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15 May 2013

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May 15, 2013

Abstract

We experimentally investigate the effect of social identification and information feedback on individual behavior in contests. In all treatments we find significant over-expenditure of effort relative to the standard theoretical predictions. Identifying subjects through photo display decreases wasteful effort. Providing information feedback about others' effort does not affect the aggregate effort, but it decreases the heterogeneity of effort and significantly affects the dynamics of individual behavior. We develop a behavioral model which incorporates a non-monetary utility of winning and relative payoff maximization. The model explains significant over-expenditure of effort. It also suggests that decrease in 'social distance' between group members through photo display promotes pro-social behavior and decreases over-expenditure of effort, while improved information feedback decreases the heterogeneity of effort.

JEL Classifications: C72, C91, D72, D74,
Keywords: contest, information, identification, over-expenditure, experiments

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* For helpful discussions and comments, we thank Jim Andreoni, Subhasish Chowdhury, Cary Deck, Joan Esteban, Uri Gneezy, Ernan Haruvy, Erik Kimbrough, Kai Konrad, Sherry Li, John Morgan, Brian Roberson, Sally Sadoff, Karim Sadrieh, Tim Salmon, Tim Shields, as well as seminar participants at the University of Texas at Dallas, the University of California at San Diego, participants at the Western Economics Association International Conference, the Alliances and Alliance Formation in Conflict Workshop, and the Bay Area Behavioral and Experimental Economics Workshop. We thank University of Richmond for generous funding of this project and Kory Garner for help in conducting experiments. The usual disclaimers apply.

1. Introduction

Individuals participating in contests and tournaments encounter disparate information feedback settings. Fellow contestants may be known or unknown, and their effort level may be observable or unobservable. In some contests, such as competition for a new job or admission to a university, fellow contestants are typically unknown and their effort level is unobservable. In other contests, such as promotions in the workplace and political races, fellow contestants are often known and their effort level is observable. In patent races, opponents are usually known but their effort is unobservable. Such design details can have strong bearing on individual and group behavior, yet existing theory provides little guidance on their effect on decision-making.

Since the early attempts of Bull et al. (1987) and Millner and Pratt (1989), experimental literature on contests has been rapidly expanding, encompassing facets such as player asymmetry, entry costs, risk preferences, and contest structure; for a comprehensive review see Dechenaux et al. (2012). However, most existent laboratory studies focus on the actions of agents where identity of opponents is unknown and where there is *ex post* complete information feedback about opponents' efforts. We argue that knowing the opponents' identities and effort levels are important design features that can influence individual behavior in practice (Smither et al., 2005). For instance, workplace managers may choose to explicitly identify the workers being considered for a promotion and make known their effort level, or they may choose to keep the identity of the workers being considered unknown (Harbring et al., 2007; Gürtler and Harbring, 2010).

We use a controlled laboratory experiment to investigate the effect of social identification and information feedback on individual and group behavior in a lottery contest, where individuals exert effort in order to win a prize. We consider a contest structure where higher effort leads to more socially wasteful outcomes (i.e., rent-seeking and lobbying). Using this structure, we compare an information setting where all group members are completely anonymous to one where the identity of each group member is fully revealed to others using the member's photo and first name. We also compare information conditions in which members do not learn about other group members' effort to one where they receive full information feedback about each group member's effort.

In all treatments, we find significant over-expenditure of effort relative to the standard theoretical predictions. Identifying subjects through photo display decreases wasteful effort by 17%. Providing information feedback about others' effort does not affect the aggregate effort, but it decreases the heterogeneity of effort and significantly affects the dynamics of individual behavior. We develop a behavioral model that incorporates a non-monetary utility of winning and relative payoff maximization. The model explains significant over-expenditure of effort. It also suggests that decrease in 'social distance' between group members through photo display promotes pro-social behavior and decreases over-expenditure of effort, while improved information feedback decreases the heterogeneity of effort.

The rest of the paper is organized as follows: Section 2 presents the theoretical model that we will use as a benchmark for our results. Section 3 details the experimental design and procedures. Section 4 reports the results of the experiment. Section 5 develops a behavioral model to explain the main findings of the experiment. Finally, in Section 6 we discuss the application of our findings and our contribution to the existing literature, as well as suggest directions for future research.

2. Theoretical Model

The standard rent-seeking (lottery) contest assumes that n identical risk-neutral individuals compete for a prize v by exerting efforts. The probability that an individual i wins the prize is equal to individual i's own effort e_i divided by the sum of all individuals' efforts:

$$p_i(e_i, e_{-i}) = \frac{e_i}{\sum_{j=1}^{n} e_j}. \tag{1}$$

The individual's probability of winning increases monotonically in own effort and decreases in the opponents' efforts. The expected payoff for risk-neutral individual i is given by

$$E(e_i, e_{-i}) = p_i(e_i, e_{-i})v - e_i. \tag{2}$$

That is, the probability of winning the prize $p_i(e_i, e_{-i})$ times the prize value v minus the cost of effort e_i. Differentiating (2) with respect to e_i and accounting for the symmetric Nash equilibrium leads to a classical solution (Tullock, 1980):

$$e = \frac{(n-1)}{n^2}v. \tag{3}$$

The equilibrium expected payoff can be calculated by plugging (3) into (2), which gives

$$E(e) = \frac{1}{n^2}v. \tag{4}$$

These predictions serve as a benchmark for our experiment.

3. Experimental Design and Procedures

The experiment was conducted at the Vernon Smith Experimental Economics Laboratory at Purdue University. A total of 240 undergraduate student subjects participated in 12 sessions (3 sessions per treatment), with 20 subjects participating in each session. All subjects participated in only one session of this study. Some subjects had participated in other economics experiments that were unrelated to this research.

The computerized experimental sessions used z-Tree (Fischbacher, 2007) to record subject decisions and display photos of subjects. Upon arriving at the lab, each subject was photographed and then randomly assigned to a computer station. The experiment comprised of playing a lottery contest game for a total of 20 periods with a group of 4 participants. Each subject was randomly assigned to a group of 4 at the beginning of the experiment, and remained matched with the same group members for the duration of the experiment. At the beginning of each period, each subject received an endowment of 80 experimental francs and was asked to make an effort (choose a bid) in a lottery contest with a prize valued at 80 experimental francs. Each subject's probability of winning the prize was equal to his/her effort divided by the aggregate effort of all 4 participants in the group.

We conducted four treatments, as in Table 1, using a two-by-two design in which we varied the information feedback ("no information" NI versus "information" I) and the identification of group members ("no photo" NP versus "photo" P). The only difference between the information treatments was the feedback provided to subjects at the end of each period. In the treatments with no information feedback (NP-NI and P-NI), we provided feedback only about the individual's own effort, earnings, and whether she won or not, but did not provide information about the efforts of other group members or the identity of the winner of the contest. In the treatments with information feedback (NP-I and P-I), we assigned each member an ID number (1-4), provided full information about each group member's effort and explicitly revealed (using the ID number) which subject's effort resulted in winning the contest at the end of each period. We varied the degree of social identification by varying whether or not the identities of participants were revealed to fellow group members. In treatments where no identities were revealed (NP-I and NP-NI), we did not provide any identifying information about other members in the group. On the other hand, in treatments P-NI and P-I, we provided photos and first names of each group member.[1]

At the end of the experiment, 2 out of 20 periods were selected for payment using a random draw from a bingo cage. Experimental francs were used throughout the experiment, with a conversion rate of 15 francs = \$1. The experimental earnings, including the \$5 participation fee, averaged \$18.75, and ranged from a low of \$8.25 to a high of \$30.00.[2] Sessions (including instruction time) lasted approximately 60-80 minutes. At the end of each session, subjects also completed a single-period game aimed at eliciting their non-monetary utility of winning, and a demographic questionnaire.

4. Results

4.1. Overview

Table 2 summarizes the average efforts and payoffs for all four treatments. In equilibrium, all subjects should exert an effort of 15 and receive a payoff of 5.[3] However, on average the observed effort in all treatments is significantly greater than predicted (Wilcoxon signed-rank test, all p-values<0.05, n=15), and as a result, the average payoffs are negative.[4] The persistence of over-expenditure is also shown in Figure 1, which displays the average effort over all 20 periods of the experiment. Although there is a declining trend, the average effort remains significantly higher than the Nash equilibrium prediction. Such significant over-expenditure of

[1] Before the beginning of the experiment, subjects in the P-NI and P-I treatments were asked to write their first names on a name card, and the experimenter took a photo of each subject holding up the name card. Similar to the design of Andreoni and Petrie (2004), we chose to use digital photos to identify subjects to one another because digital photos capture and preserve the appearance of the person but do not allow for communication, which may confound the effects of identification alone.

[2] Photographing participants in the photo identification treatments took more time, so an additional \$5 "surprise show up fee" was added at the end of the experiment in order to comply with the laboratory policies.

[3] According to equation (3), individual effort is e=80(4-1)/16=15, and according to equation (4), expected payoff is $E(e)$=80/16=5.

[4] The non-parametric tests employ each group of four subjects as an independent observation.

effort is consistent with previous findings of contest experiments (Dechenaux et al., 2012; Sheremeta, 2013).[5]

Result 1: In all treatments there is significant over-expenditure of effort relative to the Nash equilibrium prediction.

We also find significant heterogeneity in individual behavior, which is inconsistent with play at a unique pure strategy Nash equilibrium of 15. Figure 2 displays the distribution of the average bid by subject in each treatment. Subjects are sorted in increasing order by the average bid, which is indicated by the solid line. The error bars represent the standard deviations of bids for each subject over all 20 periods. Hence, by focusing on the solid line one can decipher the cumulative empirical distribution of the average bid across subjects (signifying the between-subjects heterogeneity), and by focusing on the error bars one can get a sense of the degree of within-subject heterogeneity. Figure 2 clearly shows that there is a very high degree of both between-subjects and within-subject heterogeneity, which is also consistent with previous findings of contest experiments (Dechenaux et al., 2012; Sheremeta, 2013).

4.2. Social Identification

Examining the impact of social identification, we find that in the treatments in which subjects' photos are revealed (P-NI and P-I), the average effort is 17% lower than when there is no photo identification (NP-NI and NP-I). Combining data from both photo treatments and comparing it to data from no-photo treatments, we find that photo display (or social

[5] Some studies that document significant overbidding in contests are done by Davis and Reilly (1998), Potters et al. (1998), Sheremeta (2010a, 2010b, 2011), Sheremeta and Zhang (2010), Price and Sheremeta (2011), Cason et al. (2012), Chowdhury et al. (2012), Mago et al. (2013), and Savikhin and Sheremeta (2013).

identification) significantly reduces the average effort (28.7 versus 24.6: Mann-Whitney test, p-value=0.06; n=m=30).[6]

Result 2: Identifying group members through photo display decreases average effort.

We also consider how the role of identification differs in early rounds as compared to later rounds (see Figure 1). We find that efforts averaged across the first 5 periods are significantly lower in treatments with identification than without identification (27.3 versus 31.4, Mann-Whitney test, p-value=0.05; n=m=30). However, in later periods 16-20, efforts are not significantly different between treatments with identification and without identification (23.4 versus 25.3, Mann-Whitney test, p-value=0.66; n=m=30). Therefore, while aggregate efforts decline in all four treatments, the rate of decline in the photo identification treatments is lower compared to treatments without identification. The impact of identification on individual behavior in contests is immediate and becomes evident in the early periods of the experiment.

4.3. Information Feedback

Examining the impact of information feedback, we find no significant difference in the average effort levels between treatments where there is information feedback and where there is no information feedback. Combining the data from both information treatments and comparing it to the data from the no-information treatments, we find no significant impact of information on effort (26.7 versus 27.1: Mann-Whitney test, p-value=0.63; n=m=30).[7]

[6] The average effort of 25.1 in P-NI is lower than the average effort of 29.1 in NP-NI, and the average effort of 24.1 in P-I is lower than the average effort of 28.3 in NP-I. However, these pair-wise treatment comparisons are not significant at the conventional level (Mann-Whitney test, p-values=0.14 and 0.24; n=m=15).

[7] The average effort of 29.1 in NP-NI is not significantly different from the average effort of 28.3 in NP-I and that the average effort of 25.1 in P-NI is not significantly different from the average effort of 24.1 (Mann-Whitney test, p-values=0.98 and 0.55; n=m=15).

Although information feedback has no impact on the average effort level, it appears to impact the heterogeneity of effort (see Figure 2). Table 3 provides two different measures of heterogeneity of effort. The *between-subjects* heterogeneity measure in period t is calculated as the absolute difference between individual effort and average group effort in period t. The *within-subject* heterogeneity measure in period t is calculated as the absolute difference between individual effort in period t and period t-1. The average *between-subjects* heterogeneity measure in the information treatments (NP-I and P-I) is significantly lower than in the no information treatments (NP-NI and P-NI), when comparing all periods (16.0 versus 13.4; Mann-Whitney test, p-value=0.03; n=m=30), as well as the first five periods (15.3 versus 12.8; Mann-Whitney test, p-value=0.05; n=m=30). However, there is no significant difference in the average *within-subject* heterogeneity measure (all p-values>0.5). Therefore, it appears that information feedback does not impact the within-subject heterogeneity, but it does make effort levels more uniform across subjects.

Next, we examine the mechanism through which information influences individual behavior. Table 4 displays a panel regression that measures the impact of different lag variables in period t-1 on *effort* in period t. When subjects receive no feedback information about others' efforts (specification 1), we find that the major predictor of individual effort is the *effort-lag* variable, i.e., their own effort in period t-1.[8] The *effort-lag* variable remains a significant predictor of effort even when subjects receive full feedback about others' efforts (specification 2). In addition, *above-lag* and *below-lag* variables are significant in specification (2). The negative and significant *above-lag* variable indicates that subjects whose effort is higher than the

[8] Note that in treatments NP-NI and P-NI, subjects actually do not learn whether their effort in t-1 was above or below the winning effort. However, the *above-lag* and *below-lag* variables in specification (1) are included to facilitate the comparison with specification (2). The estimation results of specification (1) are virtually the same when we exclude these two variables from the estimation of specification (1).

winning effort in period *t*-1 reduce their effort in period *t*; and the positive and significant *below-lag* variable indicates that subjects whose effort is lower than the winning effort in period *t*-1 increase their effort in period *t*.

Result 3: Providing information about others' efforts does not have a significant effect on the average effort level, but it decreases the within-subject heterogeneity of effort and significantly affects the dynamics of individual effort.

The dynamics of individual effort can explain several patterns in our data. First, it can explain why we find no significant impact of information on average effort – there are two opposing effects acting simultaneously (i.e., *above-lag* and *below-lag*) that on average counterbalance each other. Second, the negative *above-lag* and positive *below-lag* variables imply that over time efforts within the group should become more uniform, explaining why information significantly reduces *between-subjects* heterogeneity. Finally, the significant lag variables imply substantial *within-subject* heterogeneity of efforts, which persist over all periods of the experiment. In sum, the results of our experiment clearly indicate that providing information feedback in contests changes the dynamics of individual effort, although it does not change the aggregate effort.

5. Behavioral Model

To explain the main findings of our experiment, we develop a behavioral model. To explain over-expenditure of effort relative to the Nash equilibrium prediction (Result 1), we assume that in addition to the value of the prize v, individuals also have a non-monetary "utility of winning" w. Therefore, instead of (2), the updated expected payoff $E^w(e_i, e_{-i})$ of individual i is given by

$$E^{w}(e_i, e_{-i}) = p_i(e_i, e_{-i})(v + w) - e_i. \quad (5)$$

The non-monetary utility of winning w is not directly observable, but it can be elicited (Sheremeta, 2010a, 2010b; Price and Sheremeta, 2011, 2012). In a 'surprise' additional period at the end of the experiment, all subjects were given an endowment of 80 francs, and participated in a lottery contest for a prize valued at $v = 0$ francs. Subjects were explicitly told that their effort is costly and that the cost of effort would be subtracted from their earnings. We find that 51% of subjects indicate a non-monetary utility of winning by exerting positive efforts for the prize valued at 0 francs, with about 25% of subjects choosing efforts higher than 10 francs (equivalent to $0.67).

To analyze the extent to which non-monetary utility of winning affects subjects' efforts, we provide panel regression analysis in Table 5, where the dependent variable is the subject's *effort* and the independent variables are a *period* trend, treatment dummy-variables, and their *non-monetary* effort. The standard errors are clustered at the group level. Specification (1) indicates a significant and positive correlation between *effort* and the *non-monetary* variable.[9] This finding suggests that winning is a component in a subject's utility, and that non-monetary utility of winning may partially explain over-expenditure of effort in contests. Moreover, our data indicate that the non-monetary utility of winning is not impacted by either information about others' efforts or by identification of group members.[10] This suggests that the differences in

[9] One may argue that the non-monetary utility of winning coefficient is capturing confusion instead of a non-monetary utility of winning. We control for confusion by using the *quiz* variable that measures the number of correct answers on the quiz, which was administered right after the instructions. Consistent with the intuition, we find that subjects who understand the instructions exert lower efforts, but this result is only marginally significant for the P-I treatment. Despite controlling for confusion, the *non-monetary* coefficient is positive and significant.

[10] The non-monetary utility of winning is not significantly different across treatments. Efforts for the prize of zero are slightly higher in the no-photo treatments NP-NI and NP-I than in the photo treatments P-NI and P-I (the average of 9.2 versus 7.0), but the difference is not significant (Mann-Whitney test, p-value=0.27; n=m=120). Moreover, all pair-wise treatment comparisons show no significant difference across treatments (Mann-Whitney test, all p-values>0.15; n=m=60).

behavior observed in treatments with and without social identification are not due to changes in the non-monetary utility of winning w.

To explain how social identification (Result 2) and information feedback (Result 3) impact individual behavior, we assume that individuals care about payoffs of others in their group. Specifically, following the convention established in evolutionary game theory (Leininger, 2003; Hehenkamp et al., 2004; Riechmann, 2007), we assume that individuals care about "relative payoff maximization" instead of "absolute payoff maximization".[11] Therefore, instead of (5), individual i cares about the weighted average payoff of all group members, i.e., $E^w(e_i, e_{-i}) + s\frac{1}{n}\sum_j E^w(e_j, e_{-j})$, where s is the interdependent social payoff parameter.[12] $s > 0$ reflects preferences of pro-social individuals who strive to increase the payoff of the entire group, while $s < 0$ reflects preferences of status-seeking individuals who strive to obtain a higher relative payoff within the group.

Accounting for the behavioral factors captured by w and s, the expected payoff for a risk-neutral player i is given by

$$U_i(e_i, e_{-i}) = E^w(e_i, e_{-i}) + s\frac{1}{n}\sum_j E^w(e_j, e_{-j}). \qquad (6)$$

Differentiating (6) with respect to e_i and accounting for the symmetric Nash equilibrium gives us the equilibrium effort:

$$e = \frac{(n-1)}{n(n+s)}(v + w). \qquad (7)$$

[11] Vriend (2000) and Reichmann (2006) also show that learning by imitation of successful others is also equivalent to maximizing relative payoffs.

[12] Evolutionary game theory often assumes that players care about the absolute difference in payoffs, i.e., their "survival" payoff. Here, we assume that players care about absolute and weighted payoffs. This is a more common assumption in the social preference literature (Fehr and Schmidt, 1999).

The equilibrium effort (7) increases in the non-monetary utility of winning w, i.e., $\frac{\partial e}{\partial w} > 0$, and decrease in the social payoff parameter s, i.e., $\frac{\partial e}{\partial s} < 0$.

The interdependent social payoff parameter s represents a measure of how individuals weight their payoffs relative to others. In other words, this measure reflects the degree of 'social distance' between group members.[13] Although s is not directly observable, it can be calculated once a non-monetary utility of winning w is known. To do this, we first derive from equation (7) the effort e_0 that symmetric contestants, having a non-monetary utility of winning w, should exert in a contest with the prize of zero (i.e., $v = 0$):

$$e_0 = \frac{(n-1)}{n(n+s)} w. \tag{8}$$

Next from equations (7) and (8) we can derive the value of s:

$$s = \frac{(n-1)}{n(e-e_0)} v - n. \tag{9}$$

Using the observed average effort e for the prize of 80 francs and the effort e_0 for the prize of 0 francs, we estimate the value of s for each subject. Upon calculating individual-specific s for each subject, we find that 67% of subjects behave as status-seekers (i.e., $s < 0$) and only 33% of subjects are pro-social (i.e., $s > 0$). Therefore, the majority of subjects behave as if they are relative payoff maximizers (or status-seekers), i.e., they maximize the difference between their own payoff and weighted payoffs of other group members; and their relative payoff maximization exercise provides an equilibrium explanation for the observed over-expenditure (Leininger, 2003; Hehenkamp et al., 2004).[14] Next, we discuss how social

[13] Hoffman et al. (1996, pg. 654) define social distance to be the "degree of reciprocity that subjects believe exist within a social interaction."

[14] This quest to seek higher expected payoff than others is also consistent with the 'spite effect' contended by Hamilton (1970) or 'survival of the fittest' contended by Alchian (1950).

identification and information feedback may impact s, and consequently the individual behavior in contests.

Social Identification: A decrease in 'social distance' increases the value of the social payoff parameter s, and according to our behavioral model should decrease efforts in the contest.[15] Revealing individual identities is one way to reduce social distance between the individual and other members in the group and induce pro-social behavior (Andreoni and Petrie, 2004; Rege and Telle, 2004; Savikhin and Sheremeta, 2011).[16] Indeed, we find that the median value of the social payoff parameter s is higher in the photo treatments than in the no-photo treatments (-1.15 versus -1.48), suggesting that social identification through photo display decreases social distance between group members. Consistent with the prediction that decrease in social distance reduces over-expenditure of efforts, we find that the average effort of 24.6 in the photo treatments (P-NI and P-I) is lower than the average effort of 28.7 in the no-photo treatments (NP-NI and NP-I).

Information Feedback: Information about others' efforts can give rise to regret. The basic concept of regret, analyzed by Engelbrecht-Wiggans and Katok (2007, 2008) in the first price auction, is that the winner of the auction may regret paying too much relative to the second highest bid (winner regret) and the loser may regret missing a profitable trade opportunity by bidding too low (loser regret). Similar rationale holds true in contests, and regret theory predicts that bids (efforts) should decrease in winner regret (analogous to higher s) and increase in loser regret (analogous to lower s). Since regret effects effort in the opposite direction and the

[15] Hoffman et al. (1996, pg. 654) define social distance to be the "degree of reciprocity that subjects believe exist within a social interaction."
[16] Eckel and Petrie (2011) attribute this in part to the association of attractiveness and skin tone with expectations about a partner's behavior. Another potential explanation of why photo display enhances pro-social behavior is based on group social identity theory (Tajfel and Turner, 1979; Ahmed, 2007; Chen and Li, 2009). In addition to revealing identities, in related work Scharleman et al. (2001) find that "smiles" can elicit cooperation among strangers in a one-shot bargaining interaction.

equilibrium effort level depends on the relative weight of each type of regret, the precise effect of full information disclosure on social payoff parameter s cannot be predicted *a priori* (Engelbrecht-Wiggans and Katok, 2009). In our data, we find that the median value of the social payoff parameter s is similar across the two information treatments (-1.34 versus -1.25). However, as documented earlier (see Table 4), we find that both the *above-lag* (can be interpreted as the winner regret) and *below-lag* (can be interpreted as the loser regret) variables are significant. This helps explain why information feedback makes no difference to the average effort level, but reduces the between-subjects heterogeneity of effort.[17] In this regard, our results are consistent with the experimental test of regret theory by Engelbrecht-Wiggans and Katok (2008).[18]

In summary, our behavioral model that incorporates a non-monetary utility of winning and relative payoff maximization can explain our data. The former can explain the significant over-expenditure of effort (Result 1) and the latter can explain why social identification through photo display decreases the average effort (Result 2) and improved information feedback reduces the between-subjects heterogeneity of effort (Result 3).

6. Discussion and Conclusion

What happens to competitive behavior in contests when identities of other participants and information about their effort are revealed? Does such information increase or decrease individual effort? To answer these questions, we conduct a laboratory experiment in which we

[17] Full information feedback can also facilitate faster learning of the incentives inherent in the contest structure. When information about all individual efforts is public knowledge, subjects may learn about profitable strategies more quickly from the experience of others, and this also reduces the between-subjects heterogeneity of effort, as evident in our data.

[18] By manipulating information feedback, they find evidence of both winner regret and loser regret. However, they find that no difference in bid levels when there is complete information on both winner and loser regret compared to when there is no information about other participants' bid levels.

investigate the effect of social identification and information feedback on individual behavior in contests. In all treatments, we find significant over-expenditure of effort relative to standard theoretical predictions. Identifying subjects through photo display decreases wasteful effort. Providing information feedback about others' effort does not affect aggregate effort but it decreases the heterogeneity of effort and significantly affects the dynamics of individual behavior. We develop a behavioral model that incorporates non-monetary utility of winning and relative payoff maximization. The model explains significant over-expenditure of effort. The model also suggests that decrease in social distance between group members through photo display promotes pro-social behavior and decreases over-expenditure of effort, while improved information feedback reduces the between-subjects heterogeneity of effort.

We argue that knowing the opponents' identities and effort levels are important design features that can influence individual behavior in practice (Smither et al., 2005). Examples of practical applications include college admissions, workplace promotions, patent races, political lobbying and competition for monopolistic rents. Our results suggest that explicitly identifying contestants may decrease social distance between group members and decrease wasteful over-expenditure of effort. On the other hand, providing information feedback about others' efforts may not change the aggregate effort, although it may change the dynamics of individual behavior.

Our results contribute to several areas of research. First, our study contributes to the discussion of why there is over-expenditure of efforts in contests (Sheremeta, 2013). Over the past decade, a number of studies have offered various explanations such as mistakes (Potters et al., 1998; Sheremeta, 2011), judgmental biases and non-monotonic probability weighting (Amaldoss and Rapoport, 2009; Kalra and Shi, 2010). Our findings suggest that over-expenditure in contests can also be explained by a combination of a non-monetary utility of winning and relative payoff maximization. Moreover, we find that such over-expenditure can be reduced by identifying participants through photo display.

Second, our results contribute to the literature investigating how social identification may impact economic behavior in social dilemmas. Bohnet and Frey (1999a, 1999b) and Burnham (2003) find that visual identification increases cooperation in prisoner's dilemma and dictator games. Eckel and Wilson (2006) find that seeing one's partner impacts trust and trustworthiness. Andreoni and Petrie (2004) and Savikhin and Sheremeta (2011) find that revealing identities enhances pro-social behavior and increases contributions to the public goods game. We contribute to this literature by demonstrating that revealing identities of subjects in contests decreases wasteful over-expenditure of effort.

Our study also contributes to the literature investigating how feedback about relative performance impacts individual behavior, which has been an area of interest in many workplace settings (Smither et al., 2005).[19] Kuhnen and Tymula (2012), for example, find that after receiving feedback, subjects who rank higher in a tournament decrease their effort, while subjects who rank lower increase their effort. Similarly, Ludwig and Lünser (2012), document that in a two-stage tournament, contestants who lag behind tend to raise their effort in the second stage, while those who lead tend to reduce their effort. Ludwig and Lünser (2012) also find that on average there is no significant difference in total effort between the feedback and the no-feedback treatments. Together with these experiments, the results of our experiment indicate that

[19] There are several studies that investigate how information feedback impacts market performance. Isaac and Walker (1985), for example, find that in auctions, bidding levels decrease when bidders receive information feedback about all bids. Similarly, Dufwenberg and Gneezy (2002) find that reporting the entire distribution of prices facilitates collusion in a first-price auction.

providing information feedback does not affect aggregate effort in contests but it does change the dynamics of individual behavior.[20]

There are many avenues for future research. Given the strong impact of social recognition on individual behavior, it would be interesting to investigate other settings by varying the degree of social consciousness of players. One potential direction for future research is to investigate behavior when endowments are asymmetric. When endowments are asymmetric, the effect of displaying photos may be stronger as players with greater endowment may feel more conscious about exerting higher effort and thus imposing higher negative externality on their team members.

Finally, it is important to examine how individuals would self-select into alternative contests, knowing that their identities may be revealed. On the one hand, the results of our experiment indicate that in treatments with revealed identities subjects exert significantly lower efforts and thus earn higher payoffs. On the other hand, subjects may be averse to having their identities revealed and thus may avoid more profitable but less "private" contests. We leave these questions for future research.

[20] Interestingly, Fallucchi et al. (2012) find that giving subjects additional feedback about rivals' efforts reduces aggregate effort. A potential explanation for the different findings from our study is that our experiment lasted for 20 periods, while Fallucchi et al.'s experiment lasted for 60 periods, giving subjects more time to learn.

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Tables and Figures

Table 1: Summary of Treatments

Varying Information ⇒ Varying Identification ⇓	No Information (only own effort)	Information (all group members' efforts)
No Photo (identities not revealed)	No Photo, No Information (NP-NI) 2 sessions (60 subjects)	No Photo, Information (NP-I) 2 sessions (60 subjects)
Photo (identities revealed)	Photo, No Information (P-NI) 2 sessions (60 subjects)	Photo, Information (P-I) 2 sessions (60 subjects)

Table 2: Average Effort and Payoff

Treatment	Nash	NP-NI	NP-I	P-NI	P-I
Effort, e	15	29.1 (0.7)	28.3 (0.7)	25.1 (0.6)	24.1 (0.6)
Payoff, $E(\pi)$	5	-9.1 (0.9)	-8.3 (1.0)	-5.1 (1.0)	-4.1 (1.0)

Standard error of the mean in parentheses.

Table 3: Between-Subjects and Within-Subject Heterogeneity of Effort

Treatment	NP-NI	NP-I	P-NI	P-I
	Between-Subjects Heterogeneity Measure			
Periods 1-5	16.5 (0.65)	14.1 (0.62)	14.1 (0.62)	11.5 (0.53)
Periods 16-20	18.1 (0.71)	16.0 (0.69)	14.7 (0.66)	12.9 (0.62)
Periods 1-20	18.1 (0.35)	14.7 (0.33)	13.87 (0.31)	12.0 (0.29)
	Within-Subject Heterogeneity Measure			
Periods 1-5	15.6 (1.21)	15.7 (1.03)	14.1 (1.11)	13.2 (1.03)
Periods 16-20	9.17 (0.97)	16.9 (1.28)	13.8 (1.19)	13.3 (1.15)
Periods 1-20	14.2 (0.59)	16.0 (0.56)	13.9 (0.53)	13.6 (0.50)

Standard error of the mean in parentheses. When calculating the within-subject heterogeneity measure one period is omitted because of the lag variable.

Table 4: Panel Estimation of Determinants of Effort (Lags)

Dependent variable, *effort*	NP-NI and P-NI	NP-I and P-I
Specification	(1)	(2)
identification	-1.68	-2.27
[1 if photo]	(1.31)	(1.67)
effort-lag	0.49***	0.50***
[own effort in *t*-1]	(0.05)	(0.04)
win-lag	1.79	-1.61
[own win in *t*-1]	(2.52)	(1.88)
above-lag	-1.51	-4.35***
[1 if above the winning effort in *t*-1]	(2.65)	(1.65)
below-lag	2.67	5.34***
[1 if below the winning effort in *t*-1]	(2.58)	(1.88)
period	-0.25***	-0.19**
[period trend]	(0.07)	(0.07)
constant	15.43***	14.95***
	(3.04)	(3.30)
Observations	2,280	2,280

* significant at 10%, ** significant at 5%, *** significant at 1%.
The standard errors in parentheses are clustered at the group level. All models include a random effects error structure, with the individual subject as the random effect, to account for the multiple decisions made by individual subjects.

Table 5: Panel Estimation of Determinants of Effort (Non-Monetary Utility)

Dependent variable, *effort*	All	NP-NI	NP-I	P-NI	P-I
Specification	(1)	(2)	(3)	(4)	(5)
information	-0.37				
[1 if full information]	(1.91)				
identification	-3.76**				
[1 if photo]	(1.92)				
non-monetary	0.21***	0.26***	0.28*	0.20***	0.08
[effort for prize 0]	(0.05)	(0.07)	(0.14)	(0.05)	(0.13)
period	-0.33***	-0.50***	-0.27	-0.25**	-0.29**
[period trend]	(0.07)	(0.10)	(0.20)	(0.11)	(0.14)
quiz	-1.56	-0.19	-3.95	-0.69	-2.26*
[# correct answers on the quiz]	(1.11)	(2.89)	(2.86)	(1.72)	(1.20)
constant	37.25***	32.42**	46.52***	29.21***	36.44***
	(5.55)	(13.18)	(14.76)	(7.74)	(5.85)
Observations	4,800	1,200	1,200	1,200	1,200

* significant at 10%, ** significant at 5%, *** significant at 1%.
The standard errors in parentheses are clustered at the group level. All models include a random effects error structure, with the individual subject as the random effect, to account for the multiple decisions made by individual subjects.

Figure 1: Average Effort by Treatments

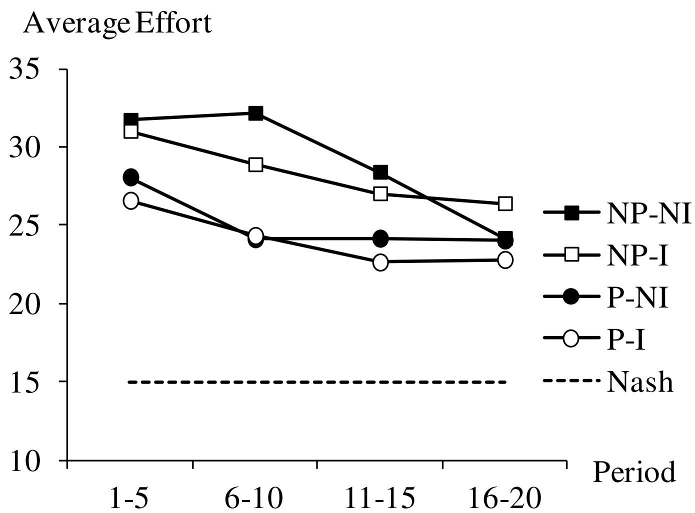
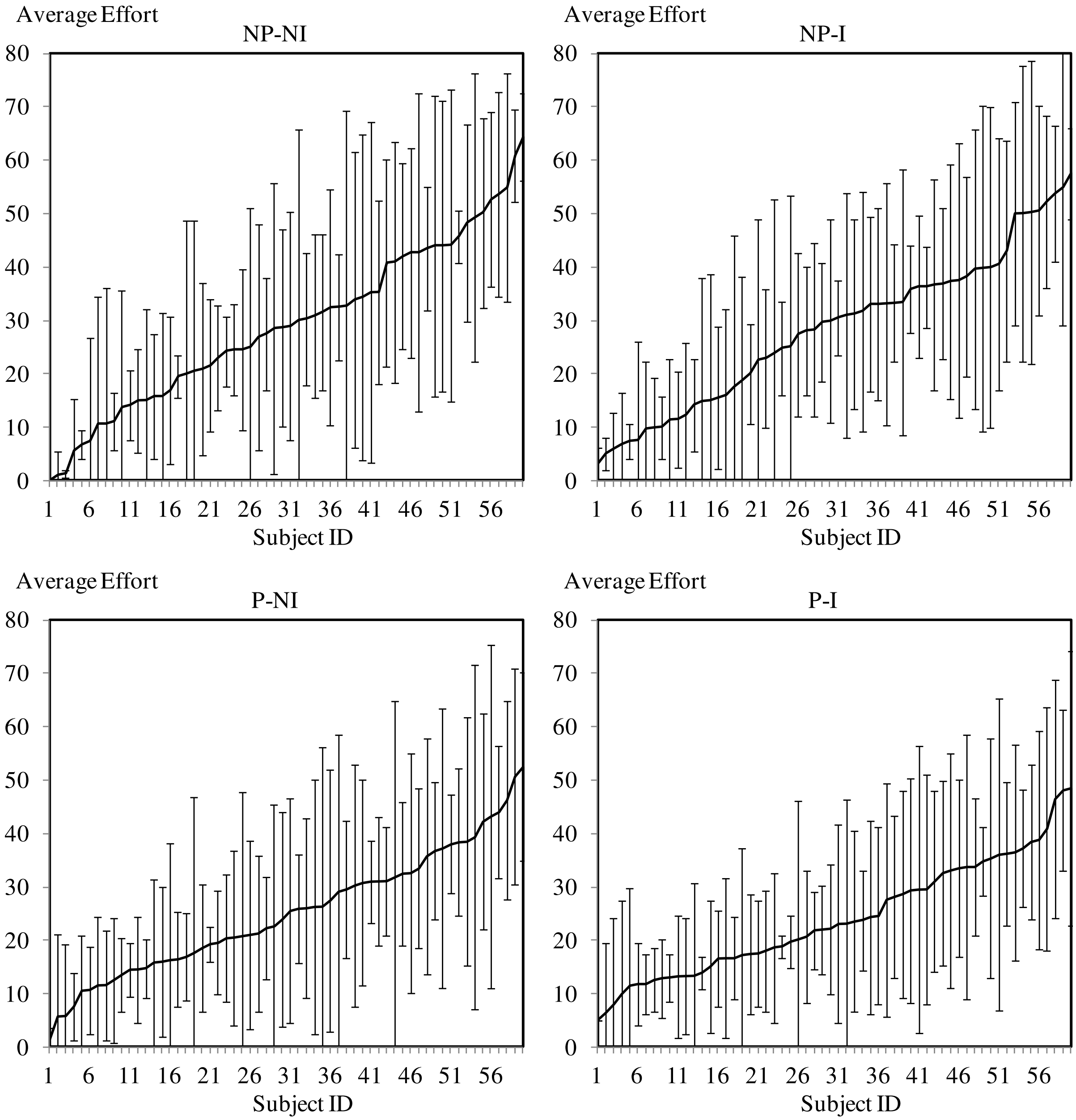


Figure 2: Distribution of the Average Bid by Subject in Each Treatment

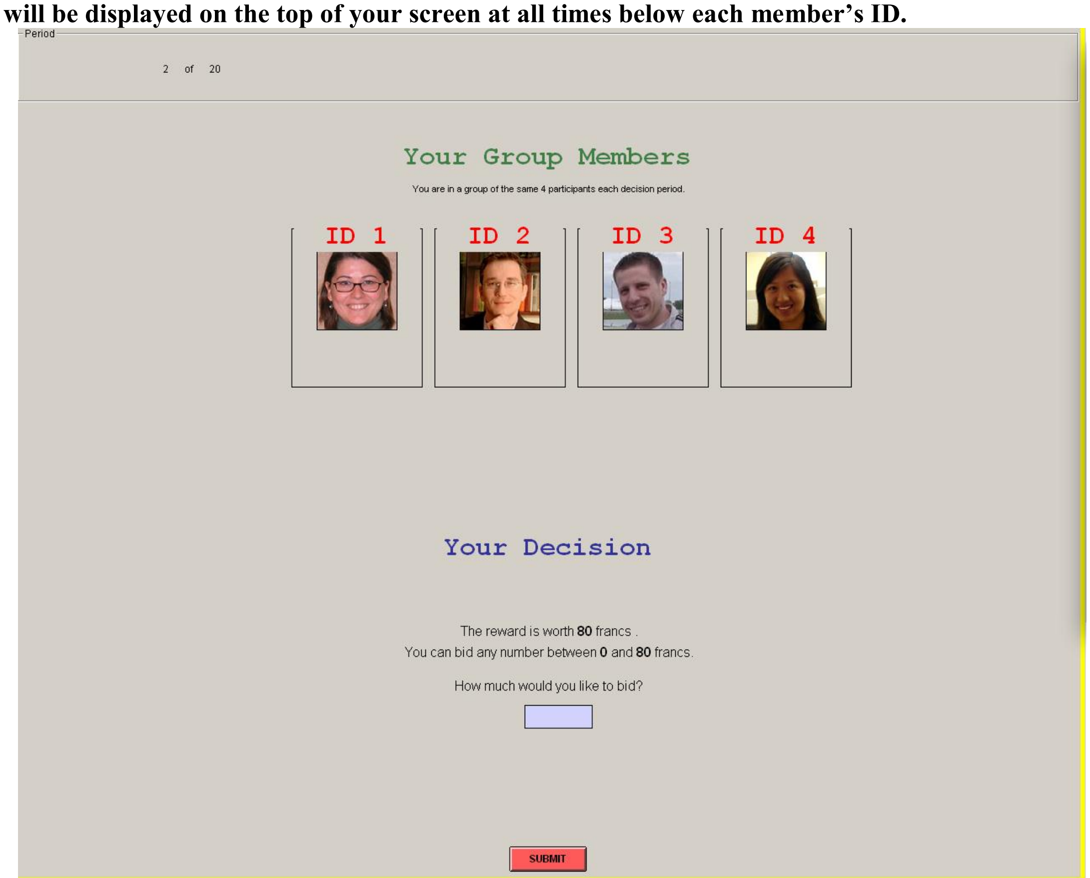


Appendix (Not for Publication) – Instructions for P-I Treatment

In this experiment you will be placed in a group of **4 participants** (including you). You will remain in the same group for the entire experiment. The experiment will consist of **20 periods**. At the end of the experiment **2 out of 20** periods will be randomly selected for payment. After you have completed all periods two tokens will be randomly drawn out of a bingo cage containing tokens numbered from **1 to 20**. The token numbers determine which two periods are going to be paid in the game.

Each period you will be given **80 francs.** Francs will be converted to U.S. dollars at the end of the experiment at the rate of **15 francs = $1.** Each period, you will select a bid.

Each group member will receive a randomly chosen ID for the experiment (a number from 1 to 4). Your ID will remain the same for the entire experiment. The photos and names of each member of your group will be displayed on the top of your screen at all times below each member's ID.



Each period, you and all other participants will be given an initial endowment of **80** francs and you will be asked to decide how much you want to bid for **a reward**. The reward is worth **80** francs to you and the other four participants in your group. You may bid any integer number of francs between **0** and **80**. After all participants have made their decisions, your earnings for the period are calculated. These earnings will be converted to cash and paid at the end of the experiment if the current period is the period that is randomly chosen for payment. If you receive the reward your period earnings are equal to your endowment plus the reward minus your bid. If you do not receive the reward your period earnings are equal to your endowment minus your bid.

If you receive the reward: Earnings = Endowment + Reward – Your Bid = 80 + 80 – Your Bid
If you do not receive the reward: Earnings = Endowment – Your Bid = 80 – Your Bid

The more you bid, the more likely you are to receive the reward. The more the other participants in your group bid, the less likely you are to receive the reward. Specifically, for each franc you bid you will receive one lottery ticket. At the end of each period the computer **draws randomly** one ticket among all the tickets purchased by **4 participants** in the group, including you. The owner of the drawn ticket receives the reward of 80 francs. Thus, your chance of receiving the reward is given by the number of francs you bid divided by the total number of francs all 4 participants in your group bid. You can never guarantee yourself the reward. However, by increasing your bid, you can increase your chance of receiving the reward. Regardless of who receives the reward, all participants will have to pay their bids.

$$\text{Chance of receiving the reward} = \frac{\text{Your Bid}}{\text{Sum of all 4 Bids in your group}}$$

In case all participants bid zero, the reward is randomly assigned to one of the 4 participants in the group.

Example: Let's say participant 1 bids 10 francs, participant 2 bids 15 francs, participant 3 bids 0 francs, and participant 4 bids 40 francs. Therefore, the computer assigns 10 lottery tickets to participant 1, 15 lottery tickets to participant 2, 0 lottery tickets to participant 3, and 40 lottery tickets for participant 4. Then the computer randomly draws **one lottery ticket out of 65** (10 + 15 + 0 + 40). As you can see, participant 4 has the **highest chance** of receiving the reward: **0.62 = 40/65.** Participant 2 has **0.23 = 15/65** chance, participant 1 has **0.15 = 10/65** chance, and participant 3 has **0 = 0/65** chance of receiving the reward.

After all participants make their bids, the computer will make a random draw which will decide who receives the reward. Then the computer will calculate your period earnings based on your bid and whether you received the reward or not.

OUTCOME SCREEN

At the end of each period, your bid, whether you received the reward or not, and your earnings for the period are reported on the outcome screen as shown below. Once the outcome screen is displayed you should record your results for the period on your **Personal Record Sheet** under the appropriate heading.

In addition, you will see the bids of your group members by their ID numbers and whether they received the reward. The photos and names of all your group members will also be displayed on the outcome screen above their IDs.