# Adding Tournament to Tournament: Combining Between-Team and Within-Team Incentives

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# Combining Between-Team and Within-Team Incentives

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**Abstract**

We examine theoretically and experimentally how combining between-team and within-team incentives affects behavior in team tournaments. Theory predicts that free-riding is likely to occur when there are only between-team incentives, and offering within-team incentives may solve this problem. However, if individuals collude, then within-team incentives may not be as effective at reducing free-riding. Consistent with the theoretical predictions, the results of our experiment indicate that although between-team incentives are effective at increasing individual effort, there is substantial free-riding and declining effort over time. Importantly, a combination of between-team and within-team incentives is effective not only at generating effort but also at sustaining effort over time, mitigating free-riding problem, increasing cooperation and decreasing collusion within teams.

*JEL Classifications*: C70, D72, H41
*Keywords*: individual incentive, team incentive, tournament, free-riding, collusion

## 1. Introduction

The use of teams in organizations has become increasingly popular in the U.S. workplace and elsewhere (Che and Yoo, 2001; Merchant and Van der Stede, 2007). Teams can increase the efficient application of specialized knowledge and skills to achieve greater collective performance (Cohen, 1993; Merchant and Van der Stede, 2007). Accordingly, how to design incentives in team settings is an interesting and important topic. Organizations consisting of teams can incentivize employees' effort based on (1) individual performance, (2) team performance, or (3) a combination of both. While the effects of individual and team incentives, in isolation, have been studied in the literature (e.g., Prendergast, 1999; Konrad, 2009; Connelly et al., 2014), less is known about the combined effects.

One way to design incentives to motivate agents in both individual and team settings is to introduce a tournament. The use of tournaments to evaluate and reward performance has increased in the corporate world (Boyle, 2001; McGregor, 2006; Pfeffer and Sutton, 2006) and in the workplace (Merchant and Van der Stede, 2007; Casas-Arce and Martinez-Jerez, 2009; Sheremeta, 2016). In this study, we are particularly interested in a combination of between-team and within-team tournaments.[1] While it is well recognized in the literature that individual tournaments are effective at eliciting high effort from contestants (Dechenaux et al., 2015), such tournaments are susceptible to collusion, especially when individuals are allowed to communicate (Harbring, 2006; Sutter and Strassmair, 2009; Cason et al., 2012, 2017). Similarly, within the literature team tournaments have been shown to effectively generate high effort (Abbink et al., 2010; Sheremeta, 2018), but such tournaments are susceptible to free-riding (Erev et al., 1993; Gunnthorsdottir and

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[1] Of course, the tournament manager has other ways of designing a tournament by changing the number of prizes (Orrison et al., 2004; Lim et al., 2009; Müller and Schotter, 2010), the number of players (Orrison et al., 2004), and heterogeneity within the tournament (Weigelt et al., 1989; Cason et al., 2010).

Rapoport, 2006). Therefore, the resulting effort from individuals under combined within-team and between-team tournaments is not clear as the problems of collusion and free-riding still potentially exist. To study the effectiveness of the combination of between-team and within-team tournaments we provide a theoretical model and test its predictions in a controlled laboratory experiment.

Our model is built on the seminal nested contest model of Nitzan (1991). Whereas the original model only contains an individual reward (within-team incentive), to examine our research question we introduce a team reward (between-team incentive). The inclusion of the team reward also makes the model more generalizable in practice, because businesses increasingly require cooperation among employees from across the organization and the use of group rewards is believed to foster this cooperation (Cohen, 1993; Merchant and Van der Stede, 2007). The theoretical Nash equilibrium predicts that free-riding behavior is likely to occur when there are only between-team incentives, and offering within-team incentives may solve this problem. However, if upon introduction of the within-team incentives individuals still choose to collude within a team, then the combined incentives may not be as effective at increasing effort and reducing free-riding.

We tested the predictions of our model using a controlled laboratory experiment in which a team of three participants competes against another team of three participants by exerting effort. We used a 2×2 design, by manipulating between-team and within-team incentives. Prior to competition, participants had an opportunity to communicate with their team members increasing the likelihood of collusion. The results of our experiment indicate that although between-team incentives are effective at increasing individual effort, as predicted by the theory, there is substantial free-riding and declining effort over time. Within-team incentives are also effective at increasing individual effort, albeit not as effective as between-team incentives in our experiment

(due to potential collusive behavior). Most importantly, a combination of between-team and within-team incentives is effective not only at generating effort but also at sustaining effort over time, mitigating free-riding problem, increasing cooperation and decreasing collusion within teams.

The rest of the paper is organized as follows. Section 2 presents the theoretical model. Section 3 describes experimental design, procedures and testable hypotheses. Section 4 provides analysis and Section 5 concludes by discussing implications and suggesting directions for future research.

## 2. Theoretical Model

Assume there are two teams competing to win a contest. For simplicity, assume that team $A$ and team $B$ each consist of $N$ risk-neutral players. All players in both teams simultaneously and independently expend irreversible costly efforts $x_{iA}$ and $x_{jB}$, where $i = 1, ..., N$ and $j = 1, ..., N$. The team performance $X_A$ (similarly $X_B$) is the sum of all individual efforts within team $A$ (Katz et al., 1990):

$$X_A = \sum_{i=1}^{N} x_{iA}. \tag{1}$$

After all players of team $A$ and team $B$ choose their efforts, $X_A$ and $X_B$ are compared. The probability of team $A$ (similarly team $B$) winning is defined by a contest success function (CSF):

$$p_A = \begin{cases} \alpha \frac{X_A}{X_A + X_B} + (1 - \alpha)\frac{1}{2} & \text{if } X_A + X_B > 0 \\ \frac{1}{2} & \text{if } X_A = X_B = 0 \end{cases}. \tag{2}$$

This CSF is different from a standard CSF defined by Skaperdas (1996) and Münster (2009). One interpretation of the CSF (2) is that, with a probability $\alpha$ winning depends on the

"merit" of one team relative to the other team (between-team incentive), and with the remaining probability $(1 - \alpha)$ winning depends on pure luck (Konrad, 2009).

All members of the winning team receive a team reward $V_T$ and an individual reward $V_I$. When the team reward is present, receiving individual reward $V_I$ is contingent on receiving $V_T$. The team reward is equally shared by all team members, so that player $i$ in team $A$ receives $\frac{1}{N} V_T$. The individual reward is allocated according to the sharing rule proposed by Nitzan (1991), so that player $i$ in team $A$ receives $s_{iA} V_I$, where

$$s_{iA} = \begin{cases} \beta \frac{x_{iA}}{X_A} + (1 - \beta) \frac{1}{N} & \text{if } X_A > 0 \\ \frac{1}{N} & \text{if } X_A = 0 \end{cases}. \tag{3}$$

Similar to the interpretation of the CSF (2), the sharing rule (3) shows that, with a probability $\beta$ the individual reward $V_I$ is allocated according to the "merit" of each individual within the team (within-team incentive), and with the remaining probability $(1 - \beta)$ the individual reward is allocated randomly.

Given (2) and (3), the expected payoff of a risk-neutral player $i$ in team $A$ can be written as:

$$\pi_{iA} = p_A \left( \frac{1}{N} V_T + s_{iA} V_I \right) - x_{iA}, \tag{4}$$

where $p_A$ is the between-team CSF defined by equation (2) and $s_{iA}$ is an individual's share of the individual reward $V_I$ defined by equation (3).

Differentiating (4) with respect to $x_{iA}$ (see the derivations in Appendix A), and solving for the symmetric Nash equilibrium, we receive:

$$x_{iA}^* = x_{jB}^* = \frac{\alpha(V_T + V_I) + \beta(2N - 2)V_I}{4N^2}. \tag{5}$$

A simple comparative static analysis shows that the equilibrium effort (5) is increasing in $\alpha$ (between-team incentive) and in $\beta$ (within-team incentive).

If, as it is in this study, communication is allowed within each team, prior literature suggests that all individuals within each team may act cooperatively as one player (e.g., Sutter and Strassmair, 2009; Cason et al., 2012). In such a case, instead of an individual payoff (4), a risk-neutral player $i$ in team $A$ should maximize the joint team payoff:

$$\pi_{iA} = \sum_{i=1}^{N} \left( p_A \left( \frac{1}{N} V_T + s_{iA} V_I \right) - x_{iA} \right) = p_A (V_T + V_I) - X_A. \tag{6}$$

Differentiating (6) with respect to $x_{iA}$ (see the derivations in Appendix A), and solving for the symmetric Nash equilibrium, we receive:

$$x_{iA}^* = x_{jB}^* = \frac{\alpha(V_T + V_I)}{4N}. \tag{7}$$

Intuitively, since each team member is maximizing the joint team payoff, the equilibrium effort (7) is only increasing in $\alpha$ (between-team incentive) and it does not depend on $\beta$ (within-team incentive).

## 3. Experimental Design, Procedures and Predictions

### 3.1. Experimental Design

In order to examine how between-team and within-team incentives affect individual behavior, we collected data from a computerized experiment (Fischbacher, 2007). We used a 2×2 design, as shown in Table 1, by manipulating between-team and within-team incentives. In all four conditions, a team of three participants (i.e., $N = 3$) competed against another team of three participants by contributing points to a team account. These points translated directly into the

probabilities of receiving a team reward of 180 (i.e., $V_T = 180$) and an individual reward of 180 (i.e., $V_I = 180$).[2]

In the baseline NONE condition, all participants automatically split the team reward and the individual reward. Therefore, there were no between-team or within-team incentives (i.e., $\alpha = 0$ and $\beta = 0$). In WITHIN condition, all participants automatically split the team reward but the individual reward was allocated according to a lottery rule. For example, if a team member contributed 30 percent of his/her team's total output, his/her probability of winning the individual reward was 30 percent. Therefore, in this condition, there are only within-team incentives (i.e., $\alpha = 0$ and $\beta = 1$). In BETWEEN condition, the team and individual rewards were allocated according to a lottery rule between teams but all participants of the winning team automatically split the team and individual rewards. For example, if a team contributed 70 percent of the two team's total output, that team's probability of winning the team and individual rewards was 70 percent. Therefore, in this condition, there are only between-team incentives (i.e., $\alpha = 1$ and $\beta = 0$). Finally, in BOTH condition, both the team reward and the individual reward were allocated according to a lottery rule. Therefore, in this condition, there are both between-team and within-team incentives ($\alpha = 1$ and $\beta = 1$).

## 3.2. Experimental Procedures

A total of 144 students at a large university participated in 12 experimental sessions. Each session lasted about 70 minutes and had 12 participants. Each experimental session consisted of two parts, corresponding to two incentive conditions from Table 1.[3] The exact order of procedures

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[2] The use of probability function in assigning rewards was designed to be consistent with the typical random noise added to an output function in labor economics literature (Lazear and Rosen, 1981).

[3] This design was chosen to minimize the number of participants necessary for the experiment, and to allow us to have direct within-subject comparisons while controlling for any between-subject differences.

is shown in Figure 1. As participants arrived, each was assigned a computer with privacy dividers. Then participants read the instructions (see Appendix B), after which they answered several questions to verify their understanding of the instructions. These forced manipulation checks ensured that participants understood all relevant aspects of the task and their particular experimental incentive condition.

In Part 1 of the experiment, corresponding to one of the four experimental incentive conditions, participants were randomly assigned to a team (a total of three members in each team) and two teams were randomly paired. Participants remained in the same team and competed against the same paired team for 10 periods. In each period, every participant received 60 experimental points as an endowment and had an opportunity to communicate with their team members for 90 seconds (40 seconds in periods 3-10) prior to making their decisions. After communication, each participant privately decided how many points (representing effort) to contribute to a team account.[4] After all participants made their decisions, they were notified whether they won the team reward, and if so, then whether they also won the individual reward. Each participant was privately notified of his or her current period payoff.

In Part 2, all participants were assigned to a new incentive condition. Each participant was also randomly assigned to a new team where their new teammates were not any of their teammates in Part 1. The new team was randomly paired with another new team and participants remained in the same team and competed against the same paired team for 10 periods under the new incentive

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[4] According to standard agency theory (Baiman, 1982; Namazi, 1985), effort is any action that satisfies three conditions: (1) the agent controls the action, (2) an increase in the action results in a rightward shift of the distribution of (i.e. greater) output, and (3) the agent receives disutility from exerting effort. Physical exertion is not a requirement for an action to be regarded as effort.

condition. To control for an order effect, in each session participants were randomly assigned to one of 12 combinations of two conditions.[5]

At the end of the experiment, participants completed a demographic questionnaire. Two periods (one from each part) were randomly selected for payments. Earnings were converted into US dollars at the rate of 20 points to $1, and participants received their payments in private and in cash, ranging from $5 to $23.75, with an average $13.98.

### 3.3. Predictions

The four experimental conditions test how between-team and within-team incentives affect individual behavior. If we assume that individuals are perfectly rational and maximize their own payoffs, then individuals should exert effort defined by equation (5). In such a case, effort in NONE condition ($\alpha = 0$ and $\beta = 0$) should be 0, in WITHIN ($\alpha = 0$ and $\beta = 1$) should be $\frac{(N-1)V_I}{2N^2} = 20$, in BETWEEN ($\alpha = 1$ and $\beta = 0$) should be $\frac{V_T+V_I}{4N^2} = 10$, and in BOTH ($\alpha = 1$ and $\beta = 1$) should be $\frac{V_T+(2N-1)V_I}{4N^2} = 30$.

Alternatively, if communication enhances group identity and causes individuals within each team to act cooperatively as one player, then individuals should exert effort defined by equation (7). In such a case, effort in NONE condition should be 0, in WITHIN should be 0, in BETWEEN should be $\frac{V_T+V_I}{4N} = 30$, and in BOTH should be $\frac{V_T+V_I}{4N} = 30$.

Finally, it could be the case that individuals have mixed motives, trying to maximize their individual payoff as well as their joint team payoff. In such a case, effort should be a convex

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[5] Picking any 2 out of 4 experimental incentive conditions yields a total of 12 ordered combinations (e.g., NONE-WITHIN and WITHIN-NONE). Each combination has 2 experimental conditions or parts. With 144 participants in total, this design results in 12 statistically independent observations (2 teams of 3 individuals each as one observation) in each condition.

combination of equations (5) and (7). Assuming a simple weighted average, see Table 2, effort in NONE condition should be 0, in WITHIN should be 10, in BETWEEN should be 20, and in BOTH should be 30.

Based on these predictions, we can state testable hypotheses. First, it is clear that both between-team and within-team incentives should increase individual effort.

**Hypothesis 1**: Between-team and within-team incentives increase individual effort relative to no incentives.

Second, combining between-team and within-team incentives should have the greatest effect at increasing individual effort.

**Hypothesis 2**: Combining between-team and within-team incentives has the greatest effect at increasing individual effort.

## 4. Results

### 4.1. Descriptive Statistics

Table 3 provides an overview of the average effort and payoff within each experimental condition. Also, a graphical summary of results is presented in Figure 2. We use the average effort over all 10 periods by 6 participants (2 teams) as one independent observation. The Wilcoxon signed-rank test shows that the average effort in all conditions is higher than the Nash equilibrium predictions: the average effort level is 47.15 in BOTH condition, 42.61 in BETWEEN, 25.07 in WITHIN, and 9.47 in NONE.[6] This is not surprising, given that the main observation, emerging

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[6] We compare the average effort to the predictions stated in Table 2, and find that in only 1 out of 9 cases the average effort is not significantly different from the predicted value. Specifically, the average effort in NONE is significantly different from 0 (Wilcoxon signed-rank; p-value < 0.01). The average effort in WITHIN is significantly different from 0 (p-value < 0.01), 10 (p-value < 0.01), but not 20 (p-value = 0.11). The average effort in BETWEEN is significantly different from 10 (p-value < 0.01), 20 (p-value < 0.01), and 30 (p-value = 0.11). Finally, the average effort in BOTH is significantly different from 30 (p-value < 0.01).

from most experimental studies on group contests is that "the actual effort of subjects is significantly higher than the Nash equilibrium prediction" (Sheremeta, 2018, p. 2).[7]

## 4.2. Differences between Conditions

The main purpose of our experiment was to examine how between-team and within-team incentives affect individual behavior. Therefore, we first examine whether between-team incentives (BOTH and BETWEEN conditions) motivate individuals to exert greater effort than when no between-team incentives are present (WITHIN and NONE conditions). On average, individual effort under between-team incentives is 27.61 greater than without between-team incentives (Wilcoxon rank-sum; p-value < 0.01), as shown in Table 4. We also examine whether within-team incentives (BOTH and WITHIN conditions) have a positive impact on individual effort. Table 4 shows that, on average, individuals exert 10.07 greater effort under within-team incentives, compared to no within-team incentives (Wilcoxon rank-sum; p-value = 0.07).[8]

**Result 1**: Consistent with Hypothesis 1, both between-team and within-team incentives increase individual effort.

Next, we examine whether individuals exert the greatest effort when between-team and within-team incentives are combined (as in BOTH condition). Table 4 shows that the average effort in BOTH condition is 37.68 greater than in NONE condition (Wilcoxon rank-sum; p-value < 0.01), 22.07 greater than in WITHIN condition (Wilcoxon rank-sum; p-value < 0.01), and 4.53 greater than in BETWEEN condition (Wilcoxon rank-sum; p-value = 0.46).

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[7] The most common explanations for significant over-expenditure in group contests are overly competitive behavior of individuals in contests (Sheremeta, 2013, 2017), overly cooperative behavior in social dilemmas and collective action games (Ledyard et al, 1995; Chaudhuri, 2011), parochial altruism (Bernhard et al., 2006; Choi and Bowles, 2007), and group identity (Tajfel and Turner, 1979; Chowdhury et al., 2016).
[8] We obtain similar results, when examining the data only from the first part of the experiment (see Table 4C in Appendix C).

Since each individual participated in two conditions, we can also analyze the data using a within-subject comparison. This is a more powerful non-parametric test as it gives us direct results as to how a participant behaves in two different incentive conditions. As shown in Table 5, individuals in BOTH condition exert the greatest effort, compared to other conditions (Wilcoxon signed-rank; all p-values < 0.03). This brings us to our next result:

**Result 2**: Consistent with Hypothesis 2, combining between-team and within-team incentives has the greatest effect at increasing individual effort.


**4.3. Effort over Time**

Figure 3 shows the average effort across 10 periods for each condition. There are two immediate observations. First, there are clear differences between conditions. Second, effort decreases over time, most notably in NONE and BETWEEN conditions. In order to examine how repetition influences behavior, we conduct a time series cross-sectional regression analysis. In Table 6, we report the estimated results of linear cross-sectional time-series models with random effects on the participant level.[9] We use the individual effort in a given period as the dependent variable, and the period number and constant as independent variables. Estimation results show that effort in NONE and BETWEEN conditions decreases with repetition of the experiment, which is demonstrated by a significantly negative period coefficient (p-value < 0.01).

**Result 3**: Effort decreases over time when there are no incentives or only between-team incentives, while it remains stable when there are within-team incentives or combination of between-team and within-team incentives.

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[9] Taking the average effort in a group of six participants (i.e., both teams) as the unit of observation yields similar qualitative results.

In addition, the regression analysis confirms our previous results. Specifically, the last column of Table 6 shows that, compared to no incentives (the omitted NONE condition), within-team incentives (WITHIN condition) increase effort by 15.60 (Wald Chi-Square test; p-value < 0.01), between-team incentives (BETWEEN condition) increase effort by 33.14 (Wald Chi-Square test; p-value < 0.01), and combined between-team and within-team incentives (BOTH condition) increase effort by 37.68 (Wald Chi-Square test; p-value < 0.01). Moreover, effort in BOTH condition is significantly higher than in WITHIN condition (Wald Chi-Square test; p-value < 0.01) and BETWEEN condition (Wald Chi-Square test; p-value = 0.05), suggesting that combining between-team and within-team incentives has the greatest effect at increasing individual effort.[10]

## 4.4. Free-riding

In this section, we examine how between-team and within-team incentives affect free-riding. Similar to Gunnthorsdottir and Rapoport (2006) and Sheremeta (2011), we define free-riding in a team contest when an individual exerts an effort of 0. Table 7 presents the frequency of zero effort in each condition by period. It is important to emphasize that an effort of 0 can be interpreted as a free-riding only in BETWEEN and BOTH conditions. There are a total of 103 instances where individuals free-ride in BETWEEN condition, and only 31 in BOTH condition. Directly comparing BOTH condition with BETWEEN condition, we find about 69.9 percent less free-riding in BOTH condition. This difference is significant (Wilcoxon rank-sum; p-value = 0.03), confirming that a combination of between-team and within-team incentives is effective at mitigating free-riding problem.

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[10] We obtain similar results, when examining the data only from the first part of the experiment (see Table 6C in Appendix C).

**Result 4**: There is substantial free-riding when there are only between-team incentives, but free-riding behavior is reduced when between-team incentives are combined with within-team incentives.

### 4.5. Cooperation and Collusion

In our experiment, participants could communicate with each other by sending messages via chat windows. To analyze these messages, we first read the messages and established a set of four categories for cooperation and four for collusion.[11] The details of these categories are shown in Table 8. There are a total of 7,671 communication messages recorded, with an average of 80 chat messages within a single team in each experimental session. On average, in each experimental session there are 289 messages in NONE condition, 288 messages in WITHIN, 350 messages in BETWEEN, and 353 messages in BOTH. Next, two graduate students, trained separately, independently read and coded the communication messages for each team in each period, assigning the value of 1 if a message belongs to a given category and 0 otherwise.[12] The coders were not informed about any of the hypotheses in the study. All messages within each team in each period are taken as one observation for coding, resulting in 960 coding observations. Within each observation, each category for cooperation or collusion is coded either 0 or 1. Therefore, the same observation may belong to more than one category in each period. We also established two summary categories label overall cooperation (Panel A of Table 8) and overall collusion (Panel B of Table 8), which are coded as 1 if any of the specific four categories about cooperation (collusion) appears, and 0 otherwise.

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[11] Collusion is a form of cooperation. However, in this study, "cooperation" refers to working hard and/or effort increasing cooperation. "Collusion" in this study only refers to minimizing effort because collusion within a team would lead to zero effort due to the fixed reward and costly effort.

[12] Taking each single team and period as one unit for coding is consistent with Sutter and Strassmair (2009).

Table 9 presents pairwise comparisons between conditions using logistic regressions. There are several general patterns that we see. First, we find that between-team incentives (BETWEEN and BOTH conditions) increase cooperation within teams ("overall cooperation" category, all p-values < 0.01). Specifically, compared to NONE and WITHIN conditions, in BETWEEN and BOTH conditions, individuals are significantly more likely to cooperate with their team members by proposing to choose high effort levels within their team or stating their own choices of high effort (category C2), by agreeing on their team members' high effort proposals (category C3) and by giving reasons why they need to choose high efforts (category C4). Second, we find that between-team incentives (BETWEEN and BOTH conditions) decrease collusion within teams ("overall collusion" category, all p-values < 0.01). Specifically, individuals are significantly less likely to propose low effort within a team (category C5), to agree on team members' suggestions of contributing low effort (category C6), and to give reasons why they need to choose low effort (category C8). Further, we find that BOTH condition is the most effective in mitigating the collusion problem ("overall collusion" category, all p-values < 0.05). These findings can be summarized as following:

**Result 5**: Between-team incentives increase cooperation and decrease collusion within teams, and the collusion problem is mostly mitigated when between-team incentives are combined with within-team incentives.


## 5. Discussions and Conclusion

We examine theoretically and experimentally how combining between-team and within-team incentives affects behavior in team tournaments. The theoretical Nash equilibrium predicts that free-riding behavior is likely to occur when there are only between-team incentives, but

offering within-team incentives may solve this problem. However, if individuals collude within a team, then within-team incentives may not be as effective at reducing free-riding.

The results of our experiment indicate that although between-team incentives are effective at increasing individual effort, as predicted by the theory, there is substantial free-riding and declining effort over time. Within-team incentives are also effective at increasing individual effort, albeit not as effective as between-team incentives in our experiment and not without collusion. Most importantly, a combination of between-team and within-team incentives is very effective not only at generating effort but also at sustaining effort over time, mitigating the free-riding problem, increasing cooperation and decreasing collusion within teams.

What are the implications of our findings? First, our study provides evidence that individuals exert the greatest effort when organizations use a combination of between-team and within-team incentives. Using both incentives simultaneously is important for mitigating the free-riding problem within teams and sustaining effort over time. Not surprisingly, therefore, tournament-like incentives have been gaining more popularity in the workplace (Che and Yoo, 2001; Merchant and Van der Stede, 2007; Connelly et al., 2014).

Second, our findings show that when individuals are allowed to communicate they appear to not only maximize their individual payoff, but also their joint team payoff. This finding contributes to the literature studying how communication enhances social identity within teams (Sutter and Strassmair, 2009; Cason et al., 2012, 2017). Specifically, social identity theory suggests that one of the most distinctive features of group identity and intergroup relations is positive distinctiveness – a belief that "we" are better than "them" (Tajfel and Turner, 1979; Turner, 1984; Hogg, 2006). Communication may help individuals to enhance their group identity causing team members to go to great lengths to protect and promote positive distinctiveness from other teams

and thus contribute more effort to help their teams win reward (Hogg, 2006). Allowing communication also generalizes to the workplace as between-team tournaments are unlikely in environments were communication or direct contact between participants is not possible.

Although we only used tournaments in our experiment, we believe that our results are also applicable to other relative performance incentive settings (Cason et al., 2010; Agranov and Tergiman, 2013; Güth et al., 2016). The tournament winner is determined by calculating the team/individual's performance (output) relative to other teams/individuals. Although individuals' absolute effort levels may change when using other relative performance incentives, the direction of the effort differences across the incentive settings should hold. Future research could explore how effective between-team and within-team incentives are in other relative performance incentive settings, how individuals change their behavior in response to asymmetric valuations of a reward or individuals' heterogeneity in costs/abilities, and how results change when communication is costly.

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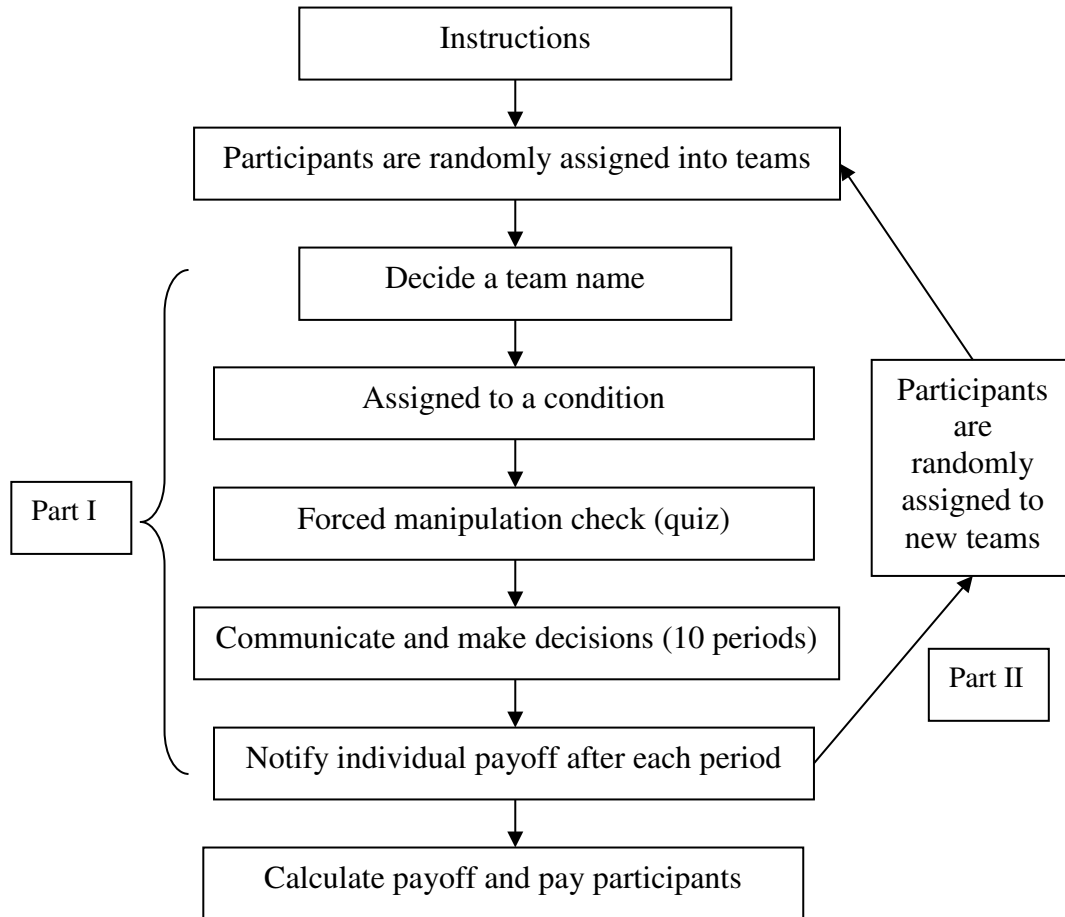
**Figure 1: Experimental procedures.**
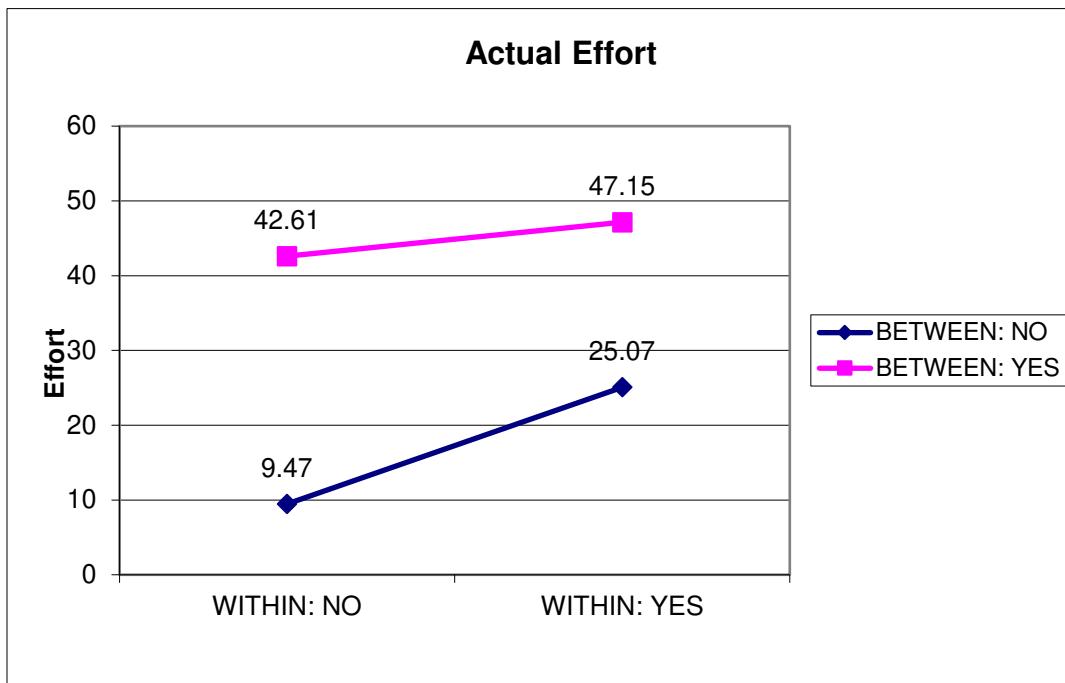
**Figure 2: Average effort.**



**Figure 3: Average effort across 10 periods.**
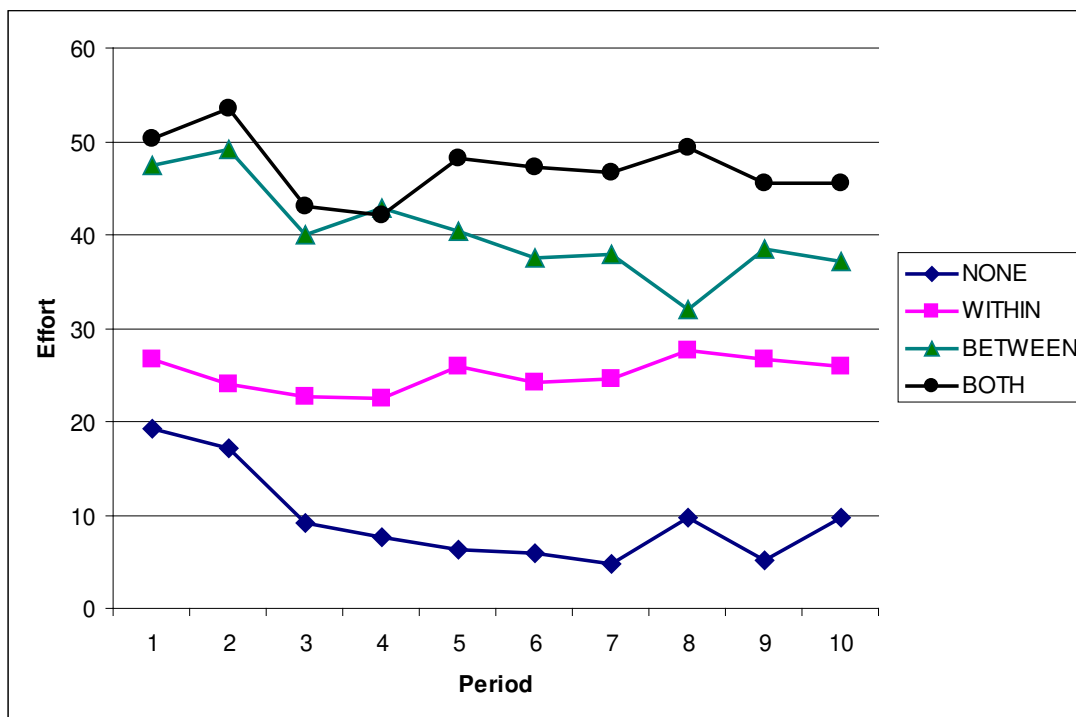
**Table 1: Summary of experimental conditions.**

| | | Within-team incentive | |
|---|---|---|---|
| | | No | Yes |
| Between-team | No | NONE | WITHIN |
| incentive | Yes | BETWEEN | BOTH |

**Table 2: Theoretical predictions.**

| | Effort prediction | | | | | |
|---|---|---|---|---|---|---|
| Condition | Individual | | Joint | | Mixed = (Individual + Joint) / 2 | |
| NONE | 0 | = 0 | 0 | = 0 | 0 | = 0 |
| WITHIN | $\dfrac{(N-1)V_I}{2N^2}$ | = 20 | 0 | = 0 | $\dfrac{(N-1)V_I}{4N^2}$ | = 10 |
| BETWEEN | $\dfrac{V_T+V_I}{4N^2}$ | = 10 | $\dfrac{V_T+V_I}{4N}$ | = 30 | $\dfrac{(N+1)}{2}\dfrac{(V_T+V_I)}{4N^2}$ | = 20 |
| BOTH | $\dfrac{V_T+(2N-1)V_I}{4N^2}$ | = 30 | $\dfrac{V_T+V_I}{4N}$ | = 30 | $\dfrac{(N-1)V_I}{4N^2}+\dfrac{(N+1)}{2}\dfrac{(V_T+V_I)}{4N^2}$ | = 30 |

**Table 3: Average effort and payoff.**

| Condition | Participants | Independent observations | Average effort | Standard deviation | Average payoff | Standard deviation |
|---|---|---|---|---|---|---|
| NONE | 36 | 12 | 9.47 | 7.75 | 110.53 | 7.75 |
| WITHIN | 36 | 12 | 25.07 | 7.84 | 94.93 | 8.10 |
| BETWEEN | 36 | 12 | 42.61 | 11.31 | 77.38 | 11.31 |
| BOTH | 36 | 12 | 47.15 | 4.16 | 72.35 | 3.87 |

**Table 4: Average effort difference between conditions.**

| Conditions | | | Independent observations | Average difference | Wilcoxon rank-sum | p-value |
|---|---|---|---|---|---|---|
| BOTH + BETWEEN | vs. | WITHIN + NONE | 48 | 27.61 | 5.62 | < 0.01 |
| BOTH + WITHIN | vs. | BETWEEN + NONE | 48 | 10.07 | 1.77 | = 0.07 |
| BOTH | vs. | NONE | 24 | 37.68 | 4.15 | < 0.01 |
| BOTH | vs. | WITHIN | 24 | 22.07 | 4.15 | < 0.01 |
| BOTH | vs. | BETWEEN | 24 | 4.53 | 0.46 | = 0.64 |
| BETWEEN | vs. | WITHIN | 24 | 17.54 | 3.34 | < 0.01 |
| BETWEEN | vs. | NONE | 24 | 33.14 | 4.09 | < 0.01 |
| WITHIN | vs. | NONE | 24 | 15.61 | 3.69 | < 0.01 |

**Table 5: Average effort difference between conditions (within-subject comparison).**

| Conditions | | | Independent observations | Average difference | Wilcoxon signed-rank | p-value |
|---|---|---|---|---|---|---|
| BOTH | vs. | NONE | 8 | 33.60 | 2.52 | = 0.01 |
| BOTH | vs. | WITHIN | 8 | 25.85 | 2.52 | = 0.01 |
| BOTH | vs. | BETWEEN | 8 | 13.53 | 2.24 | = 0.02 |
| BETWEEN | vs. | WITHIN | 8 | 19.74 | 2.52 | = 0.01 |
| BETWEEN | vs. | NONE | 8 | 36.23 | 2.52 | = 0.01 |
| WITHIN | vs. | NONE | 8 | 20.94 | 2.52 | = 0.01 |

**Table 6: Time series cross-sectional regression analysis.**

| Independent variables | Condition | | | | |
|---|---|---|---|---|---|
| | NONE | WITHIN | BETWEEN | BOTH | All conditions |
| Period | -1.06*** | 0.25 | -1.20*** | -0.32 | -0.58*** |
| | (0.47) | (0.37) | (0.41) | (0.42) | (0.22) |
| Constant | 15.30*** | 23.67*** | 49.24*** | 48.91*** | 12.67*** |
| | (3.82) | (2.45) | (2.74) | (2.37) | (2.61) |
| WITHIN | | | | | 15.60*** |
| | | | | | (3.08) |
| BETWEEN | | | | | 33.14*** |
| | | | | | (3.83) |
| BOTH | | | | | 37.68*** |
| | | | | | (2.45) |

Note: * p-value < 0.10, ** p-value < 0.05, *** p-value < 0.01
Robust standard errors are in parenthesis.

**Table 7: Frequency of free-riding (effort of 0).**

| Period | Condition | | | |
|---|---|---|---|---|
| | NONE | WITHIN | BETWEEN | BOTH |
| 1 | 26 | 10 | 6 | 1 |
| 2 | 26 | 10 | 4 | 1 |
| 3 | 35 | 13 | 10 | 5 |
| 4 | 39 | 23 | 10 | 4 |
| 5 | 46 | 16 | 13 | 2 |
| 6 | 51 | 19 | 9 | 2 |
| 7 | 51 | 15 | 14 | 2 |
| 8 | 52 | 17 | 16 | 3 |
| 9 | 49 | 16 | 8 | 5 |
| 10 | 48 | 13 | 13 | 6 |
| Total | 189 | 152 | 103 | 31 |

## Table 8: Summary of communication messages.

| Category | Description | NONE | WITHIN | BETWEEN | BOTH |
|---|---|---|---|---|---|
| | Panel A: Cooperation within teams | | | | |
| C1 | Ask for the opinions of other team members | 0.188 | 0.333 | 0.379 | 0.396 |
| C2 | Proposal to choose *high* efforts within team or state own choice of *high* efforts | 0.129 | 0.167 | 0.654 | 0.692 |
| C3 | Agree on team members' proposals of *high* effort | 0.058 | 0.075 | 0.554 | 0.571 |
| C4 | Give reasons why need to choose *high* efforts | 0.025 | 0.008 | 0.104 | 0.146 |
| | Overall cooperation | 0.263 | 0.413 | 0.725 | 0.750 |
| | Panel B: Collusion within teams | | | | |
| C5 | Proposal to choose *low* efforts within team or state own choice of *low* efforts | 0.529 | 0.558 | 0.221 | 0.129 |
| C6 | Agree on team members' proposals of *low* effort | 0.371 | 0.392 | 0.146 | 0.063 |
| C7 | Proposal to take turns in winning the tournament | 0.000 | 0.142 | 0.000 | 0.021 |
| C8 | Give reasons why need to choose *low* efforts | 0.233 | 0.167 | 0.050 | 0.038 |
| | Overall collusion | 0.567 | 0.600 | 0.221 | 0.146 |

## Table 9: Summary of communication messages.

| Category | BOTH vs. NONE | BOTH vs. WITHIN | BOTH vs. BETWEEN | BETWEEN vs. WITHIN | BETWEEN vs. NONE | WITHIN vs. NONE |
|---|---|---|---|---|---|---|
| | Panel A: Cooperation within teams | | | | | |
| C1 | *** | 0.131 | 0.690 | *** | 0.266 | ** |
| C2 | *** | *** | 0.371 | *** | *** | 0.242 |
| C3 | *** | *** | 0.637 | *** | *** | 0.463 |
| C4 | *** | *** | 0.157 | ** | ** | 0.173 |
| Overall | *** | *** | 0.519 | *** | *** | ** |
| | Panel B: Collusion within teams | | | | | |
| C5 | *** | *** | * | *** | *** | 0.517 |
| C6 | *** | *** | * | *** | *** | 0.636 |
| C7 | NA | *** | N/A | N/A | N/A | N/A |
| C8 | *** | *** | 0.504 | *** | *** | 0.067 |
| Overall | *** | *** | * | *** | *** | 0.456 |

Note: The p-values reported in this table are based on Wald Chi-Square statistics.
* p-value < 0.05, ** p-value < 0.001, *** p-value < 0.0001

## Appendix A – Theoretical Derivations

We can rewrite the expected payoff (4) as:

$$\pi_{iA} = \left( \alpha \frac{X_A}{X_A + X_B} + (1 - \alpha) \frac{1}{2} \right) \left( \frac{1}{N} V_T + \left( \beta \frac{x_{iA}}{X_A} + (1 - \beta) \frac{1}{N} \right) V_I \right) - x_{iA}. \tag{A1}$$

Further expanding the expression, we get:

$$
\begin{aligned}
\pi_{iA} = {}& \left( \alpha \frac{X_A}{X_A + X_B} + (1 - \alpha) \frac{1}{2} \right) \left( \frac{1}{N} (V_T + (1 - \beta) V_I) + \beta \frac{x_{iA}}{X_A} V_I \right) - x_{iA} = \\
& \frac{X_A}{X_A + X_B} \alpha \frac{1}{N} (V_T + (1 - \beta) V_I) + \frac{x_{iA}}{X_A + X_B} \alpha \beta V_I + \\
& + (1 - \alpha) \frac{1}{2} \frac{1}{N} (V_T + (1 - \beta) V_I) + (1 - \alpha) \frac{1}{2} \beta \frac{x_{iA}}{X_A} V_I - x_{iA}
\end{aligned}
\tag{A2}
$$

Differentiating (A2) with respect to $x_{iA}$, we receive the following FOC:

$$\frac{X_B}{(X_A + X_B)^2} \alpha \frac{1}{N} (V_T + (1 - \beta) V_I) + \frac{X_A + X_B - x_{iA}}{(X_A + X_B)^2} \alpha \beta V_I + (1 - \alpha) \frac{1}{2} \beta \frac{X_A - x_{iA}}{(X_A)^2} V_I = 1. \tag{A3}$$

Solving for the symmetric Nash equilibrium, we receive:

$$x_{iA}^* = x_{jB}^* = \frac{\alpha(V_T + V_I) + \beta(2N - 2)V_I}{4N^2}. \tag{A4}$$

If the expected payoff is given by (6), then the maximization problem is the following:

$$\pi_{iA} = \left( \alpha \frac{X_A}{X_A + X_B} + (1 - \alpha) \frac{1}{2} \right) (V_T + V_I) - X_A. \tag{A5}$$

Further expanding the expression, we get:

$$\pi_{iA} = \alpha \frac{X_A}{X_A + X_B} (V_T + V_I) + (1 - \alpha) \frac{1}{2} (V_T + V_I) - X_A. \tag{A6}$$

Differentiating (A6) with respect to $x_{iA}$, we receive the following FOC:

$$\frac{X_B}{(X_A + X_B)^2} \alpha (V_T + V_I) = 1. \tag{A7}$$

Solving for the symmetric Nash equilibrium, we receive:

$$x_{iA}^* = x_{jB}^* = \frac{\alpha(V_T + V_I)}{4N}. \tag{A8}$$

**Appendix B (Not for Publication) – Experimental Instructions**

**General Instructions**

Welcome! You are participating in a decision-making study. The study will proceed in two parts. Each part requires you to make a series of choices which will determine your total compensation for the study.

Your decisions as well as the decisions of other participants will remain anonymous. The decision problems are <u>not</u> designed to test you; there is no right or wrong answer. I am simply interested in the choices you make. You will be paid privately in cash at the end of the study. The points you earn in the study will be converted to U.S. Dollars at a rate of **20** to **1**. The amount you earn will depend on your decisions, so please follow the instructions carefully.

Please turn off your cell phone, laptop computer, or any other device you may have brought with you. To maintain anonymity, please do not communicate, unless directed otherwise, with any other participants until the study is completely over. If at any point you have a question, or need assistance of any kind, please raise your hand and I will come to your desk. Thank you for your cooperation.

**Instructions for Part 1**

Part 1 of the study consists of several decision-making periods. At the beginning of the first period, you will be randomly and anonymously placed into a team of 3 people. You will remain in the same team for all periods in Part 1 of the study.

At the beginning of the first period, your **team** will be randomly paired with another **team** to **<u>share</u>** bonuses. Your team will be paired with the **<u>same</u>** team for all periods in Part 1 of the study.

**TEAM NAME**

After you are assigned to a team, you will be asked to communicate with your team members via a chat window to decide on a team name. However, to maintain anonymity, it is very important that you do not reveal your name, seat number or anything that might disclose your identity to your teammates.

**YOUR DECISION**

Assume you are an employee of **ABC** Company. Your compensation package consists of the following:
(1) a base salary (your participation fee today),
(2) any endowed points you keep (unallocated points), and
(3) two bonuses to be awarded at the end of each period: Group Bonus and Individual Bonus.

In each period your company will award two bonuses:

**Group** Bonus = **180** points;
**Individual** Bonus = **180** points.

In each period you will be given an endowment of **60** points and asked to decide how much to contribute. You may contribute any **whole** number of points between **0** and **60**, <u>inclusively</u>. Any leftover or unallocated points are yours to keep (60 – Points Contributed).

<u>For each **one** point you contribute, you will generate **one** unit of individual output</u>. A team's total output is the sum of all members' individual outputs within the team.

A hypothetical example is:

|  |  | **Individual Output**<br>= Points Contributed | **Team Output**<br>(Sum of Individual Outputs) |
|---|---|---|---|
| Team 1 | Member 1 | 60 |  |
|  | Member 2 | 30 | Team 1 Output |
|  | Member 3 | 10 | = 60+ 30 + 10 = 100 |
| Team 2 | Member 1 | 50 |  |
|  | Member 2 | 35 | Team 2 Output |
|  | Member 3 | 20 | = 50 + 35 + 20 = 105 |

The Individual Bonus and Group Bonus will be awarded as described below.

**COMMUNICATION**

Each period, before you decide how many points to contribute, you will have the opportunity to chat electronically with the members of your OWN team via an anonymous chat window. You will have <u>90 seconds</u> to chat with each other at the beginning of Period **1** and **2**, and <u>40 seconds</u> in the following periods.

Again, to remain anonymity, it is very important that you do not make threats or reveal your name, seat number or anything that might disclose your identity. While the content of your discussion has no direct binding impact on the output or bonuses, you can use the chat window to discuss strategy with your teammates.

<u>(NONE Condition)</u> **YOUR EARNINGS**

After all participants have made their decisions, your earnings for the period are calculated as follows:

(1) Your period earnings are the sum of the earnings from the endowed points you keep AND any bonuses you receive from the company.

(2) You may keep or contribute all or some of your 60 points endowment.
    The points you <u>contribute</u> will generate individual and team outputs.

(3) <u>No matter what each team's total output is</u>, **each** TEAM will receive 90 points for **Group Bonus** AND 90 points for **Individual Bonus**.

    For example, if the outputs of both teams are as in the table below, both TEAMS will receive the same amount for Group and Individual Bonus.

|  | Team Output | **Individual** & **Group** bonuses Received |
|---|---|---|
| Team 1 | 160 | 50% = 90 points |
| Team 2 | 40 | 50% = 90 points |
| Total | 200 | 100% |

(4) Every TEAM MEMBER within each team will <u>equally</u> share the **Group** AND **Individual** bonuses.

**PAYMENT**

At the end of the study ONE period will be <u>randomly</u> chosen from Part 1 of the study for cash payment. Each period has an <u>equal</u> chance of being chosen. Hence each period is independent and you should make your decisions carefully in <u>every</u> period. The earnings for the period chosen will be converted to a U.S. dollar payment at the end of the study.

**Are there any questions?**

After all participants have made their decisions, your earnings for the period are calculated as follows:

(1) Your period earnings are the sum of the earnings from the endowed points you keep AND any bonuses you receive from the company.

(2) You may keep or contribute all or some of your 60 points endowment.
The points you contribute will generate individual and team outputs which may help your team earn Group and/or Individual bonuses as described below.

(3) Only one TEAM will receive the **Group** AND **Individual** Bonuses. The Group and Individual Bonuses will be awarded to your TEAM based on your team's output relative to the two teams' total output. For example, if your TEAM contributes 70% of the two teams' total output, your TEAM's likelihood of winning the **Group** AND **Individual** Bonuses is 70%.

That is, the greater your **TEAM** output, the more likely your **TEAM** will receive **both bonuses.**

For example, if the outputs of both teams are as in the table below, Team 1 has a 80% (=160/200) chance of winning the Group and Individual Bonus.

|  | Team Output | Chance (Probability) of Winning **Individual** & **Group** Bonuses |
|---|---|---|
| Team 1 | 160 | 160/200 = 80% |
| Team 2 | 40 | 40/200 = 20% |
| Total | 200 | 100% |

(4) If awarded, every team member within the winning team will equally share the **Group** AND **Individual** Bonuses.

## PAYMENT

At the end of the study ONE period will be randomly chosen from Part 1 of the study for cash payment. Each period has an equal chance of being chosen. Hence each period is independent and you should make your decisions carefully in every period. The earnings for the period chosen will be converted to a U.S. dollar payment at the end of the study.

**Are there any questions?**

**Instructions for Part 2**

The Part 2 of the study also consists of several decision-making periods.

**PLEASE NOTE**:

All teams formed in Part 1 of the study are **NOW DISBANDED**.

You will be randomly and anonymously placed into a **NEW** team of 3 people. Your new teammates will **NOT** be any of the same people you were previously paired with. You will remain in the same (new) team for all periods in Part 2 of the study.

At the beginning of the first period, your **team** will be randomly paired with another **team** to **share** bonuses. Your team will be paired with the **same** team for all periods in Part 2 of the study.

**NEW TEAM NAME**

After you are assigned to a NEW team, you will be asked to communicate with your **NEW** team members via a chat window to decide on a **NEW** team name. Again, to maintain anonymity, it is very important that you do not reveal your name, seat number or anything that might disclose your identity to your teammates.

**YOUR DECISION (Same as in Part 1)**

Suppose you have changed companies and your new employer is **XYZ** Company. You will make the same decision as in Part 1.

In each period your **new** company will also award two bonuses:
**Group** Bonus = **180** points;          **Individual** Bonus = **180** points.

However, the method for determining who gets what is **DIFFERENT**.

After all participants have made their decisions, your earnings for the period are calculated as follows:

(1) Your period earnings are the sum of the earnings from the endowed points you keep AND any bonuses you receive from the company.

(2) You may keep or contribute all or some of your 60 points endowment.
The points you contribute will generate individual and team outputs which may help your team earn Group and/or Individual bonuses as described below.

(3) No matter what each team's total output is, **each** TEAM will receive 90 points for **Group Bonus** AND 90 points for **Individual Bonus**.

For example, if the outputs of both teams are as in the table below, both teams will receive the same amount for Group and Individual Bonus.

| | Team Output | **Individual** & **Group** bonuses Received |
|---|---|---|
| Team 1 | 160 | 50% = 90 points |
| Team 2 | 40 | 50% = 90 points |
| Total | 200 | 100% |

**Same as Part 1** (margin annotation)

(4) Every TEAM MEMBER within each team will equally share the **Group Bonus**, i.e. 30 points per team member.

(5) However, only **one** member within each team will receive the **Individual Bonus**. The Individual Bonus will be awarded to you based on your individual output relative to the total output within your team. For example, if you contribute 70% of your team's total output, your likelihood of winning the **Individual Bonus** is 70%.

That is, the greater your **individual** output, the more likely you will receive the **Individual** bonus.

**Different from Part 1** (margin annotation)

For example, if the outputs of all members within a team are as in the table below, Member 2 has a 30% (=30/100) chance of winning the Individual Bonus.

| Team 1 or 2 | Individual Output | Chance (Probability) of Winning **Individual** Bonus |
|---|---|---|
| Member 1 | 60 | 60/100 = 60% |
| Member 2 | 30 | 30/100 = 30% |
| Member 3 | 10 | 10/100 = 10% |
| Total | 100 | 100% |

After all participants have made their decisions, your earnings for the period are calculated as follows:

**Same as Part 1**

(1) Your period earnings are the sum of the earnings from the endowed points you keep AND any bonuses you receive from the company.

(2) You may keep or contribute all or some of your 60 points endowment.
The points you <u>contribute</u> will generate individual and team outputs which may help your team earn Group and/or Individual bonuses as described below.

**Different from Part 1**

(3) Only **<u>one</u> TEAM** will receive the **Group** AND **Individual** Bonuses. The Group and Individual Bonuses will be awarded to your **TEAM** based on your team's output relative to the two teams' total output. For example, if your TEAM contributes 70% of the two teams' total output, your **TEAM**'s likelihood of winning **<u>both</u>** bonuses (**Group** AND **Individual** Bonuses) is 70%.

That is, the greater the output your **TEAM** contributes, the more likely your **TEAM** will receive **both** bonuses.

For example, if the outputs of both teams are as in the table below, Team 1 has a 80% (=160/200) chance of winning the Group and Individual Bonus.

|  | Team Output | Chance (Probability) of Winning **Individual** & **Group** Bonuses |
|---|---|---|
| Team 1 | 160 | 160/200 = 80% |
| Team 2 | 40 | 40/200 = 20% |
| Total | 200 | 100% |

(4) If awarded, every <u>team member</u> within the <u>winning</u> team will equally share the **Group Bonus**.

(5) However, if awarded the **Individual Bonus**, only **<u>one</u>** member within the <u>winning</u> team will receive the Individual Bonus. The Individual Bonus will be awarded to you based on your individual output relative to the total output within your team. For example, if you contribute 70% of your team's total output, your likelihood of winning the **Individual Bonus** is 70%.

That is, the greater your **individual** output, the more likely you will receive the **Individual** bonus.

For example, if the outputs of all members within a team are as in the table below, Member 2 has a 30% (=30/100) chance of winning the Individual Bonus.

| Team 1 or 2 | Individual Output | Chance (Probability) of Winning **Individual** Bonus |
|---|---|---|
| Member 1 | 60 | 60/100 = 60% |
| Member 2 | 30 | 30/100 = 30% |
| Member 3 | 10 | 10/100 = 10% |
| Total | 100 | 100% |

**PAYMENT**

At the end of the study ONE period will also be <u>randomly</u> chosen from Part 2 of the study for cash payment. Each period has an <u>equal</u> chance of being chosen. Hence each period is independent and you should make your decisions carefully in <u>every</u> period. The earnings for the period chosen will be converted to a U.S. dollar payment at the end of the study.

**Are there any questions?**

**Manipulation Check** (Part 1: ABC company; Part 2: XYZ company)

**Part 1:** Please answer the following questions (choose only **ONE** option for each question):

1. At the end of each period in the study, the ABC (XYZ) company will award its employees:

   A. Group Bonus
   B. Individual Bonus
   C. Group and Individual bonuses

2. The ABC (XYZ) company will award the Group and Individual bonuses to a **TEAM** based on:

   A. a team's output relative to the two teams' total output. That is, the greater of a team's output is, the more likely the **team** will receive the Group Bonus.
   B. Each **team** equally shares the Group and Individual bonuses.

3. When a team receives the **Group** Bonus:

   A. The team <u>member</u> with greater output will be more likely to receive the Group Bonus.
   B. Every <u>member</u> within the team equally shares the Group Bonus.

4. When a team receives the **Individual** Bonus:

   A. The team <u>member</u> with greater output will be more likely to receive the Individual Bonus.
   B. Every <u>member</u> within the team equally shares the Individual Bonus.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

Please do NOT turn to the next page BEFORE you answer the questions above.

The correct answers to the questions on previous page are (the given answers depend on the condition the participant is assigned to):

| Question | NONE | WITHIN | BETWEEN | BOTH |
|----------|------|--------|---------|------|
| 1 | C | C | C | C |
| 2 | B | B | A | A |
| 3 | B | B | B | B |
| 4 | B | A | B | A |

**Please check your answers and re-evaluate any <u>wrong</u> answers.**

**Appendix C (Not for Publication) – Additional Analysis**


**Table 4C: Average effort difference between conditions (only Part 1 of the experiment).**

| Conditions | | | Independent observations | Average difference | Wilcoxon rank-sum | p-value |
|---|---|---|---|---|---|---|
| BOTH + BETWEEN | vs. | WITHIN + NONE | 24 | 28.02 | 3.98 | < 0.01 |
| BOTH + WITHIN | vs. | BETWEEN + NONE | 24 | 7.93 | 1.15 | = 0.24 |
| BOTH | vs. | NONE | 12 | 35.96 | 2.88 | < 0.01 |
| BOTH | vs. | WITHIN | 12 | 27.50 | 2.88 | < 0.01 |
| BOTH | vs. | BETWEEN | 12 | 7.42 | 0.80 | = 0.42 |
| BETWEEN | vs. | WITHIN | 12 | 20.08 | 2.56 | < 0.01 |
| BETWEEN | vs. | NONE | 12 | 28.53 | 2.72 | < 0.01 |
| WITHIN | vs. | NONE | 12 | 8.45 | 3.69 | = 0.03 |


**Table 6C: Time series cross-sectional regression analysis (only Part 1 of the experiment).**

| Independent variables | Condition | | | | |
|---|---|---|---|---|---|
| | NONE | WITHIN | BETWEEN | BOTH | All conditions |
| Period | -0.58* | 0.39 | -1.11*** | -0.23 | -0. 38** |
| | (0.33) | (0.55) | (0.74) | (0.77) | (0.31) |
| Constant | 17.01*** | 20.05*** | 48.45*** | 51.03*** | 15.90*** |
| | (3.39) | (2.91) | (2.49) | (3.62) | (3.18) |
| WITHIN | | | | | 8.45** |
| | | | | | (3.80) |
| BETWEEN | | | | | 28.53*** |
| | | | | | (5.43) |
| BOTH | | | | | 35.96*** |
| | | | | | (3.05) |

Note: * p-value < 0.10, ** p-value < 0.05, *** p-value < 0.01
Robust standard errors are in parenthesis.