Winner-Take-All and Proportional-Prize Contests: Theory and Experimental Results

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Abstract

This study provides a unified framework to compare three canonical types of contests: winner-take-all contests won by the best performer, winner-take-all lotteries where probability of success is proportional to performance, and proportional-prize contests in which rewards are shared in proportion to performance. We derive equilibria and observe outcomes from each contest in a laboratory experiment. Equilibrium and observed efforts are highest in winner-take-all contests. Lotteries and proportional-prize contests have the same Nash equilibrium, but empirically, lotteries induce higher efforts and lower, more unequal payoffs. Behavioral deviations from theoretical benchmarks in different contests are caused by the same underlying attributes, such as risk-aversion and the utility of winning. Finally, we find that subjects exhibit consistent behavior across different types of contests, with subjects exerting higher effort in one contest also exerting higher effort in another contest.

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1. Introduction

A wide variety of competitions arise in economic life, and new ones are regularly introduced to attract effort and reward achievement. Such competitions are commonly modeled as contests, in which agents compete for prize funds by expending costly resources. There are many possible contest designs, but most theoretical models and most competitions created to elicit effort use winner-take-all incentives (Konrad, 2009). Despite widespread use of winner-take-all contests, a growing literature suggests that under some circumstances it is more beneficial to use payments proportional to relative performance (Cason et al., 2010; Shupp et al., 2013; Morgan et al., 2016). The first contribution of this paper is that we provide a unified theoretical and experimental framework to compare different contest designs and test how contestants respond to winner-take-all as opposed to proportional incentives.

Given the variety of contests, remarkably little attention has been paid in the experimental literature to compare individual behavior across different contest formats, and the underlying factors explaining systematic individual differences (Dechenaux et al., 2015). Therefore, the second contribution of this paper is that we use a within-subject experimental design to study consistency of individual behavior across different contests.

The unified framework allows us to compare three canonical types of contests: winner-take-all contests won by the best performer, winner-take-all lotteries where probability of success is proportional to performance, and proportional-prize contests in which rewards are shared in proportion to performance. For each case we derive the Nash equilibrium for risk-neutral and self-interested competitors. A novel feature of the model is to examine how random noise affects the mapping between a contestant's effort and their observed performance. This exogenous noise represents the effect of imperfect information, for contestants who may not know how well their efforts will produce results, and for employers or contest judges who may not be able to observe results directly. The random noise also helps us to obtain a pure strategy Nash equilibrium in the deterministic winner-take-all contest, which is not usually the case in deterministic contests (Hillman and Riley, 1989; Baye et al., 1996).

To test the predictions of our model, we conduct a laboratory experiment using a within-subjects design. Besides eliciting individual effort in various contests, we also collect independent measures of subjects' risk aversion, other-regarding preferences, and utility of winning a contest. Our central empirical finding is that the equilibrium and observed efforts are consistently highest in the simple deterministic winner-take-all contest. The lottery and the proportional-prize contest have the same, lower Nash equilibrium level of effort. Actual competitors in both contests typically over-expend effort and hence receive lower payoffs than the Nash equilibrium, but sharing the prize induces contestants to choose lower efforts and receive higher, more equitable payoffs. Sharing the prize also makes effort levels less sensitive to random noise or the subject's measured risk aversion and utility of winning. This direct comparison of the three contest types helps reveal how winner-take-all awards, whether paid deterministically or by lottery, can induce excess effort and be preferred by contest designers, even though competitors would be better off if prizes were shared proportionally. Contest designers are likely to prefer proportional prizes mainly if they wish to make payoffs more equitable by rewarding contestants other than just the top performers, to reduce excess effort associated with discrete awards, and make efforts more consistent in the face of variation in noise and contestants' individual preferences.

Additionally, our within-subjects design enables us to answer methodological questions pertaining to consistency of behavior across different contests. First, we find evidence that behavioral deviations from theoretical benchmarks in different contests, at least in part, are caused by the same underlying preference characteristics. Specifically, we find that risk-aversion and the utility of winning, elicited in an incentive compatible way, have similar impact on behavior in different contests, with greater risk aversion leading to lower effort and higher utility of winning leading to higher effort in all contests. Second, we find that subjects who exert higher effort in one contest also exert higher effort in another contest, and this correlation persists even after controlling for various factors influencing behavior in both contests. Overall, these results suggest that there is a broad behavioral consistency across different types of contests.

The rest of the paper is organized as follows: Section 2 provides a short literature review; Section 3 presents the theoretical model; Section 4 describes the experimental design, procedures and hypotheses; Section 5 reports the results of the experimental sessions; and Section 6 concludes.

2. Literature Review

Perhaps the simplest contest model in the literature is a winner-take-all competition in which the highest performing contestant wins the entire prize. In some versions, such as the rank-order tournament of Lazear and Rosen (1981), performance is stochastically related to effort due to noise in the observation of effort or in the process by which effort is translated into performance.[1] As the noise variance increases, effort decreases (Bull et al., 1987). However, even with noise, incentives in such contests follow a step function, offering much higher incentives for top performers and lower incentives for other contestants. As a result, some contestants may be discouraged from entering (Cason et al., 2010) or from performing well (Brown, 2011) by the presence of a highly skilled competitor.[2]

[1] In other variations, such as all-pay auctions, there is a one-to-one correspondence between performance and effort (Hillman and Riley, 1989; Baye et al., 1996).

[2] This is sometimes referred to as a "discouragement effect," which describes how a lower ability individual may reduce his/her effort when competing against a higher ability individual. The discouragement effect has received

A closely-related form of competition is the winner-take-all lottery contest of Tullock (1980), in which the exogenously fixed prize is allocated probabilistically in proportion to observable efforts. This contest format has been most widely used to model naturally-occurring competitions for a lump-sum reward such as political lobbying (Krueger, 1974; Tullock, 1980; Snyder, 1989) or patent races (Fudenberg et al., 1983; Harris and Vickers, 1985, 1987).

An extensive experimental literature investigates various forms of winner-take-all contests (see a review by Dechenaux et al., 2015). Almost without exception, experimental studies find puzzling and systematic anomalies – most prominently that contestants incur expenditures that exceed Nash equilibrium levels and that expenditures are widely dispersed (Sheremeta, 2013, 2015). Although over-expenditure is sometimes desirable (Morgan and Sefton, 2000), typically it reduces individual payoffs and decreases economic welfare (Sheremeta and Zhang, 2010; Cason et al., 2012, 2017). Moreover, the stark win-or-lose structure of payoffs results in a highly inequitable distribution of economic welfare (Frank and Cook, 1996).

An alternative to winner-take-all competition that might generate more efficient and more equitable outcomes is a contest that divides the prize in proportion to observable performance (Cason et al., 2010). In such a proportional-prize contest, the fixed prize is shared among contestants according to their performance. The resulting incentives are similar to a lottery contest, but with lower risks and less variance of payoffs across contestants. Proportional prizes arise naturally in economic situations such as shared rents (Long and Vousden, 1987), profit sharing (Weitzman and Kruse, 1990), and labor contracts (Zheng and Vikuna, 2007). Contest designers have typically chosen to make fixed prize awards to top performers (McKinsey and Company,

substantial support from experimental research (Kimbrough et al., 2017) on rank-order tournaments (Weigelt et al., 1989; Schotter and Weigelt, 1992), all-pay auctions (Davis and Reilly, 1998; Llorente-Saguer et al., 2016; Mago and Sheremeta, 2017), and lottery contests (Fonseca, 2009; Mago et al., 2013; Kimbrough et al., 2014).

2009), but in some situations rewards could be paid out in proportion to achievement as in Singh and Masters (2017a, 2017b).

Some related experimental studies compare behavior in different contests. For example, several early studies compare all-pay auctions to lottery contests (Davis and Reilly, 1998; Potters et al., 1998). Also, more recent studies compare behavior in lottery contests to proportional-prize contests (Fallucchi et al., 2013; Shupp et al., 2013; Chowdhury et al., 2014; Masiliunas et al., 2014; Morgan et al., 2016). We contribute to this literature by providing a generalized structure for comparing different types of contests, including all-pay auctions, rank-order tournaments, lottery contests and proportional-prize contests. Also, utilizing a within-subject experimental design, we study consistency of individual behavior across different contests.

3. The Theoretical Model

Our unified model is a contest in which two risk-neutral players i and j compete for a prize v. Both players expend individual efforts e_i and e_j. Every player who exerts effort e has to bear cost $c(e)$, where c_e,$c_{ee} > 0$. The performance y_i of player i is determined by a production function

$$y_i(e_i|\varepsilon_i) = e_i\varepsilon_i, \qquad (1)$$

where ε_i is a random variable which is drawn from the distribution F on the interval $[0, +\infty)$. This multiplicative production function (1) has been used by O'Keefe et al. (1984), Hirshleifer and Riley (1992), and Gerchak and He (2003). The random component ε_i can be thought of as random error, imperfect information about performance (Holmström, 1979), or production luck (Rubin and Sheremeta, 2015). It can also be interpreted as an unknown ability ε_i (Rosen, 1986).

The share of the prize received by player i depends on the relative individual performance and the sensitivity parameter $r > 0$:

$$p_i(e_i, e_j|\varepsilon_i, \varepsilon_j) = y_i^r/(y_i^r + y_j^r). \tag{2}$$

The share of the prize (2) can also be interpreted as the contest success function (CSF), i.e. the probability of winning the contest (Skaperdas, 1996).[3] Given (1) and (2), the expected payoff for player i can be written as:

$$E(\pi_i) = p_i v - c(e_i). \tag{3}$$

A deterministic winner-take-all contest similar to the rank-order tournament of Lazear and Rosen (1981) is obtained using the restriction $r = \infty$. A simple all-pay auction of Hillman and Riley (1989) can be obtained by further restriction of the random component, i.e. $\varepsilon_i = 1$. Given the noise distribution F and the restriction $r = \infty$, the share of the prize (2) for player i can be written as $p_i\left(e_i, e_j\middle|\varepsilon_i, \varepsilon_j\right) = \Pr\left(e_i\varepsilon_i > e_j\varepsilon_j\right) = \Pr\left(\varepsilon_j < e_i\varepsilon_i/e_j\right) = \int F\left(\frac{e_i}{e_j}\varepsilon\right) f(\varepsilon)d\varepsilon$. Taking first order conditions and assuming symmetric contestants, the pure strategy equilibrium effort in the deterministic winner-take-all contest can be obtained from

$$v\int \varepsilon[f(\varepsilon)]^2 d\varepsilon = c_e(e)e. \tag{4}$$

Both a probabilistic winner-take-all and a proportional-prize contest arise with the alternative restriction $r = 1$. These contests resemble the rent-seeking contest of Tullock (1980), with the difference that performance is subject to random noise ε_i.[4] The difference between the

[3] The production function (1), with multiplicative noise, implies that the CSF (2) satisfies the axioms introduced by Skaperdas (1996). In particular, the CSF satisfies the conditions of a probability distribution: $\sum_i p_i\left(e_i, e_j\middle|\varepsilon_i, \varepsilon_j\right) = 1$ and $p_i\left(e_i, e_j\middle|\varepsilon_i, \varepsilon_j\right) \geq 0$, for all e_i and e_j. Multiplicative noise also guarantees that the contest success function is homogeneous, i.e., $p_i\left(\lambda e_i, \lambda e_j\middle|\varepsilon_i, \varepsilon_j\right) = p_i\left(e_i, e_j\middle|\varepsilon_i, \varepsilon_j\right)$ for all $\lambda > 0$.

[4] One may argue that in a conventional Tullock competition, adding a noise component into a production function is redundant since the winner of such a contest is already chosen probabilistically. However, in our model such a noise plays a crucial role. First, the random noise is needed to obtain a pure strategy Nash equilibrium in the deterministic winner-take-all contest. Second, it provides a natural link between the probabilistic winner-take-all contest and the proportional-prize contest, since both contests have identical payoff structures. Third, production noise ε_i in (1) captures different type of uncertainty than the contest success function (2). While the contest success function captures uncertainty regarding who is going to be the winner of the contest, production noise captures uncertainty regarding individual performance.

probabilistic and proportional-prize contests is in the interpretation of p_i. Specifically, in the probabilistic contest, p_i represents the probability of winning the prize, while in the proportional-prize contest it represents the share of the prize. The pure strategy symmetric equilibrium in these contests can be obtained from the first order condition, rearranged as

$$v \iint \frac{\varepsilon_i \varepsilon_j}{(\varepsilon_i + \varepsilon_j)^2} f(\varepsilon_i) f(\varepsilon_j) d\varepsilon_i d\varepsilon_j = c_e(e)e. \quad (5)$$

Closed form solutions for (4) and (5) require assumptions about the distribution of ε and the cost function c. The most commonly used distribution in the experimental contest literature is uniform and the most commonly used cost function is quadratic (Bull et al., 1987; Harbring and Irlenbusch, 2003; Eriksson et al., 2009; Agranov and Tergiman, 2013). Therefore, we assume that ε_i and ε_j are i.i.d. and uniformly distributed on the interval $[1-a, 1+a]$, where $a \in [0,1]$ scales the variance of the distribution.[5] Note that the mean of this distribution is 1 as opposed to the mean of 0 when the noise is additive (Gerchak and He, 2003). We also assume that $c(e) = e^2/b$. Given these restrictions, the equilibrium effort in the deterministic winner-take-all contest (4) for $a \in [0.5,1]$ is given by:

$$e^* = \left(bv\frac{1}{4a}\right)^{1/2}. \quad (6)$$

Thus, adding sufficient noise in the production function leads to a pure strategy Nash equilibrium in the deterministic winner-take-all contest. No pure strategy equilibrium exists in this contest with lower levels of noise (Che and Gale, 2000), so one of the purposes of the added noise is to ensure that the same type of equilibrium (symmetric pure strategy) exists in all three contests formats considered.

[5] The assumption that the error term is uniformly distributed permits a closed form solution for the equilibrium effort. The main conclusions of the model are also robust to other noise distributions, such as a (truncated) normal distribution, a U-shaped quadratic distribution, and the exponential distribution. The numerical simulations are available upon request.

The equilibrium effort in the probabilistic and proportional-prize contest (5) has a more complicated expression:

$$e^* = \left(bv \frac{-2a^2 + a(a-2)\log(1-a) + a(a+2)\log(1+a) + \log(1-a^2)}{8a^2}\right)^{1/2}. \quad (7)$$

The equilibrium efforts in (6) and (7) depend on the value of the prize v, the cost parameter b, and the variance of the noise a. Comparative statics show that an increase in the size of the prize increases individual effort.[6] It is also straightforward to show that $\partial e^*/\partial a < 0$ in both (6) and (7), which means that as the level of noise increases the equilibrium effort decreases.[7] Finally, equilibrium effort in the deterministic contest (6) is higher than in the probabilistic and proportional-prize contest (7) for all values of noise variance a.

The expected payoff at the equilibrium (6) is:

$$E(\pi^*) = \frac{v}{2}\left(1 - \frac{1}{2a}\right). \quad (8)$$

The expected payoff at the equilibrium (7) is:

$$E(\pi^*) = \frac{v}{2}\left(1 - \frac{-2a^2 + a(a-2)\log(1-a) + a(a+2)\log(1+a) + \log(1-a^2)}{4a^2}\right). \quad (9)$$

It is straightforward to show that expected payoff in the probabilistic and proportional-prize contest (9) is higher than the expected payoff in the deterministic winner-take-all contest (8) for all values of noise variance a.[8]

[6] Dasgupta and Nti (1998) and Amegashie (2006) also obtain similar results, but in their models the noise enters the contest success function as a constant term instead of a random variable.

[7] One can also evaluate (6) and (7) at the limit as $a \to 0$. In such a case the deterministic contest transforms into an all-pay auction (Hirshleifer and Riley, 1992) and the probabilistic and proportional-prize contests transform into a rent-seeking contest (Tullock, 1980). We can solve for equilibrium as the variance of noise approaches to zero, by evaluating e^* at the limit as $a \to 0$: With L'Hopital's rule we can show that $x^* \to V/4$ as $a \to 0$. Therefore, as the variance of noise approaches zero, the equilibrium of this proportional-prize contest approaches the equilibrium of a simple Tullock lottery contest without noise (4). A smooth transition exists between this type of contest with a random noise and a lottery contest. There is no such transition between a rank-order contest and an all-pay auction (Che and Gale, 2000).

[8] The pure strategy Nash equilibrium is defined in all three contests for $a \geq 0.5$.

4. Experimental Design, Hypotheses and Procedures

The experimental design is summarized in Table 1, which shows the parameters faced by contestants, equilibrium efforts and expected profits in each of six contests. In all treatments the value of the prize is v = 100 experimental francs and the restriction on the cost function is b = 100. Column headings denote the type of competition. In the first treatment (denoted DET-L), subjects participate in the deterministic winner-take-all (DET) contest and face low (L) variance: the production noise ε has a variance of a = 0.5 that is uniformly distributed on the interval [0.5, 1.5].[9] The only difference in DET-H is that the production noise ε has a high variance a = 1 that is uniformly distributed on the interval [0, 2]. These two variance levels maximize the difference in equilibrium efforts as noise varies, which facilitates identification of treatment effects. Identical variances are used in the probabilistic (PROB) lottery-type contest and the corresponding proportional-prize (PP) contests, which are designated as PROB-L, PROB-H, PP-L and PP-H.

Table 1: Experimental Parameters and Theoretical Predictions

Treatment	DET-L	DET-H	PROB-L	PROB-H	PP-L	PP-H
Value of the Prize, v	100	100	100	100	100	100
Noise Parameter, a	0.5	1	0.5	1	0.5	1
Equilibrium Effort, e^*	70.7	50.0	34.6	31.1	34.6	31.1
Expected Payoff, $E(\pi^*)$	0.0	25.0	38.0	40.3	38.0	40.3

The theoretical predictions for the six treatments motivate the following hypotheses:

Hypothesis 1: The effort in all contests decreases in the noise variance (L versus H), leading to higher payoffs.

Hypothesis 2: Deterministic contests (DET) generate higher efforts than probabilistic (PROB) and proportional-prize (PP) contests, and hence lower payoffs.

[9] The expected payoff in (8) is non-negative for any $a \in [0.5,1]$ and in (9) it is non-negative for $a \in (0,1]$. For that reason, in the experiment we set $a \geq 0.5$.

Hypothesis 3: Probabilistic and proportional-prize contests (PROB and PP) generate the same efforts, and hence the same payoffs.

We conducted twelve sessions to observe actual behavior in contests and to test theoretical predictions stated in Hypotheses 1, 2 and 3. The sessions employed a total of 144 subjects drawn from the population of undergraduate students at Purdue University, and were implemented using z-Tree (Fischbacher, 2007). Twelve subjects participated in the lab during each session. Each session proceeded in six parts. Subjects received printouts of the instructions (available in Appendix A) at the beginning of each part and the experimenter read the instructions aloud.

The first three parts of each session corresponded to three of the treatments shown in Table 1. The DET-L, PP-L and PROB-L treatments were used in half of the sessions and DET-H, PP-H and PROB-H treatments were used in the other half of the sessions. The treatments were run in different orders in different sessions, with an equal balance of all six possible orderings for a randomized complete block design. Each of the three treatments lasted for 20 periods. In each period subjects were randomly and anonymously paired. The pairing was changed randomly every period in order to reduce repeated game incentives, since the equilibrium predictions summarized in Table 1 are for static (one-shot) interactions. Each period, both contestants were given an initial endowment of 100 francs. They could use their endowments to submit an effort between 0 and 100 (including 0.1 decimal points) in order to obtain an additional prize of 100 francs. Subjects were given a cost table which showed the quadratic cost associated with each effort. After both contestants chose their efforts, the computer multiplied them by a "personal random number" corresponding to the production noise to determine their final performance.

The computer then compared the performances of the two individuals in each group. In the DET treatments, the highest performing contestant received the entire prize; in the PROB treatments, the computer chose the winner of the entire prize with probabilities that depended on the fraction of total effort chosen by each contestant; and in the PP treatments, both contestants received a share of 100 francs according to their relative performances. At the end of each period, both individuals' efforts, random numbers, final performances, and individual earnings for the period were reported to each subject.

The final three parts of each session collected additional information about subject preferences is some simple and brief tasks. In the fourth part, subjects were given an endowment of 100 francs and could expend efforts in a deterministic contest in order to be a winner. The procedure followed closely to the DET treatment. The only difference was that the prize value was 0 francs. Subjects were told that they would be informed whether they won the contest or not. Similar to Sheremeta (2010), we used this procedure to obtain a measure of how important it is for subjects to win when winning is costly but provides no monetary reward. Subjects with a non-monetary "utility of winning" would value the prize in the main contests more highly, potentially raising their optimal effort choice.

In the fifth part we elicited subjects' risk preferences using a set of 15 lotteries shown in Table 2 to explore how risk tolerance may affect contest effort. Similar to Holt and Laury (2002), in each lottery, subjects were asked to state whether they prefer a safe or risky option. Parameters were set in such a way that a subject with risk-neutral preferences would select the first seven safe options.

Table 2: Lottery Choices for Elicitation of Risk Preferences

Choice	Option 1 (Safe Option)	Option 2 (Risky Option)	
# 1	$1	0/20 of $3	20/20 of $0
# 2	$1	1/20 of $3	19/20 of $0
# 3	$1	2/20 of $3	18/20 of $0
# 4	$1	3/20 of $3	17/20 of $0
# 5	$1	4/20 of $3	16/20 of $0
# 6	$1	5/20 of $3	15/20 of $0
# 7	$1	6/20 of $3	14/20 of $0
# 8	$1	7/20 of $3	13/20 of $0
# 9	$1	8/20 of $3	12/20 of $0
# 10	$1	9/20 of $3	11/20 of $0
# 11	$1	10/20 of $3	10/20 of $0
# 12	$1	11/20 of $3	9/20 of $0
# 13	$1	12/20 of $3	8/20 of $0
# 14	$1	13/20 of $3	7/20 of $0
# 15	$1	14/20 of $3	6/20 of $0

* Subjects choose between a safe option 1 ($1 with certainty) or a risky option 2 (a chance of receiving either $3 or $0).

Table 3: Dictator Allocations for Elicitation of Other-Regarding Preferences

Choice	Option 1 (Self, Other)	Option 2 (Self, Other)
#1	$2, $2	$2, $1
#2	$2, $2	$3, $1
#3	$2, $2	$2, $4
#4	$2, $2	$3, $5

* Subjects choose between option 1 (equal payoffs) or option 2 (unequal payoffs).

Finally, in the sixth part we elicited subjects' preferences towards inequality, using 4 simple binary choices shown in Table 3. These nonstrategic choices affected the subject's income and the income of another anonymously matched subject. Recent studies have explored how various forms of social preferences can affect behavior in contests (see a review by Sheremeta, 2016). We employed choices between payoff distributions that are similar to those used by Bartling et al. (2009). The first option is always a pair of equal payoffs and the second option is always a pair of unequal payoffs. Although option 2 always results in unequal payoffs to the subject and her counterpart, in the first two choices the subject's payoff is greater, and in the last two choices the subject's payoff is lower than that of another paired subject.

At the end of each session, 6 out of 60 periods in parts one, two and three were randomly selected for payment (2 out of 20 periods for each of the three treatments). The sum of the earnings for these 6 periods was exchanged at rate of 40 francs = $1. Subjects were also paid for the single decision made in part four, 1 out of 15 decisions made in part five, and 1 out of 4 decisions made in part six of the experiment. On average, subjects earned $24.50 each, which was paid anonymously and in cash. The experimental sessions lasted for about 90 minutes.

5. Results

5.1. Overview

Table 4 shows efforts and payoffs in all treatments. First, notice that there is significant variation in effort, with standard deviations ranging from 15.6 to 20.9, depending on the treatment. Such high variance in individual efforts is also observed in other experimental studies (Bull et al., 1987; Davis and Reilly, 1998; Potters et al., 1998; Eriksson et al., 2009; Sheremeta 2010, 2011; Sheremeta and Zhang, 2010), and it clearly demonstrates that subjects do not consistently follow the predictions of the symmetric pure strategy Nash equilibrium.

We next examine whether the aggregate behavior conforms to the predictions of the theory, beginning with the average effort in each treatment. To compare differences in average effort we report conservative, nonparametric Wilcoxon and Mann-Whitney tests that employ only statistically independent sessions as the unit of observation. As robustness checks on these results we also conducted a series of panel regressions allowing for time period trends and treatment ordering effects (which were typically insignificant), using individual subject random effects and standard errors clustered at the session level. These regressions lead to similar conclusions as the nonparametric tests.[10]

Table 4: Efforts and Payoffs

Treatment	DET-L	DET-H	PROB-L	PROB-H	PP-L	PP-H
			Effort			
Equilibrium	70.7	50.0	34.6	31.1	34.6	31.1
Average	62.4	51.2	51.3	46.1	45.2	42.4
Median	65.0	50.0	51.0	47.0	45.0	41.3
St. Dev.	20.9	17.4	20.0	17.2	15.6	17.8
			Payoff			
Equilibrium	0.0	25.0	38.0	40.3	38.0	40.3
Average	6.7	20.8	19.7	25.8	27.1	28.9
Median	0	0	0	0	27.6	28.4
St. Dev.	47.1	49.0	49.7	49.5	16.5	27.2

In the deterministic contest with high noise variance (DET-H), subjects' average effort is 51.2, which is not statistically different from the equilibrium effort of 50.0 (two-tailed Wilcoxon test, p-value = 0.46). However, when the noise is low (DET-L), subjects expend average effort of 62.4, which is lower than the equilibrium effort of 70.7 (two-tailed Wilcoxon test, p-value = 0.03). This is a surprising result, since previous studies find that efforts in deterministic winner-take-all contests (rank-order tournaments) are usually either higher or not significantly different from theoretical benchmarks (Bull et al., 1987; Harbring and Irlenbusch, 2003; Eriksson et al., 2009). The major difference of our study is the use of multiplicative noise to adjust individual final performance (Gerchak and He, 2003), whereas all other experimental studies employ additive noise (Lazear and Rosen, 1981). It is possible that subjects perceive multiplicative noise as more risky and thus they restrain their efforts. It is also possible that subjects are biased towards choices in the midpoint of the strategy space, in this case an effort of 50.[11]

[10] For brevity we do not report their details but can provide them to interested readers.
[11] To the best of our knowledge, there no other experimental studies on contests utilizing multiplicative noise and no studies examining reference points in contests.

In probabilistic contests (PROB-L and PROB-H), subjects expend average efforts of 51.3 and 46.1, which are significantly higher than the equilibrium efforts of 34.6 and 31.1 (two-tailed Wilcoxon test, p-values = 0.03 in both cases). This over-expenditure relative to theoretical benchmarks is consistent with previous results of Tullock contest experiments (Davis and Reilly, 1998; Potters et al., 1998; Sheremeta 2010, 2011; Sheremeta and Zhang, 2010). This is a new empirical result, however, since our probabilistic contest differs from the standard Tullock contest because the noise parameter leads to an imperfect mapping between a contestant's effort and her observed performance. Nevertheless, we still find similar behavioral patterns of over-expenditure.

Finally, in proportional-prize contests (PP-L and PP-H), subjects expend efforts of 45.2 and 42.4, and these effort levels are also significantly higher than the equilibrium efforts of 34.6 and 31.1 (two-tailed Wilcoxon test, p-values = 0.03 in both cases). These findings are surprising given the results from several resent experimental studies, indicating that in proportional-prize contests behavior is usually close to Nash equilibrium (Shupp et al., 2013; Chowdhury et al., 2014; Masiliunas et al., 2014). However, it is important to emphasize that our results are not directly comparable because in our proportional-prize contest individual performance is a function of both effort and noise, whereas all other proportional-prize contests do not introduce noise when mapping effort to performance.

5.2. The Impact of the Noise Variance

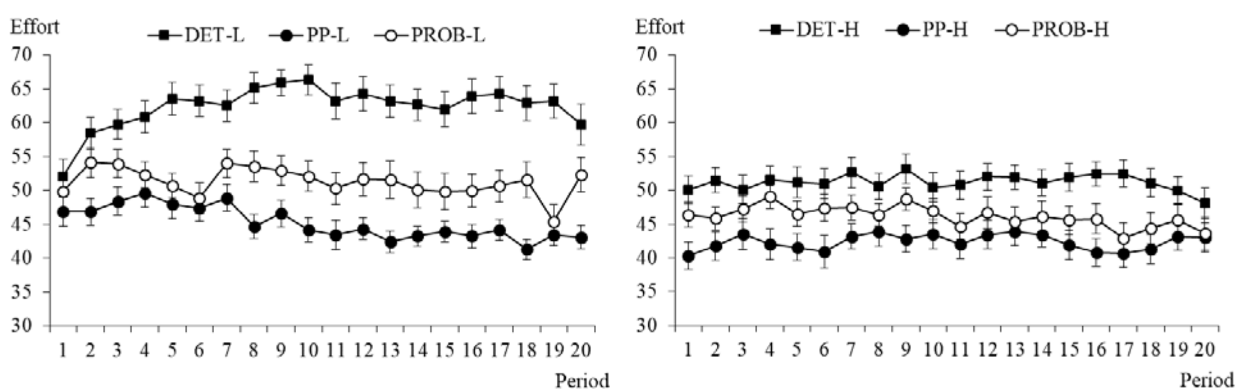
As noted above, a novel feature of this experiment is that noise affecting how effort translates into performance is varied systematically in all three contest formats. An increase in the noise variance can be considered, for example, as a decrease in a supervisor's ability to monitor employees in a promotion or bonus tournament. The theoretical model predicts that individual efforts decrease in the noise variance (Hypothesis 1). The experiment provides some support for this hypothesis. Average efforts decrease significantly from 62.4 to 51.2 in the deterministic contest and from 51.3 to 46.1 in the probabilistic contest (one-tailed Mann-Whitney test, p-value < 0.01 and p-value = 0.03, respectively). Although average efforts decrease from 45.2 to 42.4 in the proportional-prize contest with an increase in noise, this difference is only marginally statistically significant (one-tailed Mann-Whitney test, p-value = 0.08).

Result 1. Efforts in contests decrease as the noise variance increases (support for Hypothesis 1).

5.3. Comparison of Contest Structures

Our theoretical model predicts that deterministic contests generate higher efforts than the other two contests (Hypothesis 2). This prediction is clearly supported by our data for both high and low variance treatments (one-tailed Wilcoxon test, all p-values < 0.03). Moreover, the average efforts across all periods shown in Figure 1 demonstrate that the differences in efforts between treatments persist across all periods.

Figure 1: Average Effort over Periods



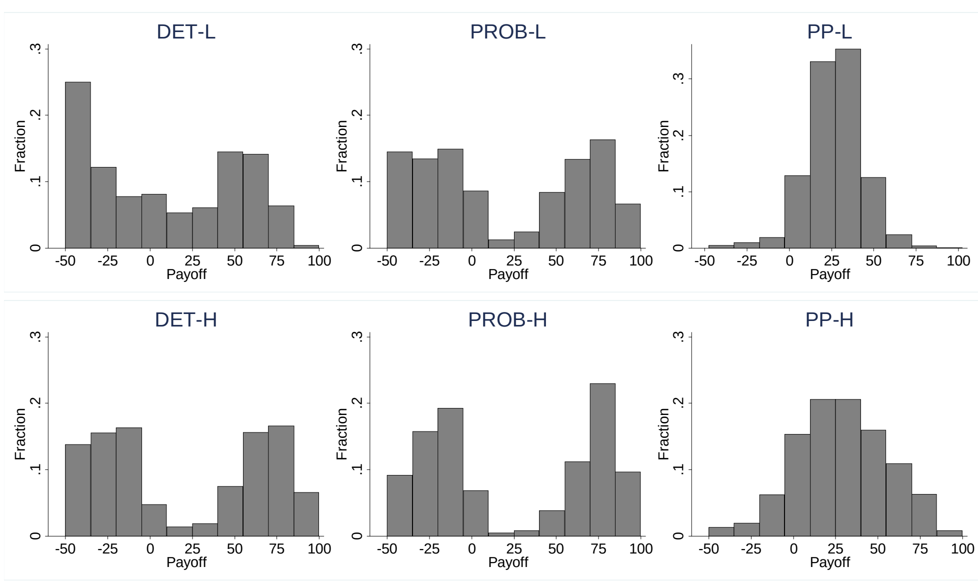
Result 2. Deterministic contests generate higher efforts than proportional-prize and probabilistic contests (support for Hypothesis 2).

Although theory predicts no difference between efforts expended in probabilistic and proportional-prize contests, the data indicate that subjects choose higher efforts in the probabilistic contest than in the proportional-prize contest. This difference is significant for both high and low variance treatments (two-tailed Wilcoxon test, p-values = 0.03 in both cases).

Result 3. Contrary to theoretical predictions, probabilistic contests generate higher efforts than proportional-prize contests (rejection of Hypothesis 3).

Eisenkopf and Teyssier (2013) observe a similar ranking of efforts in probabilistic and proportional-prize contests in a different environment. They attribute this difference to inequity aversion because inequity is necessarily greater in the winner-take-all structure of the probabilistic contest. We explore the influence of social preferences, as well as non-monetary utility of winning and risk preferences, in the next subsection.

Figure 2: Distribution of Payoffs



Since effort is costly, greater efforts in pursuit of the given prize reduce the subjects' net payoffs. Table 4 shows that average payoffs are highest in the proportional-prize contest, and these payoffs are significantly greater than in the other two contests (except for PROB-H, where the difference is not quite significant; two-tailed Wilcoxon test, p-value = 0.12). Payoffs in the proportional-prize contest are also more equitable. Figure 2 displays the distribution of payoffs in all treatments. Clearly, inequality in payoffs among contestants is significantly lower in both PP treatments than in the DET and PROB treatments.

Result 4. Proportional-prize contests generate higher and more equitable payoffs than deterministic and probabilistic winner-take-all contests.

In summary, the results of our experiment suggest that deterministic contests generate the highest efforts followed by probabilistic and then by proportional-prize contests. As a result, subjects receive the highest expected payoff in proportional-prize contests followed by probabilistic and then by deterministic contests. Moreover, proportional-prize contests generate the most equitable payoffs.

5.4. Effort and Preferences

Another question that we can answer using our data is whether commonly observed behavioral deviations from theoretical benchmarks in different contests are caused by similar observable preference characteristics (e.g., risk aversion, other-regarding preferences, and the utility of winning).

The final three tasks at the end of each experimental session elicited information about individual preference for winning (Sheremeta, 2010), risk aversion (Holt and Laury, 2002), and other-regarding preferences (Bartling et al., 2009). In this section we explore how these factors are related to individual behavior in the different contests.

Experimental studies provide evidence that in addition to monetary utility, subjects derive utility from winning itself (Delgado et al., 2008; Sheremeta, 2010; Price and Sheremeta, 2011, 2015). We measured subjects' utility of winning by asking them to submit efforts in a deterministic winner-take-all contest where the prize value is 0. Table 5 reports the distribution of efforts for the prize of 0 and the corresponding average effort difference from the treatment-specific mean for the three contests. Almost 60% of subjects submitted positive efforts in this 0-prize contest, suggesting that the majority of subjects have a non-monetary utility of winning. Moreover, Table 5 indicates that subjects who exert a high effort in this contest for a prize of 0 also tend to exert higher efforts in all three contest formats. The 15 subjects who apparently had the greatest utility of winning and expended at least 60 experimental francs ($1.50) to win the prize of 0 also exerted considerably greater effort on average in the monetary contests. Their efforts were 8.8, 9.4, and 9.1 experimental francs higher on average than the other subjects in the deterministic, probabilistic, and proportional-prize contests, respectively.

Table 5: Elicited Utility of Winning and Efforts

Effort in a Tournament with the Prize of 0	Percent of Subjects	Mean Effort Deviation in DET	Mean Effort Deviation in PROB	Mean Effort Deviation in PP
0	42.4%	-1.13	-3.70	-0.88
0.1-10	22.9%	0.59	1.10	-0.71
10.1-20	2.1%	3.29	10.73	3.43
20.1-30	4.2%	-5.90	0.82	-4.77
30.1-40	5.6%	-5.65	-3.77	-6.50
40.1-50	8.3%	2.78	1.15	1.83
50.1-60	4.2%	-0.44	8.95	1.03
60.1-70	6.3%	0.88	6.94	6.30
70.1-100	4.2%	13.45	9.32	10.10

* Effort deviations are effort choices minus treatment-specific mean efforts

Experimental research on rent-seeking contests and rank-order tournaments suggests that more risk averse subjects exert lower efforts (Millner and Pratt, 1991; Sheremeta, 2011; Eisenkopf and Teyssier, 2013; Shupp et al., 2013). To explore the influence of risk aversion among our subjects, we measured their risk preferences using a variant of the multiple price list for lotteries (similar to Holt and Laury, 2002), shown in Table 2. The vast majority of subjects chose the safe option 1 when the probability of the high payoff in the risky option 2 was small, and then crossed over to option 2 at a single point as the high payoff likelihood increased. Table 6 reports the distribution of the total number of safe options chosen by all subjects in the experiment and the corresponding average effort difference from the treatment-specific mean for the three contests. More than 60% of subjects choose more than 8 safe options, indicating risk averse preferences. Importantly, subjects who have risk averse preferences often choose lower efforts on average in the contests, although the pattern seems often mixed, especially for the deterministic contest.

Table 6: Elicited Risk Preferences and Efforts

Total Number of Safe Choices	Percent of Subjects	Mean Effort Deviation in DET	Mean Effort Deviation in PROB	Mean Effort Deviation in PP
5-6	11.8%	2.36	2.73	3.81
7-8	23.6%	3.90	4.27	1.67
9-10	36.1%	-1.43	0.23	-1.08
11-12	18.8%	-4.35	-5.41	-1.40
13-15	8.3%	2.07	-4.83	-1.49

* Effort deviations are effort choices minus treatment-specific mean efforts.

A growing body of research has examined how social preferences impact individual behavior in contests (Herrmann and Orzen, 2008; Bartling et al., 2009; Gill and Stone, 2010; Mago et al., 2016: Sheremeta, 2016). Grund and Sliwka (2005) show theoretically that inequity averse agents, who dislike disadvantageous and advantageous inequality of payoffs, exert higher efforts than purely self-interested agents. Balafoutas et al. (2012) show experimentally that spiteful subjects compete more aggressively than others when in a contest, but are less likely to enter contests. Eisenkopf and Teyssier (2013) show theoretically that efforts can be lower in proportional-prize contests with inequity averse contestants because payments are more equitable when the prize is split. We measured our subjects' other-regarding preferences using binary choices between equal and unequal payoff distributions (Table 3). The choices are constructed such that subjects choosing option 1 for the first two choices, indicate that they are ahead-averse, i.e. subjects choose not to be paid more than others, while subjects choosing option 1 for the last two choices, indicate that they are behind-averse, i.e. subjects choose not to be paid less than others consistently. Table 7 reports the distribution of choices for all subjects and their corresponding average effort differences in the three contests. Only a minority of subjects can be classified as strongly ahead averse, since only 16 percent of subjects prefer ($2, $2) over ($3, $1). Also, only a minority subjects can be classified as strongly behind averse, since only 15.3 percent of subjects prefer ($2, $2) over ($3, $5). There appears to be little systematic correlation between these measures of aheadness aversion and the efforts in the contests, but subjects who are behind-averse do tend to choose modestly higher efforts in all three contests.

Table 7: Elicited Other-Regarding Preferences and Efforts

Choice (Self, Other)	Percent of Subjects	Mean Effort Deviation in DET	Mean Effort Deviation in PROB	Mean Effort Deviation in PP
$2, $2	84.7%	-0.03	0.66	0.42
$2, $1	15.3%	0.13	-3.52	-2.45
$2, $2	16.0%	-3.21	0.29	1.30
$3, $1	84.0%	0.60	-0.03	-0.26
$2, $2	41.7%	2.32	3.57	0.42
$2, $4	58.3%	-1.67	-2.51	-0.33
$2, $2	15.3%	1.83	2.21	0.37
$3, $5	84.7%	-0.34	-0.37	-0.08

* Effort deviations are effort choices minus treatment-specific mean efforts.

We explore the significance of these independently-measured preferences on contest effort choices in a set of multivariate regressions shown in Table 8. To capture heterogeneity across individuals, we use a random effect models with individual subject effects. To account for learning that is potentially stronger in early periods, we use inverse of the period (*invper*) as the time trend. All regressions in Table 8 also include dummy-variables (not shown) to control for treatment order effects. Since strategic behavior could vary considerably across different contests, specification

(1) uses only the data from DET treatments, specification (2) uses the data from PROB treatments, and specification (3) uses the data from PP treatments.

Table 8: Random-Effect Regressions of Effort

Treatment	DET	PROB	PP
Dependent variable, effort	(1)	(2)	(3)
noise-variance	-10.27***	-3.80*	-2.00
[treatment dummy]	(3.24)	(2.04)	(2.22)
utility-of-winning	0.07*	0.13***	0.07*
[effort for prize value 0]	(0.04)	(0.04)	(0.04)
risk-averse	-3.69**	-5.67***	-3.24*
[1 if number of safe options 1 > 8]	(1.61)	(1.89)	(1.84)
aheadness-averse	-4.08	0.91	1.59
[1 if (2,2) is preferred to (2,1) and (3.1)]	(3.09)	(2.71)	(2.97)
behindness-averse	0.09	-0.93	-1.60
[1 if (2,2) is preferred to (2,4) and (3,5)]	(3.15)	(2.09)	(2.16)
invper	-6.57***	1.26	1.53
[inverse of a period trend, 1/*t*]	(2.20)	(3.31)	(3.15)
constant	64.65***	52.92***	43.60***
	(2.52)	(2.44)	(2.48)
Observations	2880	2880	2880
Number of subjects	144	144	144

* significant at 10%, ** significant at 5%, *** significant at 1%. Standard errors in parenthesis.

The estimation results indicate that the *risk-averse* variable, which is a dummy variable equal to one if a subject exhibits risk aversion in their lottery choices, is systematically associated with lower effort choices in all contests. The *utility-of-winning* variable is the costly effort expended to win the prize that has zero monetary value, and is systematically associated with higher effort especially in the probabilistic contest, where over-expenditure relative to the theoretical prediction is most pronounced. Finally, no correlation exists between our measures of other-regarding preferences (*aheadness-averse* and *behindness-averse*) and contest effort choices. These conclusions are robust when controlling for all four individual other-regarding preference responses (see Table B1 in Appendix B), demographic characteristics (see Table B2 in Appendix B), and lag variables of past expeience (see Table B3 in Appendix B).

Result 5. Risk-aversion and the utility of winning have similar impact on behavior in different contests, with higher risk aversion leading to lower effort and higher utility of winning leading to higher effort in all contests.

5.5. Correlation of Subjects' Efforts between Contests

An important feature of our within-subject experimental design is that it allows us to observe individual subject behavior in all three contests. Therefore, we can study whether subjects behave consistently across different types of contests.

Figure 3: Correlation of Subjects' Efforts between Contests

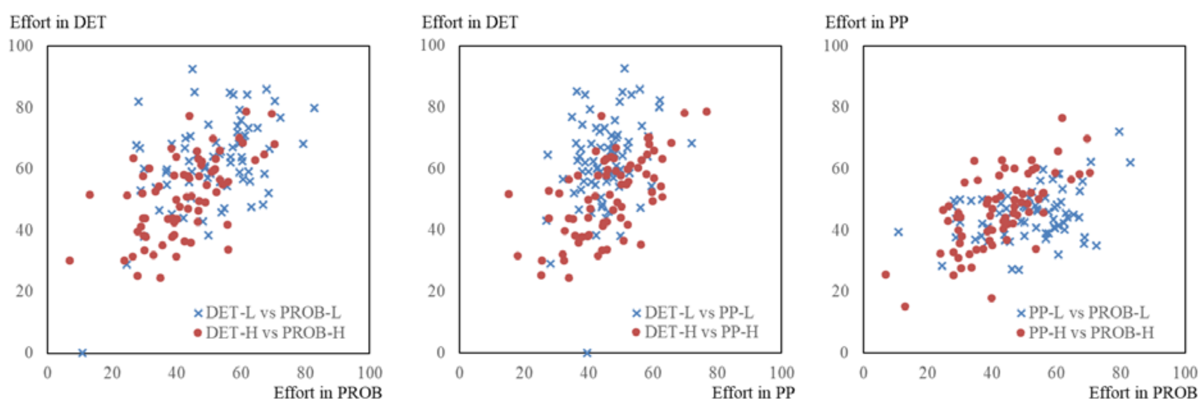


Figure 3 displays pairwise correlations of individual subjects' efforts between contests. The left panel of Figure 3 displays each subject's average effort in the winner-pay-all deterministic (DET-L and DET-H) and probabilistic (PROB-L and PROB-H) contests. A data point represents an individual subject's average effort in the deterministic contest (y-axis) and the probabilistic contest (x-axis). Consistent with the apparent correlation, the Spearman correlation coefficient between the deterministic and probabilistic efforts is ρ = 0.50. Interestingly, the correlation is higher between the high noise variance treatments (ρ = 0.59) than between the low noise variance treatments (ρ = 0.34). This suggests that at least part of the observed correlation of individual subjects' efforts between the two contests can be driven by factors that influence behavior in both contests. To check this, we have estimated several seemingly unrelated regressions (see Table B4 in Appendix B) to account for correlation of error terms between contests and factors influencing behavior in both contests, such as the noise variance and preference characteristics (e.g., risk aversion, other-regarding preferences, and the utility of winning). Accounting for all these factors reduces correlation by only 0.05, suggesting that subjects exhibit consistent behavior across different types of contests.

The middle panel of Figure 3 displays the correlation of effort between the deterministic (DET-L and DET-H) and proportional-prize (PP-L and PP-H) contests. The Spearman correlation coefficient is ρ = 0.45 using all data, ρ = 0.56 using data from the high noise variance treatments, and ρ = 0.28 using data from the low noise variance treatments. Accounting for the factors influencing behavior in both contests, the correlation is reduced by 0.04 (see Table B5 in Appendix B).

Finally, the right panels of Figure 3 displays the correlation of effort between the proportional-prize (PP-L and PP-H) and probabilistic (PROB-L and PROB-H) contests. The Spearman correlation coefficient is ρ = 0.45 using all data, ρ = 0.64 using data from high noise variance treatments, and ρ = 0.21 using data from low noise variance treatments. Accounting for the factors influencing behavior in both contests, the correlation is reduced by 0.06 (see Table B6 in Appendix B).

Result 6. A significant correlation of subjects' efforts exists between contests, as subjects who exert higher effort in one contest also typically exert higher effort in another contest. This correlation is stronger between high noise variance treatments than between low noise variance treatments. However, this correlation persists even after controlling for various factors influencing behavior across contests.

6. Conclusion

This study makes two main contributions. First, we provide a unified theoretical and experimental framework to compare different contest designs and test how contestants respond to winner-take-all as opposed to proportional incentives. Second, we examine consistency of individual behavior across different contests.

Our model compares three contest designs: In deterministic winner-take-all contests, a single prize is allocated to the highest performing contestant. Probabilistic winner-take-all contests allocate that prize by lottery with probabilities weighted by the contestants' share of total performance. A proportional-prize contest divides that same prize among the contestants according to their share of total performance. For each case we derive the Nash equilibrium for risk-neutral and self-interested competitors. To test the predictions of our model, we conduct a laboratory experiment using a within-subjects design. We also elicit contestants' levels of risk aversion, other-regarding preferences, and utility of winning a contest without monetary value, and then test the degree to which these preferences help explain subjects' choices.

Equilibrium and observed efforts are consistently highest in the deterministic winner-take-all contest. The equilibrium level of effort is lower and identical for the probabilistic and proportional contests. Relative to the Nash equilibrium, subjects incur excess effort in both of these contest types, but this over-expenditure is larger in the winner-take-all lottery than when the prize is shared proportionally to performance. Behavioral deviations from theoretical benchmarks in different contests are caused by the same underlying attributes, such as risk-aversion and the utility of winning. Finally, we find that subjects exhibit consistent behavior across different types of contests, with subjects exerting higher effort in one contest also exerting higher effort in another contest.

Our study contributes to several areas of research. First, we provide a unified theoretical model of different contests and show that deterministic and probabilistic winner-take-all and proportional-prize contests can be derived from the same underling theoretical structure. There has been some effort to identify theoretically common links between different contests in the literature (Fang, 2002; Jia, 2007; Fu and Lu, 2012; Chowdhury and Sheremeta, 2015). Hirshleifer and Riley (1992), for example, show how an R&D race between two players that is modeled as a rank-order tournament of Lazear and Rosen (1981) is equivalent to a lottery contest of Tullock (1980). Similarly, Baye and Hoppe (2003) identify conditions under which innovation tournaments and patent-race models are strategically equivalent to the lottery contest. Our contribution to this literature is to show that the three canonical models of Tullock (1980), Lazear and Rosen (1981), and Hillman and Riley (1989) can be obtained from the same generalized theoretical structure.

Our study also makes a novel contribution to the experimental literature on contests, reviewed recently in Dechenaux et al. (2015). Since the early attempts of Bull et al. (1987) and Millner and Pratt (1989), a growing number of studies have examined behavior in different types of contests. Almost without exception, existing experimental studies find systematic deviation of behavior from theoretical predictions, such as expenditures that exceed Nash equilibrium levels and are widely dispersed, but confirm the various models' comparative statics predictions. Our results are similarly consistent. We find support for our comparative statics predictions, but we also find systematic deviation of behavior from theoretical predictions. Importantly, we find that behavioral deviations from theoretical benchmarks in different contests, at least in part, are caused by similar preference heterogeneity, such as risk-aversion and the utility of winning.

Our research also complements recent experimental studies comparing behavior in proportional-prize contests to lottery contests (Cason et al., 2010; Chowdhury et al., 2014;

Masiliunas et al., 2012; Fallucchi et al., 2013). Most of these studies find that lottery contests generate higher efforts than proportional-prize contests. Our experiment shows that this same ranking between the proportional-prize and lottery contests is robust to a setting where there is a noisy mapping between a contestant's effort and their observed performance. This is a more realistic assumption for many real world contestants who may not know how well their efforts produce results and employers may not be able to observe effort or performance directly.

Finally, our study contributes to the discussion on the optimal design of contests (Gradstein, 1998; Moldovanu and Sela, 2001; Sheremeta, 2011). One principal motivation here is to help understand the behavior of both contestants and contest designers, in particular to explain why artificial contests almost always offer winner-take-all prizes instead of shared rewards (McKinsey and Company, 2009). In our setting, winner-take-all prizes elicit higher efforts, leaving contestants with lower average and more unequal payoffs. This robust difference in behavior is consistent with Nash equilibrium when the prize is paid deterministically, and arises despite an identical Nash equilibrium prediction when the prize is awarded probabilistically. The implication is that contest sponsors who choose winner-take-all incentives in this setting elicit greater effort at the expense of contestants' welfare. A contest designer concerned with social efficiency or inequality should offer proportional incentives instead.[12] Exploring the generalizability of this conclusion will require further work in other settings, including laboratory and field experiments with varying costs and payoff structures. We anticipate that such work could further advance

[12] Proportional incentives would also be helpful in situations where contestants are not symmetrical, to overcome the discouragement effect of rank order contests and elicit more entry and effort from contestants who are likely to be lower-ranked (Cason et al. 2010, Singh and Masters 2017a). Even with symmetric contestants, however, maximizing total effort and/or individual payoffs are not the only objectives that the contest designer may pursue. Often, the objective of a contest designer is to maximize the highest individual effort (as in R&D races) or to minimize the total equilibrium effort (as in electoral races). These and other objectives would require different types of contest structures that are beyond the scope of the current study.

understanding of why designers choose particular contest rules, and the resulting welfare implications.

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Appendix A (For Online Publication) - Experimental Instructions

GENERAL INSTRUCTIONS

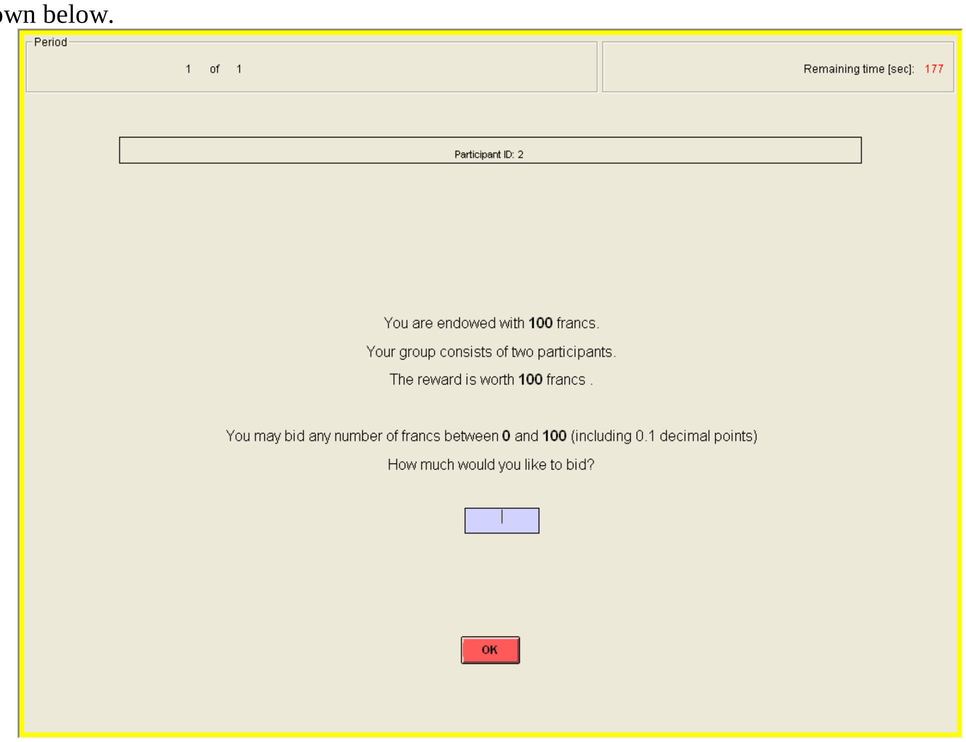
This is an experiment in the economics of strategic decision making. Various research agencies have provided funds for this research. The instructions are simple. If you follow them closely and make appropriate decisions, you can earn an appreciable amount of money.

The experiment will proceed in six parts. Each part contains decision problems that require you to make a series of economic choices which determine your total earnings. The currency used in Parts 1 through 4 of the experiment is francs. Francs will be converted to U.S. dollars at a rate of **60** francs to **1** dollar. The currency used in Parts 5 and 6 of the experiment is U.S. dollars. At the end of today's experiment, you will be paid in private and in cash. There are **12** participants in today's experiment.

It is very important that you remain silent and do not look at other people's work. If you have any questions, or need assistance of any kind, please raise your hand and an experimenter will come to you. If you talk, laugh, exclaim out loud, etc., you will be asked to leave and you will not be paid. We expect and appreciate your cooperation.

INSTRUCTIONS FOR PART 1
YOUR DECISION

This part of the experiment consists of **20 decision-making periods**. At the beginning of each period, you will be randomly and anonymously paired with someone else in a group of **two participants**. The composition of your group will be changed randomly every period. Each period, both participants will be given an initial **endowment of 100 francs**. You will use this endowment to bid for **a share of an additional 100 francs reward** available in each period. You may bid any number between **0** and **100** (including 0.1 decimal points). An example of your decision screen is shown below.



For each **bid** there is an associated **cost**. Table is attached to these instructions: each possible bid is given in column A, and its cost is given in column B. Note that as bids rise from 0 to 100, costs rise exponentially. The cost of bid can be also calculated using the following formula:

$$\text{Cost of bid} = \frac{(\text{Your bid})^2}{100}$$

After you make your bid, the computer will multiply it by a "personal random number" to determine your **final bid**. This number can take any value between 0.5 and 1.5. Each number between 0.5 and 1.5 is equally likely to be drawn and there is one separate and independent random draw between 0.5 and 1.5 for each decision period and each person in the lab.

Your final bid = your bid × your personal random number

YOUR EARNINGS

After you and the other participant in your group have chosen your bids, the computer will draw the random numbers and compare your final bid to the other participant's final bid, and allocate to you a share of the **100 franc reward** according to your share of the sum of the two final bids. In other words, your share is:

$$\text{Share} = 100 \times \frac{\text{Your final bid}}{\text{Your final bid + The other participant's final bid}}$$

You also retain any endowment not spent on the bid, so your total earnings for the period are equal to your endowment plus the share minus the cost of your bid. In other words, your earnings are:

Earnings = Endowment + Share – Cost of your bid = 100 + Share – Cost of your bid

Note that the cost of your bid is determined by the bid you chose. The random number influences only your share of the final bids for that period.

<u>An Example</u>

Let's say you make a bid of 36 francs, while the other participant in your group makes a bid of 40 francs, and then your personal random number turns out to be 1.25 while the other participant in your group has a personal random number of 0.8. Therefore, your final bid is 45 = 36 × 1.25 and the other participant's final bid is 32 = 40 × 0.8. Your share of the reward is $58.44 = 100 \times \frac{45}{45 + 32}$. Finally, your earnings for the period are 145.48 = 100 + 58.44 – 12.96, because the cost of your bid of 36 is 12.96 as shown on your Cost of Bid table.

At the end of each period, your bid, your random number, your final bid, the other participant's bid, the other participant's random number, the other participant's final bid, your share, 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.

IMPORTANT NOTES

You will not be told which of the participants in this room are assigned to which group. At the beginning of each period you will be randomly re-grouped with one of the other participants to from a two-person group.

At the end of the experiment we will randomly choose **2 of the 20** periods for actual payment for this part of experiment using a bingo cage. You will sum the total earnings for these 2 periods and convert them to a U.S. dollar payment.

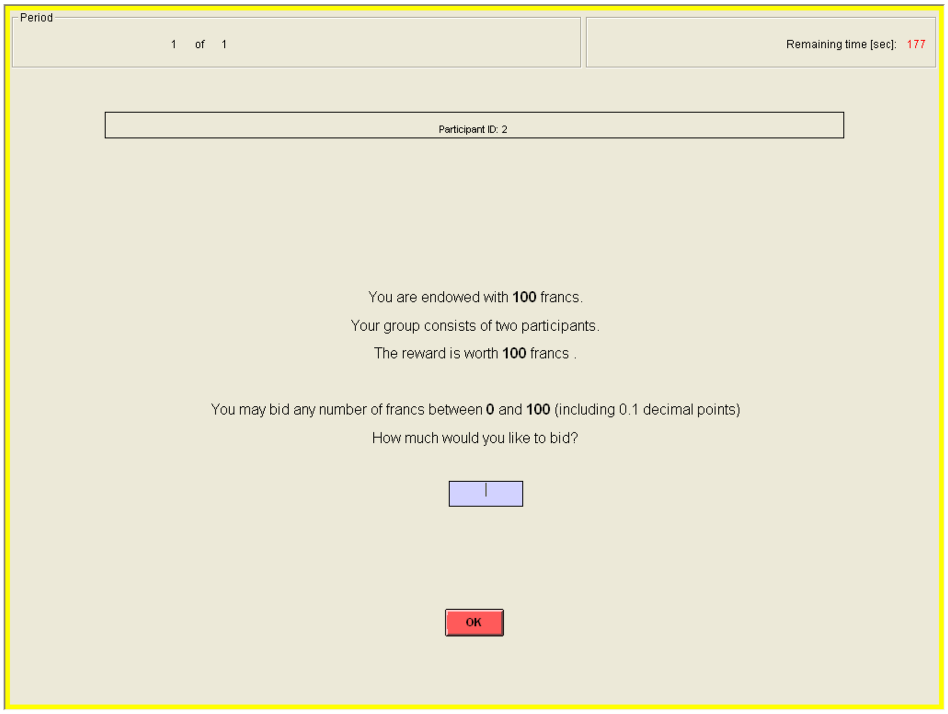
Table – Cost of Bid

Column A	Column B	Column A	Column B	Column A	Column B
Bid	Cost of Bid	Bid	Cost of Bid	Bid	Cost of Bid
0	0.00	34	11.56	68	46.24
1	0.01	35	12.25	69	47.61
2	0.04	36	12.96	70	49.00
3	0.09	37	13.69	71	50.41
4	0.16	38	14.44	72	51.84
5	0.25	39	15.21	73	53.29
6	0.36	40	16.00	74	54.76
7	0.49	41	16.81	75	56.25
8	0.64	42	17.64	76	57.76
9	0.81	43	18.49	77	59.29
10	1.00	44	19.36	78	60.84
11	1.21	45	20.25	79	62.41
12	1.44	46	21.16	80	64.00
13	1.69	47	22.09	81	65.61
14	1.96	48	23.04	82	67.24
15	2.25	49	24.01	83	68.89
16	2.56	50	25.00	84	70.56
17	2.89	51	26.01	85	72.25
18	3.24	52	27.04	86	73.96
19	3.61	53	28.09	87	75.69
20	4.00	54	29.16	88	77.44
21	4.41	55	30.25	89	79.21
22	4.84	56	31.36	90	81.00
23	5.29	57	32.49	91	82.81
24	5.76	58	33.64	92	84.64
25	6.25	59	34.81	93	86.49
26	6.76	60	36.00	94	88.36
27	7.29	61	37.21	95	90.25
28	7.84	62	38.44	96	92.16
29	8.41	63	39.69	97	94.09
30	9.00	64	40.96	98	96.04
31	9.61	65	42.25	99	98.01
32	10.24	66	43.56	100	100.00
33	10.89	67	44.89		

INSTRUCTIONS FOR PART 2

YOUR DECISION

This part of the experiment consists of **20 decision-making periods**. At the beginning of each period, you will be randomly and anonymously paired with someone else in a group of **two participants**. The composition of your group will be changed randomly every period. Each period, both participants will be given an initial **endowment of 100 francs**. You will use this endowment to bid for **an additional 100 francs reward** available in each period. You may bid any number between **0** and **100** (including 0.1 decimal points). An example of your decision screen is shown below.



For each **bid** there is an associated **cost**. Table is attached to these instructions: each possible bid is given in column A, and its cost is given in column B. Note that as bids rise from 0 to 100, costs rise exponentially. The cost of bid can be also calculated using the following formula:

$$\text{Cost of bid} = \frac{(\text{Your bid})^2}{100}$$

After you make your bid, the computer will multiply it by a "personal random number" to determine your **final bid**. This number can take any value between 0.5 and 1.5. Each number between 0.5 and 1.5 is equally likely to be drawn and there is one separate and independent random draw between 0.5 and 1.5 for each decision period and each person in the lab.

Your final bid = your bid × your personal random number

YOUR EARNINGS

After you and the other participant in your group have chosen your bids, the computer will draw the random numbers and compare your final bid to the other participant's final bid. If your final bid is higher than the other participant's final bid, you will receive a reward of **100 francs**. Otherwise you will receive **0 francs**.

If you receive the reward, your earnings for the period are equal to your endowment plus the reward minus the cost of your bid. If you do not receive the reward, your earnings for the period are equal to your endowment minus the cost of your bid. In other words, your earnings are:

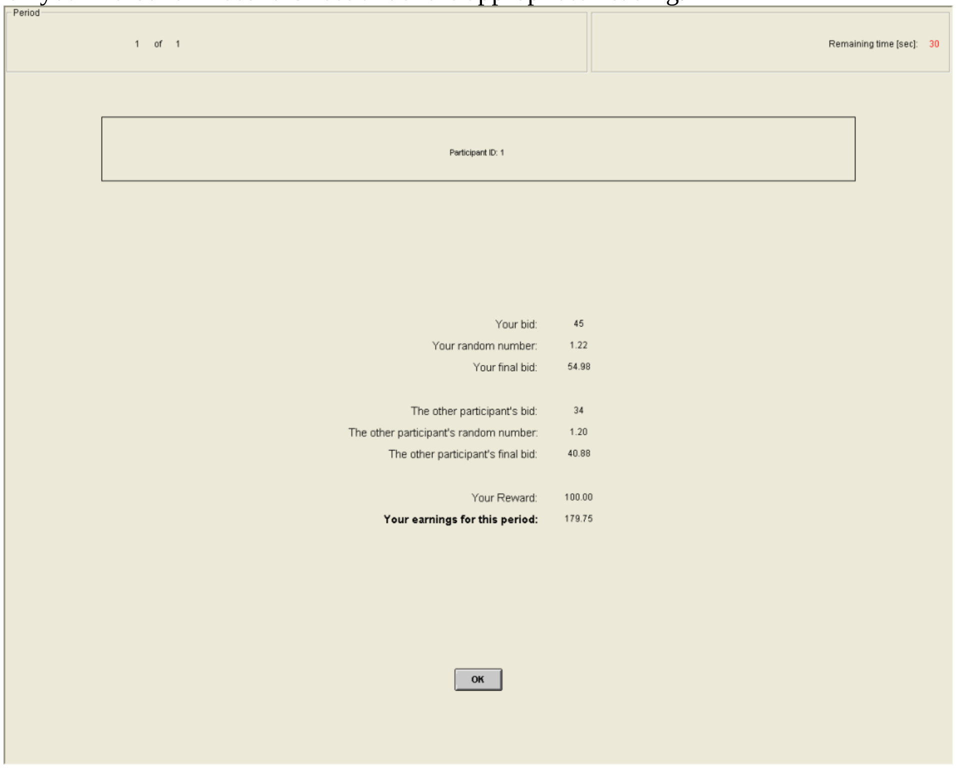
If you receive the reward:
Earnings = Endowment + Reward – Cost of your bid = 100 + 100 – Cost of your bid
If you do not receive the reward:
Earnings = Endowment – Cost of your bid = 100 – Cost of your bid

Note that the cost of your bid is determined by the bid you chose, rather than the final bid influenced by the random number.

<u>An Example</u>

Let's say you make a bid of 36 francs while the other participant in your group makes a bid of 40 francs, and then your personal random number turns out to be 1.25 while his personal random number is 0.8. Therefore, your final bid is 45 = 36 × 1.25 and the other participant's final bid is 32 = 40 × 0.8. Since your final bid of 45 is higher than the other participant's final bid of 32, you receive the reward. Your earnings for the period are 187.04 = 100 + 100 – 12.96, because the cost of your bid of 36 is 12.96 as shown on your Cost of Bid table.

At the end of each period, your bid, your random number, your final bid, the other participant's bid, the other participant's random number, the other participant's final bid, your reward, 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.



IMPORTANT NOTES

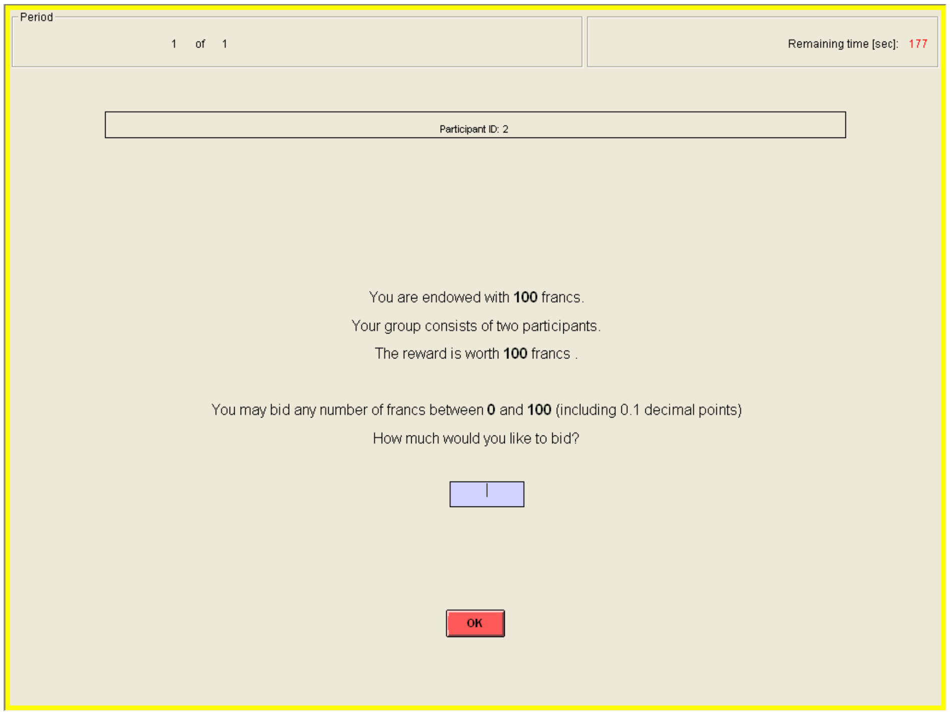
You will not be told which of the participants in this room are assigned to which group. At the beginning of each period you will be randomly re-grouped with one of the other participants to from a two-person group.

At the end of the experiment we will randomly choose **2 of the 20** periods for actual payment for this part of experiment using a bingo cage. You will sum the total earnings for these 2 periods and convert them to a U.S. dollar payment.

INSTRUCTIONS FOR PART 3

YOUR DECISION

This part of the experiment consists of **20 decision-making periods**. At the beginning of each period, you will be randomly and anonymously paired with someone else in a group of **two participants**. The composition of your group will be changed randomly every period. Each period, both participants will be given an initial **endowment of 100 francs**. You will use this endowment to bid for **an additional 100 francs reward** available in each period. You may bid any number between **0** and **100** (including 0.1 decimal points). An example of your decision screen is shown below.



For each **bid** there is an associated **cost**. Table is attached to these instructions: each possible bid is given in column A, and its cost is given in column B. Note that as bids rise from 0 to 100, costs rise exponentially. The cost of bid can be also calculated using the following formula:

$$\text{Cost of bid} = \frac{(\text{Your bid})^2}{100}$$

After you make your bid, the computer will multiply it by a "personal random number" to determine your **final bid**. This number can take any value between 0.5 and 1.5. Each number between 0.5 and 1.5 is equally likely to be drawn and there is one separate and independent random draw between 0.5 and 1.5 for each decision period and each person in the lab.

$$\text{Your final bid} = \text{your bid} \times \text{your personal random number}$$

YOUR EARNINGS

The computer will draw the random numbers to determine your final bid to the other participant's final bid. The chance that you receive the reward is higher when you bid higher, and is lower when the other participant bids higher:

$$\text{Chance of Receiving the Reward} = \frac{\text{Your final bid}}{\text{Your final bid} + \text{The other participant's final bid}}$$

You can consider the amounts of the final bids to be equivalent to numbers of lottery tickets. The computer will draw one ticket from those entered by you and the other participant through your final bids, and assign the reward to one of you through this random draw. If you receive the reward, your earnings for the period are equal to your endowment plus the reward minus the cost of your bid. If you do not receive the reward, your earnings for the period are equal to your endowment minus the cost of your bid. In other words, your earnings are:

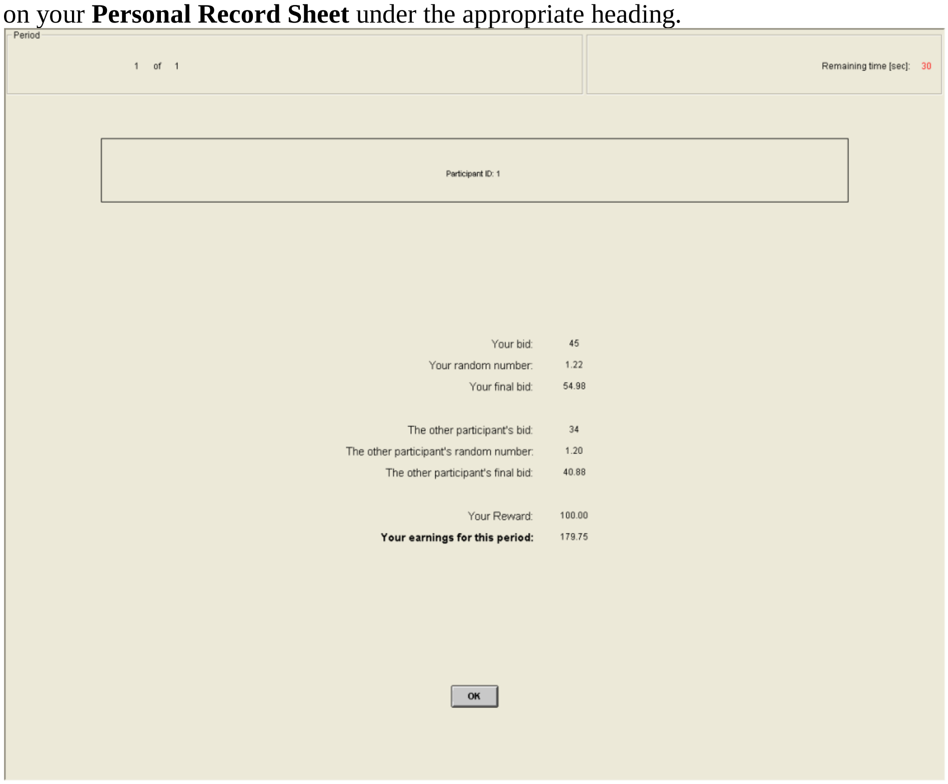
If you receive the reward:
Earnings = Endowment + Reward – Cost of your bid = 100 + 100 – Cost of your bid
If you do not receive the reward:
Earnings = Endowment – Cost of your bid = 100 – Cost of your bid

Note that the cost of your bid is determined by the bid you chose, rather than the final bid influenced by the random number.

<u>An Example</u>

Let's say you make a bid of 36 francs, while the other participant in your group makes a bid of 40 francs, and then your personal random number turns out to be 1.25 while the other participant in your group has a personal random number of 0.8. Therefore, your final bid is 45 = 36 × 1.25 and the other participant's final bid is 32 = 40 × 0.8. Your chance of receiving the reward is 0.58 = 45/(45+32). Assume that the computer assigns the reward to you, then your earnings for the period are 187.04 = 100 + 100 – 12.96, because the cost of your bid of 36 is 12.96 as shown on your Cost of Bid table.

At the end of each period, your bid, your random number, your final bid, the other participant's bid, the other participant's random number, the other participant's final bid, your reward, 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.



IMPORTANT NOTES

You will not be told which of the participants in this room are assigned to which group. At the beginning of each period you will be randomly re-grouped with one of the other participants to from a two-person group.

At the end of the experiment we will randomly choose **2 of the 20** periods for actual payment for this part of experiment using a bingo cage. You will sum the total earnings for these 2 periods and convert them to a U.S. dollar payment.

INSTRUCTIONS FOR PART 4

This part of the experiment consists of only 1 decision-making period. The rules for this part are the same as the rules for **Part 2**. At the beginning of the period, you will be you randomly and anonymously paired with someone else in a group of **two participants**. You will be given an initial **endowment of 100 francs**. You will use this endowment to bid in order to be **a winner**. You may bid any number between **0** and **100** (including 0.1 decimal points). The only difference from **Part 2** is that the winner **does not receive the reward**. Therefore, the reward is worth **0** francs to you and the other participant in your group.

After you make your bid, the computer will multiply it by a "personal random number" to determine your **final bid**. This number can take any value between 0.5 and 1.5. Each number between 0.5 and 1.5 is equally likely to be drawn and there is one separate and independent random draw between 0.5 and 1.5 for each decision period and each person in the lab. After you and the other participant in your group have chosen your bids, the computer will draw the random numbers and compare your final bid to the other participant's final bid. If your final bid is higher than the other participant's final bid, you will be declared the winner. After all participants have made their decisions, your earnings for the period are calculated:

If you **win**:
Earnings = Endowment – Cost of your bid = 100 – Cost of your bid
If you **do not win**:
Earnings = Endowment – Cost of your bid = 100 – Cost of your bid

Note that the cost of your bid is determined by the bid you chose, rather than the final bid influenced by the random number.

After all participants have made their decisions, you will learn whether you win or not. The computer then will display your earnings for the period on the outcome screen. Your earnings will be converted to cash and paid at the end of the experiment.

INSTRUCTIONS FOR PART 5
YOUR DECISION

In this part of the experiment you will be asked to make a series of choices in decision problems. How much you receive will depend partly on **chance** and partly on the **choices** you make. The decision problems are not designed to test you. What we want to know is what choices you would make in them. The only right answer is what you really would choose.

For each line in the table in the next page, please state whether you prefer option A or option B. Notice that there are a total of **15 lines** in the table but just **one line** will be randomly selected for payment. You do not know which line will be paid when you make your choices. Hence you should pay attention to the choice you make in every line. After you have completed all your choices a token will be randomly drawn out of a bingo cage containing tokens numbered from **1 to 15**. The token number determines which line is going to be paid.

Your earnings for the selected line depend on which option you chose: If you chose option A in that line, you will receive **$1**. If you chose option B in that line, you will receive either **$3** or **$0**. To determine your earnings in the case you chose option B there will be second random draw. A token will be randomly drawn out of the bingo cage now containing twenty tokens numbered from **1 to 20**. The token number is then compared with the numbers in the line selected (see the table). If the token number shows up in the left column you earn $3. If the token number shows up in the right column you earn $0.

Decision no.	**Option A**	**Option B**		Please choose A or B
1	**$1**	**$3** never	**$0** if 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
2	**$1**	**$3** if 1 comes out of the bingo cage	**$0** if 2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
3	**$1**	**$3** if 1 or 2	**$0** if 3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
4	**$1**	**$3** if 1,2,3	**$0** if 4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
5	**$1**	**$3** if 1,2,3,4,	**$0** if 5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
6	**$1**	**$3** if 1,2,3,4,5	**$0** if 6,7,8,9,10,11,12,13,14,15,16,17,18,19,20	
7	**$1**	**$3** if 1,2,3,4,5,6	**$0** if 7,8,9,10,11,12,13,14,15,16,17,18,19,20	
8	**$1**	**$3** if 1,2,3,4,5,6,7	**$0** if 8,9,10,11,12,13,14,15,16,17,18,19,20	
9	**$1**	**$3** if 1,2,3,4,5,6,7,8	**$0** if 9,10,11,12,13,14,15,16,17,18,19,20	
10	**$1**	**$3** if 1,2,3,4,5,6,7,8,9	**$0** if 10,11,12,13,14,15,16,17,18,19,20	
11	**$1**	**$3** if 1,2, 3,4,5,6,7,8,9,10	**$0** if 11,12,13,14,15,16,17,18,19,20	
12	**$1**	**$3** if 1,2, 3,4,5,6,7,8,9,10,11	**$0** if 12,13,14,15,16,17,18,19,20	
13	**$1**	**$3** if 1,2, 3,4,5,6,7,8,9,10,11,12	**$0** if 13,14,15,16,17,18,19,20	
14	**$1**	**$3** if 1,2, 3,4,5,6,7,8,9,10,11,12,13	**$0** if 14,15,16,17,18,19,20	
15	**$1**	**$3** if 1,2, 3,4,5,6,7,8,9,10,11,12,13,14	**$0** if 15,16,17,18,19,20	

INSTRUCTIONS FOR PART 6
YOUR DECISION

In this part of the experiment you will be asked to make a series of choices in decision problems. For each line in the table in the next page, please state whether you prefer option A or option B. Notice that there are a total of **4 lines** in the table but just **one line** will be randomly selected for payment. Each line is equally likely to be chosen, so you should pay equal attention to the choice you make in every line. After you have completed all your choices a token will be randomly drawn out of a bingo cage containing tokens numbered from **1 to 4**. The token number determines which line is going to be paid.

Your earnings for the selected line depend on which option you chose: if you chose option A in that line, you will receive **$2** and the other participant who will be matched with you will also receive **$2**. If you chose option B in that line, you and the other participant will receive earnings as indicated in the table for that specific line. For example, if you chose B in line 2 and this line is selected for payment, you will receive **$3** and the other participant will receive **$1**. Similarly, if you chose B in line 3 and this line is selected for payment, you will receive **$2** and the other participant will receive **$4**.

After you have completed all your choices we will use a bingo cage to determine which line is going to be paid. Then the computer will randomly and anonymously match you with another participant in the experiment. While matching you with another participant, the computer will also randomly determine whose decision to implement. If the computer chooses your decision to implement, then the earnings to you and the other participant will be determined according to your choice of A or B. If the computer chooses the other participant decision to implement, then the earnings will determined according to the other participant choice of A or B.

Decision no.	**Distribution A (you, the other participant)**	**Distribution B (you, the other participant)**	Please choose A or B
1	**$2 to you, $2 to other participant**	**$2 to you, $1 to other participant**	
2	**$2 to you, $2 to other participant**	**$3 to you, $1 to other participant**	
3	**$2 to you, $2 to other participant**	**$2 to you, $4 to other participant**	
4	**$2 to you, $2 to other participant**	**$3 to you, $5 to other participant**	

Appendix B (For Online Publication) – Additional Analysis

Table B1: Random-Effect Regressions of Effort (Controlling for All Four Individual Other-Regarding Preference Responses)

Treatment	DET	PROB	PP
Dependent variable, effort	(1)	(2)	(3)
noise-variance	-10.06***	-1.89	-3.15
[treatment dummy]	-3.39	-2.22	-2.13
utility-of-winning	0.06	0.07*	0.10***
[effort for prize value 0]	-0.04	-0.04	-0.04
risk-averse	-3.59**	-3.17*	-5.22***
[1 if number of safe options 1 > 8]	-1.75	-1.88	-1.97
aheadness-averse-1	-0.28	1.61	3.53*
[1 if (2,2) is preferred to (2,1)]	-2.47	-1.43	-1.82
aheadness-averse-2	-3.68	1.31	0.86
[1 if (2,2) is preferred to (3.1)]	-3.28	-3.03	-2.83
behindness-averse-1	2.93	-0.05	5.52
[1 if (2,2) is preferred to (2,4)]	-3.47	-2.19	-3.88
behindness-averse-2	-1.93	-1.04	-3.36
[1 if (2,2) is preferred to (3,5)]	-3.58	-2.29	-2.81
Invper	-6.57***	1.53	1.26
[inverse of a period trend, 1/*t*]	-2.20	-3.15	-3.31
constant	63.88***	42.12***	47.78***
	-3.08	-2.98	-3.33
Observations	2736	2736	2736
Number of subjects	144	144	144

* significant at 10%, ** significant at 5%, *** significant at 1%.
Standard errors in parenthesis.

Table B2: Random-Effect Regressions of Effort (Controlling for Gender and Age)

Treatment	DET	PROB	PP
Dependent variable, effort	(1)	(2)	(3)
noise-variance	-10.36***	-3.83*	-2.11
[treatment dummy]	-3.33	-2.04	-2.24
utility-of-winning	0.07*	0.13***	0.08**
[effort for prize value 0]	-0.04	-0.04	-0.04
risk-averse	-3.51**	-5.69***	-3.11
[1 if number of safe options 1 > 8]	-1.57	-1.93	-1.92
aheadness-averse	-3.82	0.64	1.72
[1 if (2,2) is preferred to (2,1) and (3.1)]	-3.08	-2.84	-3.02
behindness-averse	-0.41	-1.19	-2.07
[1 if (2,2) is preferred to (2,4) and (3,5)]	-3.61	-2.18	-2.44
invper	-6.69***	1.00	1.75
[inverse of a period trend, 1/*t*]	-2.17	-3.28	-3.15
male	-1.82	1.46	-0.63
[1 if male and 0 otherwise]	-2.53	-2.46	-1.98
age	-0.10	0.34	0.04
[age of subject]	-0.46	-0.48	-0.35
constant	68.16***	44.88***	42.78***
	-8.87	-9.79	-8.06
Observations	2840	2840	2840
Number of subjects	144	144	144

* significant at 10%, ** significant at 5%, *** significant at 1%.
Standard errors in parenthesis.

Table B3: Random-Effect Regressions of Effort (Controlling for Lag Variables)

Treatment	DET	PROB	PP
Dependent variable, effort	(1)	(2)	(3)
noise-variance	-2.74***	-1.29*	-0.31
[treatment dummy]	-0.93	-0.71	-0.99
utility-of-winning	0.03**	0.06***	0.04**
[effort for prize value 0]	-0.01	-0.02	-0.02
risk-averse	-1.58***	-2.47***	-1.63*
[1 if number of safe options 1 > 8]	-0.54	-0.80	-0.90
aheadness-averse	-1.55	0.64	0.98
[1 if (2,2) is preferred to (2,1) and (3.1)]	-1.17	-1.17	-1.56
behindness-averse	0.15	-0.78	-0.65
[1 if (2,2) is preferred to (2,4) and (3,5)]	-1.16	-0.84	-1.03
invper	4.99***	4.24*	4.02*
[inverse of a period trend, 1/*t*]	-1.69	-2.31	-2.31
effort-lag	0.66***	0.60***	0.53***
[own effort in period *t*-1]	-0.03	-0.04	-0.04
number-lag	0.24	0.23	-0.42
[own random number in period *t*-1]	-0.73	-0.65	-0.58
othereffort-lag	0.10***	0.07***	0.11***
[other effort in period *t*-1]	-0.02	-0.01	-0.03
othernumber-lag	0.40	1.40***	2.58***
[other random number in period *t*-1]	-0.45	-0.43	-0.74
constant	14.24***	15.82***	12.97***
	-1.78	-1.69	-2.23
Observations	2736	2736	2736
Number of subjects	144	144	144

* significant at 10%, ** significant at 5%, *** significant at 1%.
Standard errors in parenthesis.

Table B4: Seemingly Unrelated Regressions (DET and PROB)

Specification	(1)	(2)	(3)
Dependent variable, effort in DET			
noise-variance		-11.18***	-10.17***
[treatment dummy]		-2.31	-2.32
utility-of-winning			0.07
[effort for prize value 0]			-0.04
risk-averse			-4.45*
[1 if number of safe options 1 > 8]			-2.42
aheadness-averse			-3.24
[1 if (2,2) is preferred to (2,1) and (3.1)]			-3.10
behindness-averse			-0.40
[1 if (2,2) is preferred to (2,4) and (3,5)]			-3.32
constant	56.79***	62.38***	64.02***
	-1.24	-1.63	-2.37
Dependent variable, effort in PROB			
noise-variance		-5.16**	-3.83*
[treatment dummy]		-2.13	-2.08
utility-of-winning			0.12***
[effort for prize value 0]			-0.04
risk-averse			-5.58***
[1 if number of safe options 1 > 8]			-2.16
aheadness-averse			0.94
[1 if (2,2) is preferred to (2,1) and (3.1)]			-2.77
behindness-averse			-1.07
[1 if (2,2) is preferred to (2,4) and (3,5)]			-2.97
constant	48.72***	51.30***	51.97***
	-1.09	-1.51	-2.12
Observations	144	144	144
Correlation	0.54	0.52	0.49
p-value	<0.01	<0.01	<0.01

* significant at 10%, ** significant at 5%, *** significant at 1%.
Standard errors in parenthesis.

Table B5: Seemingly Unrelated Regressions (DET and PP)

Specification	(1)	(2)	(3)
Dependent variable, effort in DET			
noise-variance		-11.18***	-10.17***
[treatment dummy]		-2.31	-2.32
utility-of-winning			0.07
[effort for prize value 0]			-0.04
risk-averse			-4.45*
[1 if number of safe options 1 > 8]			-2.42
aheadness-averse			-3.24
[1 if (2,2) is preferred to (2,1) and (3.1)]			-3.10
behindness-averse			-0.40
[1 if (2,2) is preferred to (2,4) and (3,5)]			-3.32
constant	56.79***	62.38***	64.02***
	-1.24	-1.63	-2.37
Dependent variable, effort in PP			
noise-variance		-2.85	-1.94
[treatment dummy]		-1.75	-1.75
utility-of-winning			0.08**
[effort for prize value 0]			-0.03
risk-averse			-3.46*
[1 if number of safe options 1 > 8]			-1.82
aheadness-averse			1.92
[1 if (2,2) is preferred to (2,1) and (3.1)]			-2.33
behindness-averse			-1.81
[1 if (2,2) is preferred to (2,4) and (3,5)]			-2.50
constant	43.78***	45.21***	45.50***
	-0.88	-1.24	-1.78
Observations	144	144	144
Correlation	0.46	0.44	0.42
p-value	<0.01	<0.01	<0.01

* significant at 10%, ** significant at 5%, *** significant at 1%.
Standard errors in parenthesis.

Table B6: Seemingly Unrelated Regressions (PP and PROB)

Specification	(1)	(2)	(3)
Dependent variable, effort in PP			
noise-variance		-2.85	-1.94
[treatment dummy]		-1.75	-1.75
utility-of-winning			0.08**
[effort for prize value 0]			-0.03
risk-averse			-3.46*
[1 if number of safe options 1 > 8]			-1.82
aheadness-averse			1.92
[1 if (2,2) is preferred to (2,1) and (3.1)]			-2.33
behindness-averse			-1.81
[1 if (2,2) is preferred to (2,4) and (3,5)]			-2.50
constant	43.78***	45.21***	45.50***
	-0.88	-1.24	-1.78
Dependent variable, effort in PROB			
noise-variance		-5.16**	-3.83*
[treatment dummy]		-2.13	-2.08
utility-of-winning			0.12***
[effort for prize value 0]			-0.04
risk-averse			-5.58***
[1 if number of safe options 1 > 8]			-2.16
aheadness-averse			0.94
[1 if (2,2) is preferred to (2,1) and (3.1)]			-2.77
behindness-averse			-1.07
[1 if (2,2) is preferred to (2,4) and (3,5)]			-2.97
constant	48.72***	51.30***	51.97***
	-1.09	-1.51	-2.12
Observations	144	144	144
Correlation	0.52	0.50	0.46
p-value	<0.01	<0.01	<0.01

* significant at 10%, ** significant at 5%, *** significant at 1%.
Standard errors in parenthesis.