcome.

is hired, the manager pays workers based on their true relative ability (that is the relative ability as perceived by the manager) and workers form teams whenever $\gamma \geq 1$. A truthful telling equilibrium (TTE) is such that all the information is revealed in equilibrium.[19] This occurs if workers truthfully reveal their perceived performances ($a_i = \sigma_i \equiv (\sigma_{ii}, \sigma_{ij}), i \neq j$). In that case, workers are able to recover the true information about their performances and this implies that learning biases are fully recognized. This PBE holds as long as the manager has an interest to participate, that is $\xi > \hat{\xi}$.[20] We provide in the next proposition a rationale for the existence of managers by establishing the conditions for the existence of the truthful telling PBE previously mentioned. Managers prevent team conflicts by designing contracts based on informed and objective beliefs about workers' abilities. Managers possess an informational rent that is the result of their ability to provide unbiased assessments about workers' abilities. The main difference with the situation considered in Section 2 is that one of the agent (the manager) involved in the team has complete information at $t = 1$. Workers 1 and 2 only observe correctly their co-worker's performance whereas the manager observes both team members' performances accurately.

As long as ξ can be taken sufficiently close to 0, the presence of a manager is optimal for any of the situations in which an ETE is not achievable. That is, as stated in Proposition 3, if $\hat{\xi} = 0$ a manager is hired whenever $\gamma\phi < \frac{2\hat{q}_G}{q_B + \hat{q}_G}$ $\left[\frac{\gamma}{\phi} < \frac{2\hat{q}_G}{q_B + \hat{q}_G}\right]$.[21]

[19] In a context in which bribery is possible, the conditions for the implementation of the ETO are more difficult to meet. Indeed, Bribery increases the cost of hiring a manager given that managers always have the possibility to reject the bribery offer. Also, the benefits associated to the presence of a manager are at most the same when bribery is possible. The gains of engaging a manager are maximum when the ETO can be implemented due to the presence of a manager. This happens when no bribery is possible but may not happen when opportunities for bribery exist. As a result, if γ or p are not sufficiently high, managers may not be hired in the presence of bribery for $\gamma\phi < \frac{2\hat{q}_G}{q_B + \hat{q}_G}$ $\left[\frac{\gamma}{\phi} < \frac{2\hat{q}_G}{q_B + \hat{q}_G}\right]$ if a team has [not] been formed at $t = 0$.

[20] We denote $\hat{\xi} 2\gamma\phi q^*$ the revenue associated to the manager's outside option, where $2\gamma\phi q^*$ is the expected aggregate outcome for the second period when workers decide to continue with the team project.

[21] Notation: in the rest of the paper, the condition into brackets will correspond to the case in which a team

Proposition 3. For $\gamma\phi < \frac{2\hat{q}_G}{q_B+\hat{q}_G}$ $\left[\frac{\gamma}{\phi} < \frac{2\hat{q}_G}{q_B+\hat{q}_G}\right]$, a manager is hired with a strictly positive maximum rent increasing in the level of synergies (γ) and in the level of coworkers' biases (p).

For $\gamma\phi \geq \frac{2\hat{q}_G}{q_B+\hat{q}_G}$ $\left[\frac{\gamma}{\phi} \geq \frac{2\hat{q}_G}{q_B+\hat{q}_G}\right]$ an ETE can be reached by using a simple equal sharing rule ($\eta = \frac{1}{2}$) so that managers will not be hired in that case. We derive in Appendix B the contracts that lead to the highest workers' expected payoffs for $\gamma\phi < \frac{2\hat{q}_G}{q_B+\hat{q}_G}$ $\left[\frac{\gamma}{\phi} < \frac{2\hat{q}_G}{q_B+\hat{q}_G}\right]$. These contracts are respectively the rigid allocation rule (*e.g.* $\eta = \frac{1}{2}$) in the absence of a revelation game and contracts $(C^1_{TTE,\frac{1}{2}})$, $\left(C^2_{TTE}\right)$ and (C^3_{TTE}) if the revelation game is implemented.[22] In the absence of a communication game, workers decide to hire a manager as long as $\xi \leq 1-\chi(\gamma,\phi,p)$, where $\chi(\gamma,\phi,p) = p_{BB}\frac{q_B}{q^*}\left[(1-p)^2 + \frac{1-(1-p)^2}{\gamma\phi}\right] + (p_{GG} + p_{GB}\gamma\phi)\frac{q_G}{q^*}$ and $\frac{\partial\chi(\gamma,\phi,p)}{\partial\gamma} < 0, \frac{\partial\chi(\gamma,\phi,p)}{\partial p} < 0$. We call $2[1-\chi(\gamma,\phi,p)]\gamma\phi q^*$ the maximum rent of the manager. If contracts $(C^1_{TTE,\frac{1}{2}})$, $\left(C^2_{TTE}\right)$ and (C^3_{TTE}) are available, the maximum rents for the manager are respectively:

(3) $\quad 2[1-\chi_1(\gamma,\phi,p)]\gamma\phi q^*$ where: $\chi_1(\gamma,\phi,p) = \chi(\gamma,\phi,0)$

(4) $\quad 2[1-\chi_2(\gamma,\phi,p)]\gamma\phi q^*$

(5) $\quad 2[1-\chi_3(\gamma,\phi,p)]\gamma\phi q^*$ where:

(6) $\quad \chi_2(\gamma,\phi,p) \equiv \frac{p_{BB}q_B}{q^*}\left[(1-p)^2 + \frac{1-(1-p)^2}{\gamma\phi}\right] + \left(p_{GG}\frac{q_G}{q^*} + p_{GB}\right)\frac{q_B+q_G}{q^*}$

(7) $\quad \chi_3(\gamma,\phi,p) \equiv \frac{p_{BB}q_B}{q^*}\left[\left(1-p^2\right) + p_{BB}\frac{p^2}{\gamma\phi} + p_{BG}\right] + (p_{GG}+p_{GB})\frac{q_G}{q^*}$

It is easy to see that these maximum rents are increasing in both γ and p.

Proposition 3 stresses how the objectivity of managers can be rewarded in equilibrium. The manager is hired if the level of synergies is not too high, that is for $\gamma\phi < \frac{2\hat{q}_G}{q_B+\hat{q}_G}$ $\left[\frac{\gamma}{\phi} < \frac{2\hat{q}_G}{q_B+\hat{q}_G}\right]$, but his rent is increasing in γ in this interval. The rent of managers is increasing in the synergy parameter since the presence of managers allows more teams to be formed. The more

has not been formed at $t = 0$.

[22] The definition of the different contracts are provided in Appendix B. Team contracts are analyzed in details in a Working Paper available upon request (Corgnet 2005).

team formation is valued, the more team managers earn in equilibrium. Another reasonable result is that managers' pay increases as co-workers' cognitive biases increase. This is the case because managers' earnings depend on their informational advantage compared to co-workers. The more frequently workers overestimate their ability the more often team managers have an informational rent. As a result, the manager's informational rent and then his pay are increasing in p. In our model, there exists an incentive for team managers to maintain workers' biased self-attribution at a high level in order to maximize their informational rent. This behavior of managers is a limitation to the process of debiasing workers that adds to the individual's psychological cost of overcoming one's own biases.

3.2 Team management when observing coworkers' performances is costly

Proposition 3 is based on the fact that a team manager can observe co-workers' performances without costs. In this section, we extend our initial model by considering the case in which managers observe workers' performances at a cost $c > 0$. In that case, at $t = 1$ managers will decide whether to observe workers' performances or not.

Assumption 2 (Costs of observing coworkers' performances)

At $t = 1$ the manager either chooses to observe the performances of the two workers or he chooses not to observe any performances.

We consider that observing coworkers' performances involves a cost $c > 0$.

Assumption 3 (Structure of synergies)

We consider the possibility of formation of inefficient teams. In particular, we assume that forming a team composed of workers that performed badly at $t = 1$ ($X_{1,1} =$

$X_{2,1} = B$) is inefficient. That is, if workers choose to form a team when $X_{1,1} = X_{2,1} = B$, they will receive with probability ω a payoff $v\left(X_{1,1} + X_{2,1}\right)$ where $v < 1$, and they will receive with probability $(1-\omega)$ a payoff $\gamma\left(X_{1,1} + X_{2,1}\right)$.

As long as the gains in terms of increased cooperation are sufficiently high, even managers suffering costs of gathering information may be hired in equilibrium.

Proposition 4. Even if a manager observes workers' performances at a cost $c > 0$, he will be hired in equilibrium as long as $c \leq 2\omega\left(\gamma - v\right) p_{BB} q_B$.

In Proposition 4, we show that managers are hired in equilibrium as long as the cost of observing workers' performances is not too high compared to the benefits of observing performances. The benefits associated to observing workers' performances depend on the likelihood of inefficient team formation (ωp_{BB}) and on the magnitude of the inefficiency of teams formed by bad-performance workers ($2\left(\gamma - v\right) q_B$). Managers do not have incentives to observe workers' performances in equilibrium when $c > 0$ if teams are always efficient ($\gamma = v$). In that case, team workers will anticipate that the manager will not observe workers' performances and they will decide not to hire a manager at $t = 0$. To the contrary, if $c \leq 2\omega\left(\gamma - v\right) p_{BB} q_B$ team workers know that managers will observe performances in equilibrium. Then, workers know that hiring a manager at $t = 0$ will make possible the formation of any efficient team if the manager decides at $t = 1$ to reward workers according to their true relative performances.[23] As a result, hiring a manager is going to increase workers' expected payoffs with respect to any of the contracts considered in Appendix B. This is the case since there exist no contracts that allow for the formation of all the efficient teams when $\gamma\phi < \frac{2\hat{q}_G}{q_B + \hat{q}_G}$.

[23] An inefficient team occurs with probability ω when workers performing badly in the first period decide to work together. Any other team is efficient.

4 Discussion on self-managed teams

In this paper we developed a model of team formation in which workers are learning about their ability for a specific task. Backed by extensive psychological evidence, we considered the case in which workers are learning positively about themselves. In that context efficient teams are not always formed because self-serving workers process information differently and hold different beliefs about workers' abilities. As a result, workers have private information about the ability of their co-workers, but are not willing to inform their talented partners for fear of receiving a lower share of the team outcome. We then explored the possibility of hiring a team manager in order to reduce the inefficiency in teams, and assumed that managers had the ability to observe workers' performances objectively. They were then able to design team contracts based on true abilities. This implies the existence of an equilibrium in which workers learn correctly about themselves and always form efficient teams. We also showed that managers would be hired in equilibrium even if observing workers' performances is costly.

As a result, we expect self-managed teams to be more commonly observed in contexts in which workers have low degrees of self-serving biases. In particular, cultural differences in the way people learn about themselves have been documented by psychologists. For example, Japanese appear to be more self-critical than US and Canadian citizens (Kitayama et al. 1997, Heine et al. 1999, Heine, Kitayama, and Lehman 2001). An observation that seems to confirm our model is that the Japanese society characterized by self-criticism rather than self-serving attribution is associated with a corporate culture based on the intensive use of self-managed teams (Haitani 1990, Koike 1988).

In general, we expect autonomy in teams to be more detrimental as workers are learning intensively about their abilities. We expect self-managed teams to perform better when the

team task leads to unambiguous feedback. Indeed, there exists evidence that individuals' self-serving biases are stronger when the outcome of the task is more difficult to assess (Farh and Dobbins 1989, Huber 1991, Audia and Brion 2006). This is the case because individuals can more easily distort ambiguous information. We then predict that autonomy in teams will lead to higher performances in the case of teams involved in routine tasks associated with little learning and unequivocal feedback compared to creative team tasks involving extensive learning and ambiguous feedback. This implication of our model is contrary to the analysis developed in the literature on self-managed teams, which stresses how autonomy in teams should be more beneficial for creative and conceptual tasks than for routine tasks (Manz and Stewart 1997, Stewart and Barrick 2000). These authors argue that autonomy facilitates communication, flexibility, and conflict resolution, and therefore that creative and knowledge tasks - which are more demanding in these dimensions - are expected to benefit more from self-leadership than routine tasks. However, the meta-analytic review undertaken by Stewart (2006) supports the reverse empirical implication as is expected with our framework. Thus, we can regard workers' self-serving biases as a psychological limitation to increased autonomy in teams.

5 Appendices

Appendix A: comments on the assumptions

Instead of assuming perfect observability of co-workers' performances, it may appear more natural to consider that workers learn more about their partner when they work as a team. We can study the case in which workers are able to observe other's performance only when they form a team. This leads to a framework in which workers may decide to hide bad news about their abilities in order to signal themselves as being high-ability co-workers. In this setting the $teams\ inefficiency\ result$ remains valid for any of the equilibria of the game. This is the case since the conditions for team formation at $t = 0$ crucially depend on the conditions for team formation at $t = 1$ when a team has been formed at $t = 0$. Since these conditions do not change with respect to the benchmark model, the conditions for team formation at $t = 0$ are not modified.

Concerning the risk neutrality assumption, we have to mention that taking into account risk aversion is likely to strengthen our results. The idea is that, as self-serving biases increase, the uncertainty about team continuation at $t = 1$ rises. As a result, the negative impact of self-serving attribution on workers' cooperation is likely to be higher for risk averse agents.

Instead of assuming the presence of a learning by doing effect (ϕ), we can consider a fixed cost $C > 0$ incurred for shifting from the individual [team] project to the team [individual] project at $t = 1$. The analysis of this game is available in an extended version of this paper that is available upon request. We show that the main results of our paper are not modified.

We consider in our model a situation in which workers have the possibility to leave the team at $t = 1$. However, there exist cases in which agents may attempt to commit at $t = 0$ to continue with the project started in the first period. We have to stress that commitment at $t = 0$ may be broken at

$t = 1$ by one of the two workers. In our framework commitment is not credible as it happens in many real life situations in which an exante agreement can be broken without further costs.

Appendix B

In this appendix we derive, assuming a team has been formed at $t = 0$, the contracts that are most likely to lead to team formation when $\gamma\phi < \frac{2\hat{q}_G}{q_B + \hat{q}_G}$. These contracts are defined and compared below. Similar contracts can be defined if a team has not been formed at $t = 0$ by substituting ϕ by $\frac{1}{\phi}$ in the definitions of contracts $\left(C^2_{TTE}\right)$ and (C^3_{TTE}). For $\gamma\phi < \frac{2\hat{q}_G}{q_B + \hat{q}_G}$ we know that contracts based on fixed allocation rules cannot ensure team formation whenever $\gamma \geq 1$. We then consider contingent contracts and analyze the truthful telling PBE associated to these contracts. We use the set S' defined as follows:

$$S' \equiv \left\{ \begin{array}{l} (q, r, q, r) \, \forall \, (q, r) \in S, \ (G, B, k, l) \, \forall \, (k, l) \in S \, \hat{\mathsf{A}} \, (G, B) \\ \\ (m, m, B, G) \, \forall m \in \{B, G\} \end{array} \right\}$$

Contract $(C^1_{TTE,\hat{\eta}})$ is defined by the following system of equations:

$$(C^1_{TTE,\hat{\eta}}) \Leftrightarrow \left\{ \ \eta \, (i, j, k, l) = \hat{\eta}, \forall \, (i, j, k, l) \in S^2 \right.$$

$C^1_{TTE,\hat{\eta}}$ is the contract associated to the TTE derived in Proposition 2. It is such that allocation rules are independent of the signals revealed by workers at $t = 1$. This contract leads to team formation for $\gamma\phi \geq \frac{2q_G}{q_B + q_G}$ $\left[\frac{\gamma}{\phi} \geq \frac{2q_G}{q_B + q_G}\right]$ when $\hat{\eta} = \frac{1}{2}$.

Contract $\left(C^2_{TTE}\right)$ is defined by the following conditions:

$$\left(C^2_{TTE}\right) \Leftrightarrow \left\{ \begin{array}{l} \eta_{GBGB} \in \left[\frac{q_G}{\gamma\phi(q_B + q_G)}, 1 - \frac{q_B}{\gamma\phi(q_B + q_G)}\right], \eta_{GBGG} = \eta_{GBGB} \\ (\eta_{GBBB}, \eta_{GBBG}, \eta_{BBBG}) \in A^3, \text{ where } A \equiv \left[0, \frac{1}{2\gamma\phi}\right[\\ \eta_{BGBG} \in \left[\frac{q_B}{(q_B + q_G)\gamma\phi}, 1 - \frac{q_G}{\gamma\phi(q_B + q_G)}\right], \eta_{GGBG} = \eta_{BGBG} \\ (\eta_{GGGG}, \eta_{BBBB}) \in B^2, \text{ where } B \equiv \left[\frac{1}{2\gamma\phi}, 1 - \frac{1}{2\gamma\phi}\right] \\ \forall \, (i, j, k, l) \notin S', \eta_{ijkl} = 0 \end{array} \right.$$

Contract $\left(C_{TTE}^{2}\right)$ is such that allocation rules depend on the signals revealed by co-workers at $t=1$. In particular, considering $\gamma\phi < \frac{2\hat{q}_G}{q_B+\hat{q}_G}$, the share of the group outcome given to the first worker is higher [lower] than equal splitting since $\frac{q_G}{\gamma\phi(q_B+q_G)} > \frac{1}{2}$ $\left[1-\frac{q_G}{\gamma\phi(q_B+q_G)} < \frac{1}{2}\right]$ for $(X_{1,1}, X_{2,1}) = (G,B)$ $[(B,G)]$. This contingent contract associated with full revelation of information in equilibrium allows workers to be rewarded based on their true relative ability. However, this contract does not permit teams to be formed when both workers receive a bad signal and at least one of them suffers from self-serving biases. This is the case since truthful revelation is not a possible equilibrium when $\gamma\phi < \frac{q_B+3q_G}{2(q_B+q_G)}$ $\left[\frac{\gamma}{\phi} < \frac{q_B+3q_G}{2(q_B+q_G)}\right]$ if teams are formed for both $\sigma \equiv (\sigma_1, \sigma_2) \in \Sigma$ and $(X_{1,1}, X_{2,1}) \in V$. We denote $\Sigma \equiv \{(G,B,B,G);(G,B,B,B);(B,B,B,G)\}$ and $V \equiv \{(G,B);(B,G)\}$. In order to ensure team formation for $(X_{1,1}, X_{2,1}) \in V$, we have to prevent team formation for $\sigma \in \Sigma$ by taking η_{GBBG}, η_{GBBB} and η_{BBBG} sufficiently low, that is inferior to $\frac{1}{2\gamma\phi}$.

Contract $\left(C_{TTE}^{3}\right)$ is defined for $\gamma\phi \geq \frac{q_B+3q_G}{2(q_B+q_G)}$ as follows.

$$\left(C_{TTE}^{3}\right) \Leftrightarrow \begin{cases} \eta_{GBGB} \in \left[\frac{q_G}{\gamma\phi(q_B+q_G)}, 1-\frac{1}{2\gamma\phi}\right] \\ \eta_{BGBG} \in \left[\frac{1}{2\gamma\phi}, 1-\frac{q_G}{\gamma\phi(q_B+q_G)}\right] \\ \eta_{GBGG} = \eta_{GBBB} = \eta_{GBGB},\ \eta_{GGBG} = \eta_{BBBG} = \eta_{BGBG} \\ (\eta_{GGGG}, \eta_{BBBB}) \in B^2, \text{ where } B \equiv \left[\frac{1}{2\gamma\phi}, 1-\frac{1}{2\gamma\phi}\right] \\ \eta_{GBBG} \in \left[0, \frac{1}{2\gamma\phi}\right[,\ \forall\,(i,j,k,l) \notin S',\ \eta_{ijkl} = 0 \end{cases}$$

Contract $\left(C_{TTE}^{3}\right)$ depends, similarly to contract $\left(C_{TTE}^{2}\right)$, on the signals revealed by co-workers at $t=1$. Contract $\left(C_{TTE}^{3}\right)$ is defined for $\gamma\phi \geq \frac{q_B+3q_G}{2(q_B+q_G)}$ whereas contract $\left(C_{TTE}^{2}\right)$ is implementable for any $\gamma \geq 1$. The reason is that for $\gamma\phi \geq \frac{q_B+3q_G}{2(q_B+q_G)}$, contract $\left(C_{TTE}^{2}\right)$ can be improved by taking $\eta_{BBBG} = \eta_{BGBG}$ and $\eta_{GBBB} = \eta_{GBGB}$ since then teams can be formed for both $\sigma \in \{(G,B,B,B);(B,B,B,G)\}$ and $(X_{1,1}, X_{2,1}) \in \{(G,B);(B,G)\}$. However, contract $\left(C_{TTE}^{3}\right)$ does not ensure team formation for any $\gamma\phi \geq \frac{q_B+3q_G}{2(q_B+q_G)}$ since teams are not formed when

both workers receive a bad signal and both workers exhibit self-serving learning. The three contracts previously defined do not strictly dominate each other, choosing the best contract depends on the level of synergies and on the level of learning biases. This result is stated below, where the Best contract is defined as the contract implementing the highest co-workers' expected aggregate welfare in equilibrium.

Contracts that lead to the highest co-workers' expected payoffs for $\gamma\phi < \frac{2\hat{q}_G}{q_B + \hat{q}_G}$ are as follows.

$i)$ For $\gamma\phi < \frac{q_B + 3q_G}{2(q_B + q_G)}$ $\left[\gamma\phi \geq \frac{q_B + 3q_G}{2(q_B + q_G)}\right]$ and $p_G < \frac{(2p - p^2)p_B}{2}$ $\left[p_G \geq \frac{p^2 p_B}{2}\right]$,

$(C^1_{TTE,\frac{1}{2}})$ is the Best contract.

$ii)$ For $\gamma\phi < \frac{q_B + 3q_G}{2(q_B + q_G)}$ and $p_G \geq \frac{(2p - p^2)p_B}{2}$, (C^2_{TTE}) is the Best contract.

$iii)$ For $\gamma\phi \geq \frac{q_B + 3q_G}{2(q_B + q_G)}$ and $p_G \geq \frac{p^2 p_B}{2}$, (C^3_{TTE}) is the Best contract.

We know from Proposition 2 and the definitions above that contract $(C^1_{TTE,\frac{1}{2}})$ leads to individual work when the signals received are asymmetric whereas team formation is obtained in that case for the two other contracts. The three contracts are not equivalent since contracts (C^2_{TTE}) and (C^3_{TTE}) are preferred when self-serving biases are not too high, that is respectively when $p\,(2 - p) \leq \frac{2p_G}{p_B}$ and $p \leq \sqrt{\frac{2p_G}{p_B}}$. An increase in co-workers' learning biases (p) does not affect the probability $(p_{GG} + p_{BB})$ with which a team is formed under contract $(C^1_{TTE,\frac{1}{2}})$ whereas it decreases the frequency with which teams are formed under contracts (C^2_{TTE}) and (C^3_{TTE}).

Appendix C

Proof of Proposition 1. The proposition follows from the conditions for team formation at $t = 1$ under the relative ability allocation rule. By comparing expected payoffs associated to team projects and individual projects, it is easy to see that teams are formed at $t = 1$ after a team has [not] been formed at $t = 0$ if $\gamma \geq \phi$ $[\frac{1}{\phi}]$. As a result, at $t = 0$, teams are formed whenever $\gamma \geq 1$. This is equivalent to say that the ETO is achieved.

Proof of Proposition 2. We denote $\sigma_1 \equiv (\sigma_{11}, \sigma_{12})$ and $\sigma_2 \equiv (\sigma_{21}, \sigma_{22})$, and we take p_G $[p_B]$ to be the expected probability given information at $t = 0$ that $X_{i,1} = G$ $[X_{i,1} = B]$, $\forall i \in \{1; 2\}$.

$i)$ First, we show that an ETE is only possible if it is a truthful telling equilibrium (TTE). A truthful telling PBE is such that in equilibrium workers reveal their observed signals: $a_i = \sigma_i$. As a result, beliefs in equilibrium are such that $P\left[\left(X_{1,0'}, X_{2,0'}\right) = (a_{12}, a_{21})\right] = 1$. Assume the payoff at $t = 0^{'}$ is $\left(X_{1,0'}, X_{2,0'}\right) = (B, B)$ and both agents suffer from self-serving learning (i.e. $\sigma_1 = (G, B)$ and $\sigma_2 = (B, G)$). The ETO is implemented if team formation is obtained for any $\gamma\phi \geq 1$ $\left[\frac{\gamma}{\phi} \geq 1\right]$. These conditions for team formation can be obtained only if workers' beliefs converge in the revelation game. As long as agents' beliefs diverge, efficient teams cannot always be formed. The only way beliefs can converge in the case mentioned above ($\left(X_{1,0'}, X_{2,0'}\right) = (B, B)$; $\sigma_1 = (G, B)$; $\sigma_2 = (B, G)$) is when both workers tell the truth. In that case, both workers learn that they performed poorly in the first period. As a result, an ETE has to be truthful telling.

$ii)$ Second, we prove that a truthful telling PBE cannot implement the ETO. This is the case since efficient teams ($\gamma \geq 1$) may not be formed when a team has [not] been formed at $t = 0$ for $\gamma\phi < \frac{2q_G}{q_B + q_G}$ $\left[\frac{\gamma}{\phi} < \frac{2q_G}{q_B + q_G}\right]$. A TTE must be such that workers cannot be worse-off by playing $a_i \neq \sigma_i$ whether a team has been formed at $t = 0$ or not. These conditions generate a system of 8 inequations that lead to the following unique solution $\eta_{(ijkl)} = \hat{\eta}, \forall (i, j, k, l) \in S^2$. The lower bound for achieving team formation is then $\gamma\phi \geq \frac{2q_G}{q_B + q_G}$ $\left[\frac{\gamma}{\phi} \geq \frac{2q_G}{q_B + q_G}\right]$ and corresponds to the case $\hat{\eta} = \frac{1}{2}$. Since $\frac{2q_G}{q_B + q_G} > 1$, we get the inefficiency result stated in Proposition 2.

Proof of Proposition 3. The first part of the proposition follows from simple algebra comparing the expected utility of a worker in the different cases. We consider the case of symmetric contracts (each worker pays the same amount to the manager) so that the expected utility of the two co-workers is the same. This is the most favorable situation for hiring the manager since it is the case in which

the expected payoffs for the worker with the lowest expected welfare are maximum. Under symmetric contracts the necessary conditions for hiring a manager are less demanding than for any other contracts. The second part of the proposition is proved in the main text

Proof of Proposition 4. A manager will be hired in equilibrium if he decides to observe workers' performances at a cost $c > 0$. A manager will observe workers' performances in equilibrium if and only if:

$$\xi\left(2\gamma q^{*}\omega - c\right) \geq \xi\left(2p_{GB}\gamma\left(q_{B} + q_{G}\right) + 2p_{GG}\gamma q_{G} + 2p_{BB}vq_{B}\right)\omega$$

$$\Leftrightarrow c \leq 2\omega\left(\gamma - v\right)p_{BB}q_{B}.$$

Under this condition, the manager does not have incentives to deviate since not observing workers' performances leads to a lower expected payoff. As a result, if $c \leq 2\omega\left(\gamma - v\right)p_{BB}q_{B}$ there exists a PBE in which a manager is hired. In equilibrium the manager decides to observe workers' performances and he decides to pay workers according to their true relative abilities.

6 References

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