Experimental Comparison of Multi-Stage and One-Stage Contests

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Abstract

This article experimentally studies a two-stage elimination contest and compares its performance with a one-stage contest. Contrary to the theory, the two-stage contest generates higher revenue than the equivalent one-stage contest. There is significant over-dissipation in both stages of the two-stage contest and experience diminishes over-dissipation in the first stage but not in the second stage. Our experiment provides evidence that winning is a component in a subject's utility. A simple behavioral model that accounts for a non-monetary utility of winning can explain significant over-dissipation in both contests. It can also explain why the two-stage contest generates higher revenue than the equivalent one-stage contest.

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1. Introduction

Contests are economic, political, or social interactions in which agents expend resources to receive a certain prize. Examples include marketing and advertising by firms, patent races, and rent-seeking activities. All these contests differ from one another on multiple dimensions including group size, number of prizes, number of inter-related stages, and rules that regulate interactions. The most popular theories investigating different aspects of contests are based on the seminal model of rent-seeking introduced by Tullock (1980). The main focus of rent-seeking literature is the relationship between the extent of rent dissipation and underlying contest characteristics (Nitzan, 1994).

The majority of rent-seeking studies are based on the assumption that contests consist of only one stage. Many contests in practice, however, consist of multiple stages. In each stage contestants expend costly efforts in order to advance to the final stage and win the prize. Two major purposes of our study are to compare the performance of a one-stage contest versus a two-stage elimination contest and to examine whether over-dissipation is observed in both stages of the two-stage contest. The experiment is also designed to elicit non-monetary utility of winning from subjects in order to explain potential over-dissipation in contests.

We find that, contrary to the theory, the two-stage contest generates higher revenue and higher dissipation rates than the equivalent one-stage contest. Over-dissipation is observed in both stages of the two-stage contest and experience diminishes over-dissipation in the first stage but not in the second stage. Our experiment also provides evidence that winning is a component in a subject's utility. A simple behavioral model that accounts for a non-monetary utility of winning can explain significant over-dissipation in both contests. It can also explain why the two-stage contest generates higher revenue than the equivalent one-stage contest.

Recent theoretical models of multi-stage elimination contests reveal interesting dynamic aspects. Gradstein and Konrad (1999) consider a multi-stage elimination contest in which a number of parallel contests take place at each stage and only winners are promoted to the next stage. The authors show that, depending on the contest success function, a multi-stage contest may induce higher effort by the participants than a one-stage contest. Under a lottery contest success function, however, the two structures are equivalent. In the same line of research, Baik and Lee (2000) study a two-stage elimination contest with effort carryovers. In this contest, players in two groups compete non-cooperatively to win a prize. In the first stage, each group selects a finalist who competes for the prize in the second stage. First-stage efforts are partially (or fully) carried over to the second stage. Baik and Lee (2000) demonstrate that, in the case of player-specific carryovers, the rent-dissipation rate (defined as the ratio of the expended total effort to the value of the prize) increases in the carryover rate and the rent is fully dissipated with full carryover. Other theoretical studies of multi-stage elimination contests have been conducted by Rosen (1986), Clark and Riis (1996), Gradstein (1998), Amegashie (1999), Stein and Rapoport (2005), Fu and Lu (2009), and Groh et al. (2009).[1] All these studies investigate different aspects of multi-stage contests such as elimination procedures, interdependency between the stages, asymmetry between contestants, and resource constraints.

Since rent-seeking behavior in the field is difficult to measure, researchers have turned to experimental testing of the theory, with almost all studies focused on one-stage contests (Millner and Pratt, 1989, 1991; Shogren and Baik, 1991; Davis and Reilly, 1998; Potters et al., 1998;

[1] Another type of multi-stage contests is the multi-battle contests. In a multi-battle contest, players compete in a sequence of simultaneous move contests to win a prize and the player whose number of victories reaches some given minimum number wins the prize. Such contests have been studied by Harris and Vickers (1985, 1987), Klumpp and Polborn (2006), and Konrad and Kovenock (2009).

Anderson and Stafford, 2003).[2] Despite considerable differences in experimental design among these studies, most share the major finding that aggregate rent-seeking behavior exceeds the equilibrium predictions.[3] Several researchers have offered explanations for such behavior based on non-monetary utility of winning (Parco et al., 2005), misperception of probabilities (Baharad and Nitzan, 2008), quantal response equilibrium, and heterogeneous risk preferences (Goeree et al., 2002; Sheremeta, 2009).

There are currently only a few experimental studies that investigate the performance of multi-stage contests.[4] Schmitt et al. (2004) develop and experimentally test a model in which rent-seeking expenditures in the current stage affect the probability of winning a contest in both current and future stages. Two other experimental studies are based on a two-stage rent-seeking model developed by Stein and Rapoport (2005). In this model all players have budget constraints. In the first stage, players compete within their own groups by expending efforts, and the winner of each group proceeds to the second stage. In the second stage, players compete with one another to win a prize by expending additional efforts subject to budget constraints. The experimental studies of Parco et al. (2005) and Amaldoss and Rapoport (2009) reject the equilibrium model of Stein and Rapoport (2005) because of significant over-dissipation in the first stage. Both experimental studies conjecture that the non-monetary utility of winning plays a crucial role in explaining excessive over-dissipation in the first stage. Our experimental design is based on Gradstein's and Konrad's (1999) theoretical model, which compares the performance of a one-stage contest versus a multi-stage elimination contest.

[2] For empirical results on multi-stage elimination tournaments in sports see Ehrenberg and Bognanno (1990) and Bognanno (2001).
[3] Shogren and Baik (1991) do not find excessive expenditure.
[4] Exception is a study by Amegashie et al. (2007) on multi-stage all-pay auction.

2. Theoretical Model

In a simple one-stage contest N identical players compete for a prize of value V. Each risk-neutral player i chooses his effort level, e_i, to win the prize. The probability that a contestant i wins the prize is given by a lottery contest success function:

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

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

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

That is, the probability of winning the prize, $p_i(e_i, e_{-i})$, times the value of the prize, V, minus the effort expended, 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 simple model considered above is the building block of contest theory. Gradstein and Konrad (1999) extended this model to study a multi-stage elimination contest. In their contest, N players expend irreversible efforts in an attempt to advance to the final stage. In the first stage, all players are divided into several groups. The winner of each group proceeds to the second stage, where contestants again are divided into competing groups, etc. The winner of the final stage receives a prize of value V. For our analysis, assume that there are only two stages. In the first stage, all players are divided into K equal groups (N/K players per each group), with the winner of each group proceeding to the final stage. To analyze the two-stage contest, we apply backward induction. According to (3), in the second stage each finalist will expend effort of

$$e_2^* = \frac{(K-1)}{K^2}V. \tag{4}$$

The resulting expected payoff in the second stage is $E(\pi_2^*) = V/K^2$. Knowing this, in the first stage N/K players within each group compete as if the value of the prize was $E(\pi_2^*)$. Therefore, according to (3), the first stage equilibrium effort is given by

$$e_1^* = \frac{(N-K)}{N^2K}V. \tag{5}$$

It is straightforward to show that, under the equilibrium strategy, the second order conditions hold and the resulting expected payoff is non-negative.[5] Formulas (4) and (5) demonstrate how the first and second stage equilibrium efforts of each player depend on the prize value and the number of contestants in each stage.

3. Experimental Design and Procedures

3.1. Experimental Design

Our experiment consists of two different contests. The outline of the experimental design and theoretical predictions for each contest are shown in Table 3.1. In each contest there are 4 players and the prize value is 120 experimental francs. In a baseline treatment, all 4 contestants compete with each other for the prize in a one-stage (OS) contest. In equilibrium the revenue collected in this contest is 90. The resulting dissipation rate, defined as the total efforts divided by the value of the prize, is 0.75.

The second treatment is a two-stage (TS) contest which consists of 4 players divided between 2 equal groups. The first stage winner of each group proceeds to the second stage and the winner of the second stage receives the prize. This contest resembles many real life situations. For instance, swimming or track tournaments often place competitors in different groups called "heats" with the winner of each "heat" proceeding to the finale. The major

[5] For a more detailed derivations, see Amegashie (1999), Gradstein and Konrad (1999), and Baik and Lee (2000).

competition in TS arises between the two players in the second stage (see Table 3.1). Therefore, the revenue collected from the second stage is substantially higher than the revenue collected from the first stage. The total revenue collected from both stages in the TS treatment is 90, which is equivalent to the revenue collected in the OS treatment. This equivalence was proved by Gradstein and Konrad (1999) for a more general multi-stage contest under lottery contest success function.

Table 3.1 – Experimental Design and Equilibrium Effort Levels

Treatment	OS	TS
Value of the Prize, V	120	120
Number of Players, N	4	4
Number of Groups, K	1	2
Effort in stage 1, e_1^*	22.5	7.5
Effort in stage 2, e_2^*	—	30
Total Revenue	90	90
Dissipation Rate	0.75	0.75

3.2. Experimental Procedures

The experiment was conducted at the Vernon Smith Experimental Economics Laboratory. A total of 84 subjects participated in seven sessions (12 subjects per session). All subjects were Purdue University undergraduate students who participated in only one session of this study. Some students had participated in other economics experiments that were unrelated to this research.

The computerized experimental sessions were run using z-Tree (Fischbacher, 2007). Each experimental session proceeded in four parts. Subjects were given the instructions, available in the Appendix, at the beginning of each part and the experimenter read the instructions aloud. Before the actual experiment, subjects completed the quiz on the computer to verify their understanding of the instructions. The experiment started only after all subjects had answered all quiz questions. In the first part subjects made 15 choices in simple lotteries, similar to Holt and Laury (2002).[6] This method was used to elicit subjects' risk preferences. The second and the third parts corresponded to OS and TS treatments ran in different orders. In three sessions we ran the OS treatment first and in three other sessions we ran the TS treatment first. Each subject played 30 periods in the OS treatment and 30 periods in the TS treatment.

In each period, subjects were randomly and anonymously placed into a group of 4 players and designated as participant 1, 2, 3, or 4. Subjects were randomly re-grouped after each period. In the first stage of the TS treatment, participant 1 was paired with participant 2 and participant 3 was paired with participant 4. In the OS treatment, all 4 participants were paired against each other. At the beginning of each period, each subject received an endowment of 120 experimental francs. Subjects could use their endowments to expend efforts (make bids). After all subjects submitted their efforts, the computer chose the winner by implementing a simple lottery rule. In the TS treatment, the two finalists – one from each pair – again made their effort choices in the second stage. At the end of the second stage the computer chose the winner of the prize and displayed the following information to all subjects: the opponent's effort in the first stage, the other opponent's effort in the second stage, the result of the random draw in the first and second stage, and personal period earnings. Subjects who did not proceed to the second stage in the TS treatment did not receive any information about the decisions made in the second stage. All subjects were informed that by increasing their efforts, they would increase their chance of

[6] Subjects were asked to state whether they preferred safe option A or risky option B. Option A yielded $1 payoff with certainty, while option B yielded a payoff of either $3 or $0. The probability of receiving $3 or $0 varied across all 15 lotteries. The first lottery offered a 5% chance of winning $3 and a 95% chance of winning $0, while the last lottery offered a 70% chance of winning $3 and a 30% chance of winning $0.

winning and that, regardless of who wins the prize, all subjects would have to pay for their efforts. The instructions explained the structure of the game in detail.

In the final fourth part of the experiment, subjects were given an endowment of 120 francs and were asked to expend efforts in a one-stage contest in order to be a winner. The procedure followed closely to the OS 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. We used this procedure to receive an indication of how important it is for subjects to win when winning is costly and there is no monetary reward for winning.

At the end of the experiment, 1 out of 15 decisions subjects made in part one was randomly selected for payment. Subjects were also paid for 5 out of 30 periods in part two, for 5 out of 30 periods in part three, and for the 1 decision they made in part four. The earnings were converted into US dollars at the rate of 60 francs to $1. On average, subjects earned $25 each which was paid in cash. Each experimental session lasted about 90 minutes.

4. Results

4.1. General Results

Table 4.1 summarizes average efforts, average net payoffs, and average dissipation rates over the treatments. The first striking feature of the data is that, on average, net payoffs in both OS and TS treatments are negative and the actual dissipation rates are significantly greater than predicted.[7] Similar findings are also reported in Davis and Reilly (1998) and Gneezy and

[7] Separately for each treatment, we estimated a random effects model, with individual subject effects, where the dependent variable is effort and the independent variables are a constant and a period trend. A standard Wald test, conducted on estimates of a model, clearly rejects the hypothesis that the constant coefficients are equal to the predicted theoretical values as in Table 4.1 (*p-value* < 0.01).

Smorodinsky (2006). In both studies, revenues collected repeatedly exceeded the prize and subjects earned, on average, negative payoffs.

Result 1. There is significant over-dissipation in one-stage and two-stage contests.

Table 4.1 – Average Statistics

Treatment	OS		TS	
	Equilibrium	Actual	Equilibrium	Actual
Effort in stage 1	22.5	34.1 (0.7)	7.5	18.9 (0.6)
Effort in stage 2	—	—	30	47.2 (0.9)
Net Payoff	7.5	-4.1 (1.1)	7.5	-12.5 (1.2)
Total Revenue	90	136	90	170
Dissipation Rate	0.75	1.14	0.75	1.42

Standard error of the mean in parentheses.

There are several possible explanations for significant over-dissipation. First, it is possible that subjects expend significantly higher efforts because each period they receive a "free" endowment of 120 francs.[8] Note that this endowment is substantially higher than the Nash equilibrium predictions. While the endowment itself has no theoretical impact, it certainly may have a behavioral impact, causing subjects to over-dissipate. The second explanation, related to the endowment size effect, is that subjects are likely to make "errors." Sheremeta (2009) shows how the quantal response equilibrium developed by McKelvey and Palfrey (1995), which accounts for errors made by individual subjects, can explain some over-dissipation in lottery contests. Finally, and probably most importantly, subjects may have a non-monetary utility of winning. If that is the case, then in addition to the monetary value of 120 francs, subjects also compete to be winners. In Section 4.3 we provide evidence consistent with subjects having a

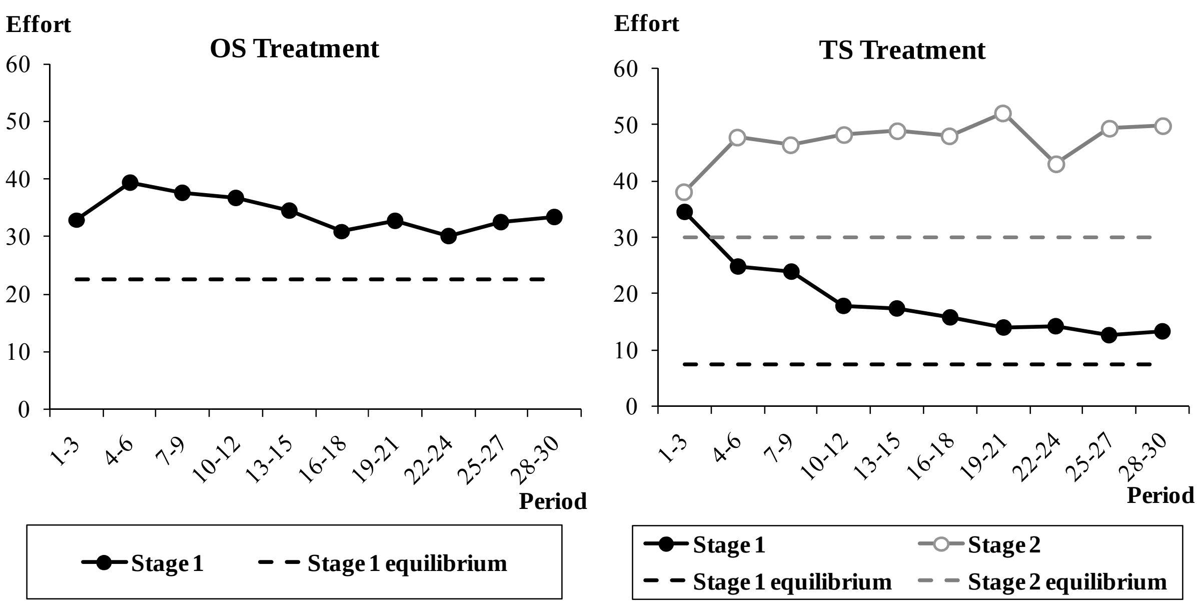
[8] The endowment was chosen for several reasons. First, the endowment was chosen to be equal to the prize value to be consistent with other studies (Anderson and Stafford, 2003; Herrmann and Orzen, 2008). Second, the endowment of 120 francs was also chosen to be substantially higher than the Nash equilibrium predictions in order to make sure that in the two-stage contest subjects are not budget constrained (otherwise, we would have to provide additional endowment in the second stage of a two-stage contest which would cause substantial differences in earnings between two treatments).

non-monetary utility of winning which may explain why there is persistent over-dissipation in both treatments.

It is important to emphasize that the over-dissipation in the TS treatment takes place in both stages of the competition. In the first stage of TS treatment, subjects expend an average effort of 18.9 which is more than double the equilibrium effort of 7.5 (Table 4.1). In the second stage, instead of the equilibrium effort of 30, subjects expend an average effort of 47.2. The first and the second stage efforts in TS treatment are higher than theoretical values in all periods of the experiment (Figure 4.1).

Result 2. In the two-stage contest, significant over-dissipation is observed in both stages.

Figure 4.1 – Average Efforts by Treatments



This result is very different from previous experimental findings. In a related study, Parco et al. (2005) find significant over-dissipation only in the first stage of a two-stage contest. Given the first stage over-dissipation, and the fact that subjects are budget constrained, there is significant under-dissipation in the second stage. Our study shows that, after eliminating the budget constraints, over-dissipation in a two-stage contest occurs in both stages.

It is often argued that subjects need to get some experience in order to learn how to play the equilibrium. For that reason, Figure 4.1 displays the average effort over all 30 periods of the experiment. As players become more experienced, the average efforts made in the first stage of OS and TS treatments decrease. A simple regression of the first stage effort on a period trend shows a significant and negative relationship (p-value < 0.01). Although this is true for the first stage, it is not the case for the subjects' behavior in the second stage.

Result 3. Experience diminishes over-dissipation in the first stage but not in the second stage.

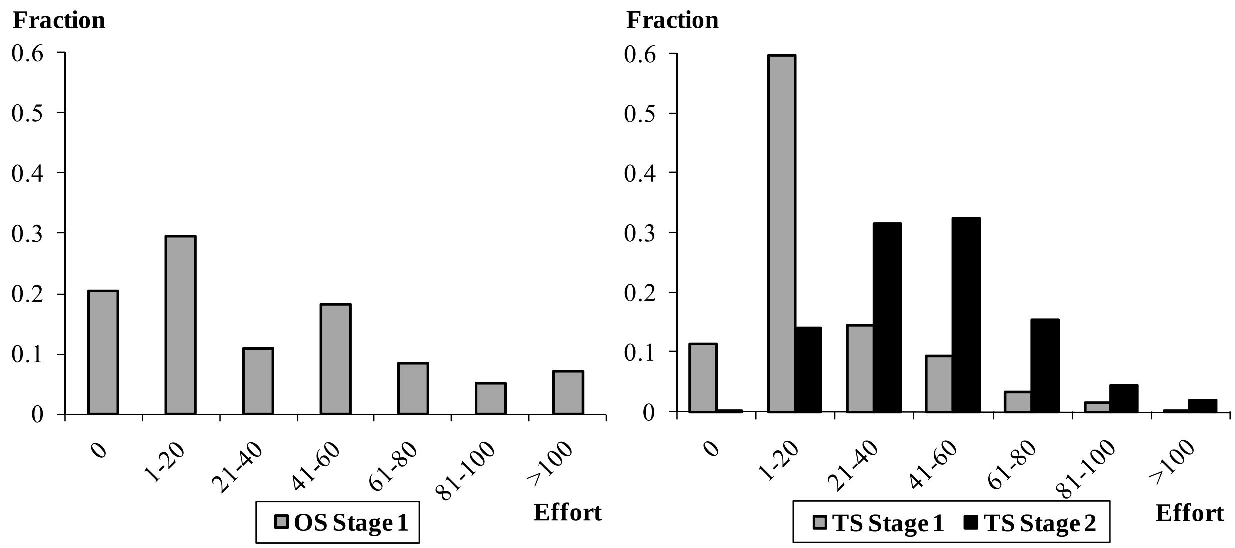
One possible reason for this finding is that at the beginning of the TS treatment, subjects apply similar strategies to both stages of the competition. This may occur because the decisions are cognitively difficult, which causes subjects to apply similar heuristics or "rules of thumb" to both stages (Gigerenzer and Goldstein, 1996). But with the repetition, subjects learn the strategic aspect of the two-stage contest and correctly redistribute their efforts between the first stage and the second stage. Note that in the second half of the experiment the magnitude of relative to the equilibrium over-dissipation in the first stage is very similar to the magnitude of relative over-dissipation in the second stage (efforts are approximately one and a half times higher than the equilibrium predictions).[9]

Another point that is worth noting is that subjects' efforts are distributed on the entire strategy space, which is clearly inconsistent with play at a unique pure strategy Nash equilibrium. Figure 4.2 displays the full distribution of efforts made in the first stage of the OS treatment and both stages of the TS treatment. Instead of a single point equilibrium, efforts range from 0 to 120.

[9] We estimated a convergence model as in Noussair et al. (1995) and found that the first stage effort in OS and TS treatments does not converge to the predicted level of 22.5 and 7.5 (*p-value* < 0.01 for both treatments) and the second stage effort in TS treatment does not converge to the predicted level of 30 (*p-value* < 0.01).

Result 4. There is substantial variance in individual efforts.

Figure 4.2 – Distribution of Efforts



High variance in individual efforts is consistent with previous experimental findings of the contest literature (Davis and Reilly, 1998; Potters et al., 1998). Several explanations have been offered. The first is that subjects play a quantal response equilibrium by drawing their effort levels from the equilibrium distribution and thus causing some variance.[10] A second explanation for effort fluctuations is based on the probabilistic nature of contests, which may affect individual decisions from period to period. A third explanation is that subjects value winning differently (see Table 4.3), which may explain why individual efforts are different. Finally, it might be the case that subjects have different preferences towards risk that affect their behavior. In our experiment we elicited a measure of risk attitudes from a series of lotteries. We find substantial evidence that the measurement of risk attitude is a good predictor of subject's behavior in a contest: less risk-averse subjects expend higher efforts than more risk-averse

[10] Another commonly made argument is that players may play an asymmetric equilibrium instead of a symmetric equilibrium. However, this argument does not apply to rent-seeking contests since the equilibrium in such contests is unique (Szidarovszky and Okuguchi, 1997).

subjects.[11] This observation is consistent with theoretical work by Hillman and Katz (1984) and it can also explain why individual efforts are not identical and instead are distributed on the entire strategy space.

4.2. One-Stage versus Multi-Stage

The major purpose of this study is to compare the performance of a one-stage contest with a multi-stage contest. Theoretically, OS and TS treatments should produce the same revenues and the same dissipation rates. However, Table 4.1 reveals a big difference in the revenue collected between the two treatments. The total revenue in the OS treatment is 136, while the total revenue in the TS treatment is 170. Subjects behave more aggressively in the multi-stage contest, exerting efforts that are 25% higher than efforts in the one-stage contest. The estimation of a random effects model, where the dependent variable is the effort and the independent variables are a treatment dummy-variable and a period trend, indicates that the treatment difference is significant (*p-value* < 0.01). The difference is significant even when we exclude the first 15 periods of the experiment (*p-value* < 0.01).

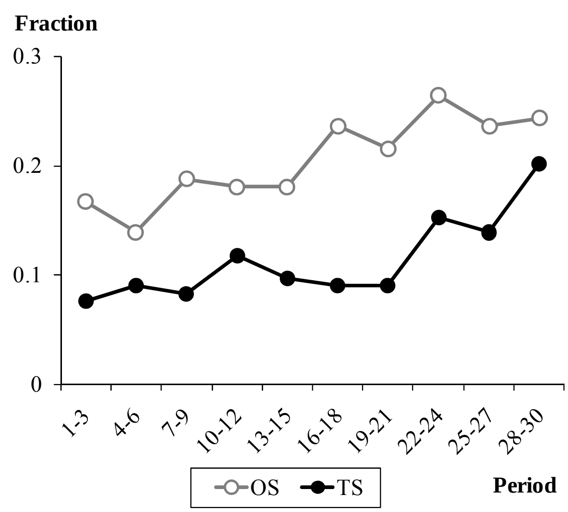
Result 5. The two-stage contest generates higher revenue and higher dissipation rates than an equivalent one-stage contest.

What is causing this substantial treatment difference? A closer look at the distribution of first stage efforts in Figure 4.2 reveals that there are almost twice as many drop-outs (effort of 0) in the OS treatment than in the TS treatment. From Figure 4.3 we see that this difference persists throughout all periods of the experiment. This difference is significant based on the estimation of

[11] We estimate several random effects models where the dependent variable is the total effort expended and the independent variables are the measurements of risk-aversion, session, and treatment dummy-variables. All specifications indicate that risk attitudes elicited from lotteries have significant influence on the effort expended in contests. The results of the estimation are available from the author upon request.

a random effects probit model, where the dependent variable is whether or not the subject expended any effort and the independent variables are a treatment dummy-variable and a period trend (*p-value* < 0.01). One immediate explanation comes from the fact that in the OS treatment each subject always competes with three other subjects at the same time while in the TS treatment each subject competes with only one other subject at the same time. Therefore, less competitive subjects drop out of the contest more often in the OS treatment than in the TS treatment. To look for more evidence on the "drop-out" effect, we conducted an additional session (12 subjects) where two subjects were given the endowment of 120 francs and were competing in a contest for a prize value of 120 francs. The results fully support the "drop-out" phenomenon: when the contest is between two players, there are only 2% of drop-outs, and when the contest is between four players, there are 16% of drop-outs. These differences suggest that "drop-out" phenomenon may partially explain the higher over-dissipation in TS treatment relative to OS treatment.[12]

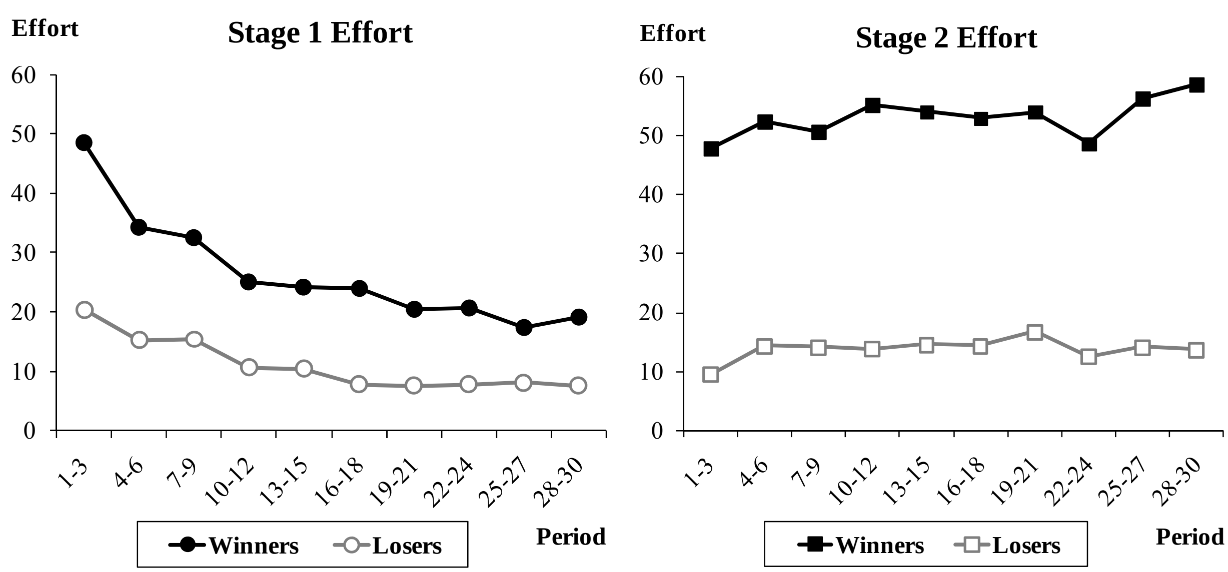
Figure 4.3 – Fraction of Drop-Outs (0 Effort) over 30 Periods



[12] Muller and Schotter (2009) also documented the drop-out phenomenon in a contest developed by Moldovanu and Sela (2001).

Another explanation for significant over-dissipation in the TS treatment comes from the dynamic nature of the multi-stage contest. Figure 4.4 displays the average efforts by both winners and losers in each stage of the TS treatment. In equilibrium, symmetric players should expend the same effort and therefore should have equal probability of winning the first and second stage. However, in contrast to the equilibrium predictions, in both stages there is strong heterogeneity in individual behavior with winners expending significantly higher efforts than losers (the difference is especially large in the second stage). This important observation can also help to explain why a multi-stage contest generates significantly higher revenue than a one-stage contest. Subjects who expend higher efforts in the first stage are more likely to proceed to the second stage. Therefore, the first stage serves as a catalyst that helps to select more competitive subjects into the second stage. As a result of the selection effect, more competitive subjects compete twice in the same TS treatment.

Figure 4.4 – The Average Effort by Outcome of Stage in TS treatment



To look for more evidence on the selection effect, we conducted two additional sessions (24 subjects) with a treatment very similar to the TS treatment. The only difference was that, instead of subjects making their own decisions in the first stage, subjects had to choose the efforts suggested by the computer. The computer randomly chose the first stage efforts, drawn independently for each subject from efforts observed in the first stage of original TS treatment. In the second stage, the two finalists made their own second stage efforts. This treatment was designed to eliminate the selection effect by exogenously assigning different subjects to the second stage. Consistent with our hypothesis, the average effort in the second stage significantly dropped from 47.2 originally to 35.3 ($p\text{-}value < 0.01$).[13] This finding suggests that the selection effect in fact contributes to the over-dissipation in the TS treatment and it can also explain why the TS treatment generates higher dissipation than the OS treatment.[14]

Behavioral economists may recognize yet another possible explanation for significant over-dissipation in TS treatment. Instead of a selection effect in the first stage, one may argue that significant over-dissipation in the second stage is a result of a sunk cost fallacy. In economics, sunk costs are costs that have been incurred and which cannot be recovered. Rational economic agents should not let sunk costs influence their decisions. However, there is some evidence that economic agents fall prey to a sunk cost fallacy (Arkes and Blumer, 1985; Meyer, 1993; Friedman et al., 2007). In our experiment, subjects who get to the second stage of the TS treatment are the subjects who expended some positive efforts in the first stage. If subjects do not discard sunk costs associated with the first stage efforts, they will expend more efforts in the second stage. This implies that the second stage efforts should decrease when the first stage efforts decrease. The data clearly rejects this prediction. Although, with experience, subjects decrease the first stage efforts in TS treatment, they do not decrease the second stage efforts, as

[13] We estimated a random effects model, where the dependent variable is the second stage effort and independent variable is a session dummy. The session dummy was significant with confidence level of 1%.

[14] Eriksson et al. (2009) report results from an experiment where subjects could self-select into a tournament. Their results show that when the subjects choose to enter a tournament, the average effort is higher than when the tournament payment scheme is imposed.

the sunk cost fallacy would predict (Result 3, right panel of Figure 4.1). Moreover, the data from the session investigating "drop-out" effects indicates that in a two-player contest subjects expend the average effort of 33.5. This effort is very close to effort expenditures of 35.3 in the session where subjects are exogenously assigned into the second stage of TS treatment. Note that the difference between these two sessions is that in the first session the selection and sunk cost effects are eliminated while in the second session only the selection effect is eliminated. Only minor differences in effort expenditures (33.5 versus 35.3) indicate that additional elimination of the sunk costs effect does change individual behavior. Therefore, we conclude that the sunk cost fallacy is unlikely to explain the differences in dissipation rates between TS and OS treatments.[15]

4.3. Non-Monetary Utility of Winning

The theoretical predictions in Section 2 are based on the assumption that subjects care only about the monetary value of prize. However, previous experimental research has suggested that subjects may care about winning itself. Schmitt et al. (2004) argue that the presence of over-dissipation in numerous experimental studies (including their own) suggests that it is not the result of subjects misunderstanding the experimental environment. They further propose that winning may be a component in a subject's utility. Parco et al. (2005) show that a descriptive model, which incorporates non-monetary utility of winning, better accounts for the behavior observed in the two-stage contest with budget constraints. Other studies addressing the utility of winning (or "joy of winning") include Goeree et al. (2002), Amaldoss and Rapoport (2009), and

[15] Note that the sunk cost fallacy works in a different way than the selection effect. The sunk cost fallacy means that subjects who get to the second stage expend higher efforts because they are not willing to forgo their efforts in the first stage. The selection effect means that more competitive subjects get to the second stage and therefore they compete more during the second stage. We believe that selection effect and possibly sunk cost fallacy can explain why TS treatment generates higher dissipation than OS treatment.

Herrmann and Orzen (2008). None of these studies, however, experimentally elicit non-monetary utility of winning from subjects.

Table 4.3 – Effort in a Contest with No Prize

Effort in a Contest with No Prize	Percent of Subjects	Average Effort in Contests with Prize
0	57.7%	31.3
0-10	17.3%	33.4
10-20	2.6%	39.9
20-30	10.3%	45.1
30-40	1.3%	50.6
40-50	2.6%	73.2
50-60	2.6%	74.3
>60	5.8%	54.2

In our experiment we elicited a non-monetary value of winning. At the end of each session subjects were given a trivial task. In a treatment similar to OS treatment, all subjects were given an initial endowment of 120 francs and were asked to submit their efforts for a prize value 0. Subjects were explicitly told that they would have to pay for their efforts. This task was used to elicit subject's non-monetary utility of winning. It is reasonable to assume that subjects who exert higher efforts in such a task have a higher non-monetary utility of winning. We were very surprised to discover that about 30% of subjects submitted efforts between 1 and 30, and about 12% of subjects chose efforts higher than 30 (30 francs is equivalent to $0.5). Table 4.3 shows that the higher efforts subjects expend in a contest with no prize, indicating higher non-monetary utility of winning, the higher their total effort in contests with prize is.

An obvious question that one may ask is whether the non-monetary utility of winning is a good predictor of subject's effort expenditures in a contest. To answer this question we estimate several random effects models where the dependent variable is the total effort expended and the independent variables are a period trend, a treatment dummy-variable, and non-monetary expenditures. We also include dummy-variables to control for session effects (not shown in the table). The results of the estimation are presented in Table 4.4. Specifications (1) and (2) use the data from both treatments, while specifications (3) and (4) use the data from OS and TS treatments separately.

Table 4.4 – Determinants of Effort in Contests with Prize

Specification	(1)	(2)	(3)	(4)
Dependent variable, total effort	OS+TS	OS+TS	OS	TS
period-trend	-0.27***	-0.27***	-0.11**	-0.56***
[inverse of a period trend, 1/*t*]	(0.05)	(0.05)	(0.05)	(0.10)
non-monetary	0.28***	0.26***	0.22***	0.41***
[effort in a contest with no prize]	(0.08)	(0.08)	(0.08)	(0.13)
quiz		-2.93*	-1.97	-5.48*
[number of correct quiz answers]		(1.72)	(1.64)	(3.05)
OS dummy	-6.24***	-6.24***		
[1 if OS treatment]	(1.12)	(1.12)		
Observations	3960	3960	2520	1440

* significant at 10%, ** significant at 5%, *** significant at 1%.
Robust standard errors in parentheses. Random effect models account for individual characteristics of subjects. In each regression we control for session, period, and treatment effects.

The estimation of specification (1) in Table 4.4 indicates a very significant and positive correlation between the total effort and the *non-monetary* variable. One may argue that *non-monetary* coefficient is capturing confusion instead of a non-monetary utility of winning. The problem with such an argument is that subjects participated in the contest with no prize at the very end of the experiment, after they played other contests for 60 periods. In specification (2) we use the *quiz* variable measuring the number of correct quiz answers to further control for confusion.[16] We find that subjects who understand the instructions better expend significantly

[16] This is a measure of how well subjects understand the instructions. Before the actual experiment, subjects completed the quiz on the computer to verify their understanding of the instructions. If a subject's answer was incorrect, the computer provided the correct answer. The experiment started only after all participants had answered all quiz questions.

lower efforts in contests. Nevertheless, controlling for confusion, the *non-monetary* coefficient is still positive and highly significant. This finding suggests that winning is a component in a subject's utility and that higher non-monetary utility of winning causes higher over-dissipation in contests. It is also evident that the *non-monetary* coefficient is almost twice as high in the TS treatment as in the OS treatment (specifications 3 versus 4). This suggests that the non-monetary utility of winning may be more important in a two-stage contest than in a one-stage contest.

What are the implications of these findings? First, the non-monetary utility of winning can explain why there is persistent over-dissipation in numerous experimental studies, including our own. Second, the non-monetary utility of winning can explain why the two-stage contest generates higher revenue than an equivalent one-stage contest. To formalize this argument, consider the following revised version of the theoretical model presented in Section 2. To account for a non-monetary utility of winning, we assume that each player, in addition to the prize of value V, has a non-monetary value of winning w. In such a case, the expected payoff of a risk-neutral player i competing in a simple N-player one-stage contest is given by

$$E(\pi_i) = p_i(e_i, e_{-i})[V + w] - e_i. \tag{6}$$

The crucial difference from the original model is that the total value of winning the contest is $V + w$. Differentiating (6) with respect to e_i leads to a Nash equilibrium solution

$$e^* = \frac{(N-1)}{N^2}[V + w]. \tag{7}$$

Next, consider a two-stage contest, where in the first stage N players are divided into K equal groups. By backward induction, according to (7), in the second stage each finalist will expend effort of

$$e_2^* = \frac{(K-1)}{K^2}[V + w]. \tag{8}$$

The resulting expected payoff in the second stage is $[V+w]/K^2$. Knowing this, in the first stage N/K players within each group compete as if the value of the prize was $[V+w]/K^2$, and the first stage non-monetary value of winning was w. Therefore, according to (7), the first stage equilibrium effort is given by

$$e_1^* = \frac{(N-K)}{N^2 K}[V + w + wK^2]. \tag{9}$$

Note that this simple behavioral model can explain several phenomena observed in our experiment. First, it can explain significant over-dissipation in both contests and in both stages of the competition.[17] It is also straightforward to show that this model predicts higher effort expenditures in the two-stage contest, $\frac{(N-1)}{N}[V+w] + \frac{(N-K)}{N}Kw$, than in the one-stage contest, $\frac{(N-1)}{N}[V+w]$. The reason behind this result is that in the two-stage contest some players receive non-monetary utility of winning twice (in the first stage and then in the second stage), while in the one-stage contest such utility is received only once. One possible extension to this model is to assume that the non-monetary value of winning depends on the number of contestants, i.e. $w = w(N)$. For example, one can replicate all qualitative predictions of our behavioral model under the assumption of linear non-monetary utility of winning, i.e. $w(N) = wN$. Obviously, the correct specification of the non-monetary utility of winning is an important question for future research.[18]

[17] The non-monetary utility of winning is not the only explanation for significant over-dissipation. Indeed, such a utility cannot explain why individual subjects change their effort levels when they receive different endowments (Sheremeta, 2009), and thus it may not generalize to other contest environments. Nevertheless, we believe that a positive utility from winning is an important factor that contributes to individual over-expenditures in contests.

[18] One can also provide a more sophisticated analysis, assuming heterogeneous players. For example, consider the case of a simple asymmetric two-player contest, with only one player having a positive utility from winning. It is straightforward to show that such asymmetry leads to higher equilibrium effort for the player with a positive utility from winning and lower equilibrium effort for the other player. Moreover, the total effort in such an asymmetric contest increases relative to a symmetric two-player contest. This basic consideration implies that adding a non-monetary utility from winning to a player causes his effort to increase, and the other player's effort to decrease (but by less), thus explaining both over-dissipation (Result 1) and variance in effort levels (Result 4).

The non-monetary utility of winning w in (7), (8), and (9) is not directly observable. It can be elicited through a simple experiment in which $V = 0$, however, as we did in the final stage of our experiment. The data suggests that the average non-monetary value of winning is about 62.9 experimental francs, which is equivalent to \$1.05.[19] Accounting for such addition utility of winning, the revised equilibrium effort in the one-stage contest is 34.3. This prediction is almost identical to the average effort of 34.1 that subjects expended in OS treatment. In the two-stage contest, the revised first stage equilibrium effort is 27.1 and the second stage effort is 45.7. These predictions are also relatively close to the observed actual efforts of 18.9 and 47.4 in TS treatment. One reason why our behavioral model overestimates the effort expenditures in the first stage is due to the assumption that subjects correctly account for the future utility of winning in the second stage. However, if subjects are myopic and they do not recognize the possibility of receiving an additional utility of winning in the second stage then their expenditures in the first stage will be lower.

5. Conclusions

Many contests in the real world last for multiple stages. In each stage contestants exert costly efforts in order to advance to the final stage and win the prize. The majority of experimental studies, however, focus on one-stage static contests. In this article, we depart from conventional practice by studying a multi-stage elimination contest and comparing its performance with a one-stage contest. We find significant over-dissipation in both contests and in both stages of the competition. This over-dissipation can be explained by a non-monetary utility of winning.

[19] Equation (7) implies that $w = eN^2/(N-1) - V$. In a contest with no prize, $V = 0$ and $N = 4$, subjects expend an average effort of $e = 11.8$. Therefore, the implied value of w is 62.9.

More importantly, contrary to the theory, the two-stage contest generates higher revenue than the equivalent one-stage contest. We propose several explanations for this finding. First explanation is based on the observation that there are twice as many drop-outs in the one-stage contest than there are in the two-stage contest. Another explanation is a selection effect which implies that more competitive subjects win the first stage and thus proceed to the second stage. As a result, more competitive subjects compete twice in the same two-stage contest. We find evidence for the selection effect: when subjects are exogenously assigned into the second stage, subjects on average expend significantly lower second stage efforts than when the assignment is endogenous. Finally, and probably most importantly, we find that the non-monetary utility of winning can account for the majority of differences between the one-stage and two-stage contests.

The results of this study have important implications for contest design (Rosen, 1986; Gradstein and Konrad, 1999). By using a multi-stage contest instead of a one-stage contest, the designer can extract higher total efforts from contestants. Moreover, by using a multi-stage contest, the designer can increase participation rate. Knowing that the major competition takes place in the latter stages, the designer can guarantee high performance from contestants in the final stage of a multi-stage contest.

This study also points out the importance of modeling theoretically a number of behavioral considerations such as heterogeneity between players and a non-monetary utility of winning. By incorporating these behavioral considerations, we can understand why individual behavior does not comply with the equilibrium predictions of classical models. Obviously, this study also opens several interesting questions about how one should model the non-monetary utility of winning, what are the alternative elicitation mechanisms that can reveal individual preferences towards winning, and what are the implications of such preferences in different economic environments.

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Appendix

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 four 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 Part 1 of the experiment is U.S. Dollars. The currency used in Part 2, 3 and 4 of the experiment is francs. Francs will be converted to U.S. Dollars at a rate of **_60_** francs to **_1_** dollar. At the end of today's experiment, you will be paid in private and in cash. **12** participants are 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.

At this time we proceed to Part 1 of the experiment.

INSTRUCTIONS FOR PART 1
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 ignore 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.

Any questions?

Participant ID _________

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 comes out	**$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, or 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	

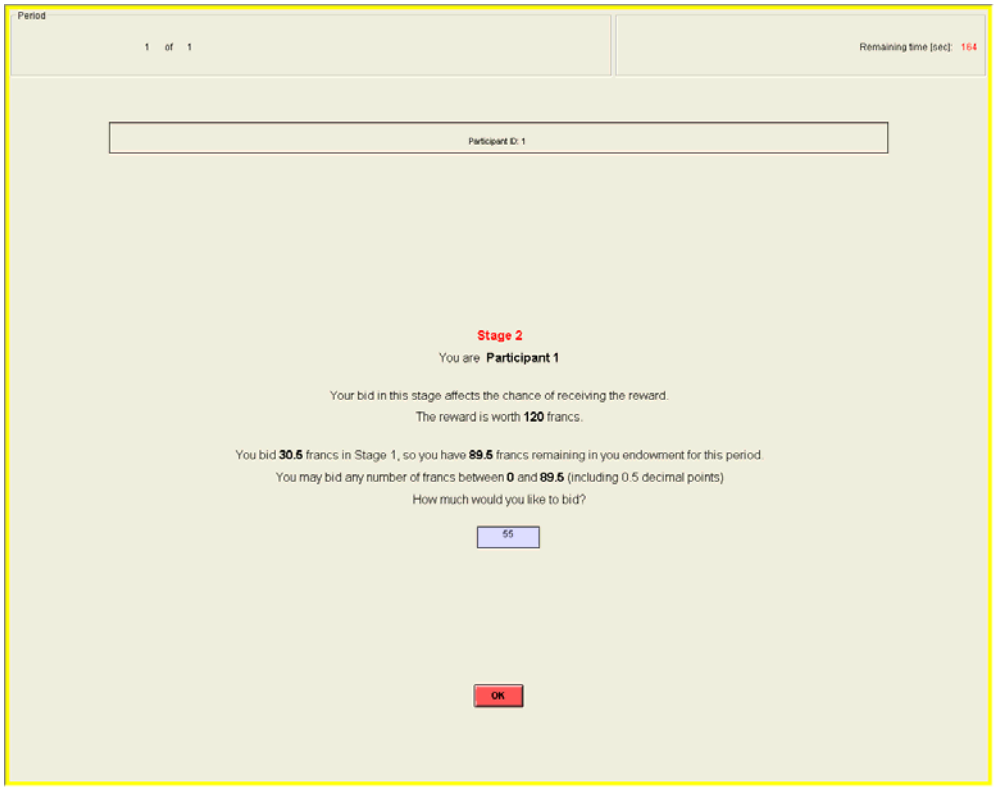
14	**$1**	**$3** if 1,2,3,4,5,6,7,8,9,10 11,12,13	**$0** if 14,15,16,17,18,19,20	
15	**$1**	**$3** if 1,2,3,4,5,6,7,8,9,10 11,12,13,14	**$0** if 15,16,17,18,19,20	

INSTRUCTIONS FOR PART 2

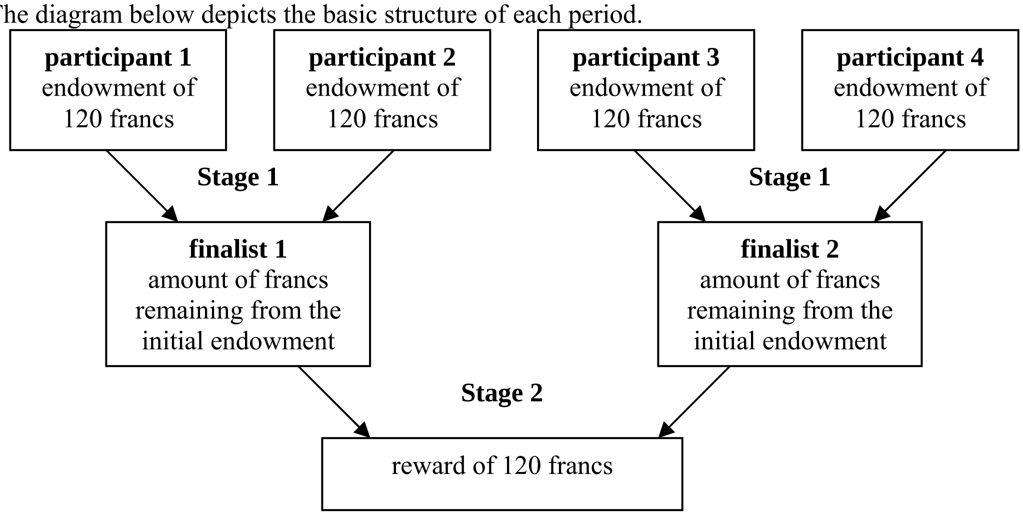
YOUR DECISION

The second part of the experiment consists of **30** decision-making periods and each period consists of **two stages**. At the beginning of each period, you will be randomly and anonymously placed into a group of **four participants**. The composition of your group will be changed randomly every period. Each period you will be randomly and anonymously assigned as **participant 1, 2, 3, or 4**. In **Stage 1** participant 1 will be paired with participant 2 and participant 3 will be paired with participant 4. All four participants will be given an initial endowment of **120** francs. You will use this endowment to bid for a chance of participating in the final Stage 2. An example of your decision screen is shown below.

The two finalists – one from each pair – will proceed to Stage 2. The other two participants who did not win in Stage 1 will no longer participate in this period. In **Stage 2** the two remaining participants will bid for a reward. The reward is worth **120** francs. The two participants may bid any number of francs between **0** and **the amount of francs remaining from the initial endowment** (including 0.5 decimal points). An example of the decision screen is shown below.



The diagram below depicts the basic structure of each period.



YOUR EARNINGS

If you receive the reward your period earnings are equal to your endowment plus the reward minus your bids in Stage 1 and Stage 2. If you do not receive the reward your period earnings are equal to your endowment minus your bids in Stage 1 and Stage 2. Note that if you do not win in Stage 1, your bid in Stage 2 is automatically assigned to zero.

If you receive the reward:
Earnings = Endowment + Reward – Your Bid in Stage 1 – Your Bid in Stage 2 =
= 120 + 120 – Your Bid in Stage 1 – Your Bid in Stage 2
If you do not receive the reward:
Earnings = Endowment – Your Bid in Stage 1 – Your Bid in Stage 2 =
= 120 – Your Bid in Stage 1 – Your Bid in Stage 2

The more you bid in each stage, the more likely you are to win that stage. The more the other participants bid, the less likely you are to win. Specifically, in Stage 1, for each franc you bid you will receive one lottery ticket. At the end of Stage 1 the computer **draws randomly** one ticket among all the tickets purchased by **you and the other participant**. The owner of the drawn ticket wins Stage 1 and proceeds to Stage 2. Thus, your chance of winning in Stage 1 is given by the number of francs you bid divided by the total number of francs you and the other participant bids.

$$\text{Chance of winning in Stage 1} = \frac{\text{Your Bid}}{\text{Your Bid + The other participant's bid}}$$

In case both participants bid zero in Stage 1, the computer randomly chooses one participant who wins Stage 1 and proceeds to Stage 2. In Stage 2, for each franc you bid you will also receive one lottery ticket. At the end of Stage 2 the computer **draws randomly** one ticket among all the tickets purchased by **you and the other finalist of Stage 1**. The owner of the drawn ticket wins Stage 2 and receives the reward of 120 francs. Thus, your chance of winning Stage 2 is given by the number of francs you bid divided by the total number of francs you and the other participant bids.

$$\text{Chance of winning in Stage 2} = \frac{\text{Your Bid}}{\text{Your Bid + The other participant's bid}}$$

In case both participants bid zero in Stage 2, the winner is determined randomly.

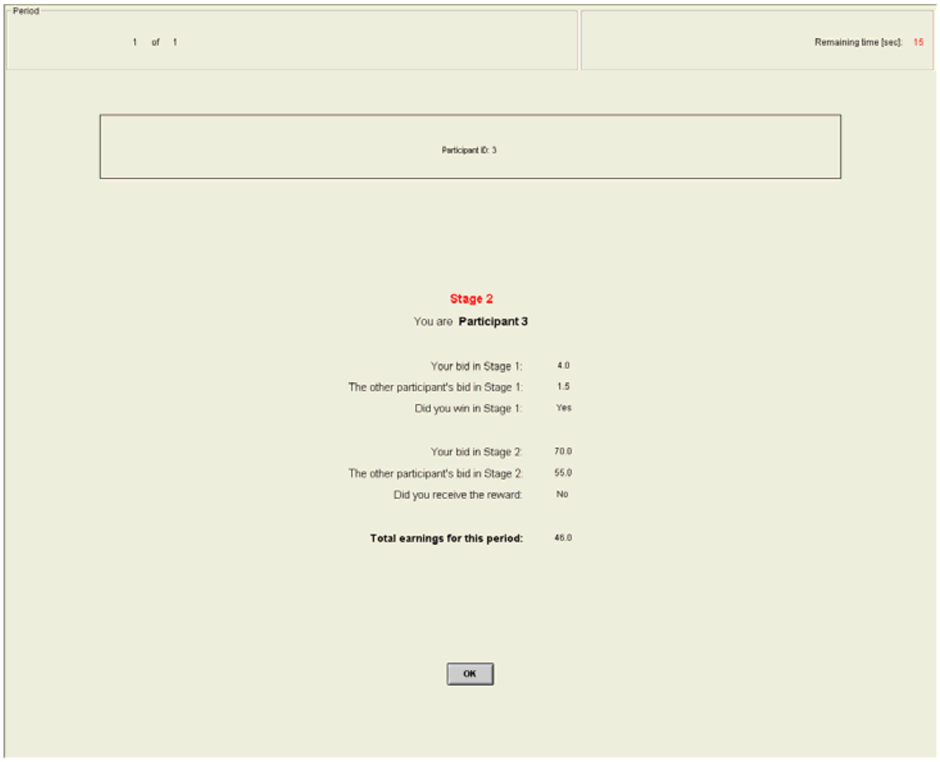
<u>Example of the Random Draw</u>

This is a hypothetical example of how the computer makes a random draw. Let's say, in Stage 1, participant 1 bids 10 francs, participant 2 bids 5 francs, participant 3 bids 0 francs, and participant 4 bids 40 francs. Therefore, the computer assigns 10 lottery tickets to participant 1, 5 lottery tickets to participant 2, 0 lottery tickets to participant 3, and 40 lottery tickets to participant 4. In Stage 1, participant 1 is paired with participant 2. Therefore, for this fist pair the computer randomly draws **one lottery ticket out of 15** (10 lottery tickets for participant 1 and 5 lottery tickets for participant 2). As you can see, participant 1 has **higher chance** of winning in Stage 1: **0.67 = 10/15.** Participant 2 has **0.33 = 5/15** chance of winning in Stage 1. Similarly, participant 3 is paired with participant 4 in Stage 1. For this second pair, the computer randomly draws **one lottery ticket out of 40** (0 lottery tickets for participant 3 and 40 lottery tickets for participant 4). As you can see, in this pair participant 3 has no chance of winning in Stage 1: **0 = 0/40**.

Let's say that computer made a random draw in Stage 1 and the winner of the first pair is participant 2 while the winner of the second pair is participant 4. Therefore, participant 2 and participant 4 proceed to Stage 2. Let's say, in Stage 2, participant 2 bids 60 francs and participant 4 bids 20 francs. Therefore, the computer assigns 60 lottery tickets to participant 2 and 20 lottery tickets to participant 4. Then the computer randomly draws **one lottery ticket out of 80** (60 + 20). As you can see, participant 2 has **higher chance** of winning in Stage 2: **0.75 = 60/80.** Participant 4 has **0.25 = 20/80** chance of winning in Stage 2.

After four participants make their bids in Stage 1, the computer will make a random draw which will decide who wins in Stage 1 and thus proceeds to Stage 2. Then after two remaining participants make their bids in Stage 2, the computer will make a random draw which will decide who wins in Stage 2. Then the computer will calculate your period earnings based on your bid in Stage 1 and Stage 2 and whether you received the reward or not. These earnings will be converted to cash and paid at the end of the experiment if the current period is one of the five periods that is randomly chosen for payment.

At the end of each period, your bid in Stage 1, the other participant's bid in Stage 1, whether you won in Stage 1 or not, your bid in Stage 2, the other participant's bid in Stage 2, whether you received the reward or not, and the 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.



Outcome Screen

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 three other participants to from a four-person group. You can never guarantee yourself the reward. However, by increasing your contribution, you can increase your chance of winning in Stage 1 and Stage 2 and thus increase your chance of receiving the reward. Regardless of who receives the reward, all participants will have to pay their bids in Stage 1 and Stage 2.

At the end of the experiment we will randomly choose **5 of the 30** periods for actual payment in **Part 2** using a bingo cage. You will sum the total earnings for these 5 periods and convert them to a U.S. dollar payment, as shown on the last page of your record sheet.

Are there any questions?

INSTRUCTIONS FOR PART 3

The third part of the experiment consists of **30** decision-making periods. The rules for **part 3** are similar to the rules for **part 2**. At the beginning of each period, you will be randomly and anonymously placed into a group of **4 participants**. The composition of your group will be changed randomly every period. Each period you will be given an initial endowment of **120** francs. You will use this endowment to bid for a reward. The reward is worth **120** francs to you and the other three participants in your group. The only difference is that in part 3, there will be only one stage (instead of two stages). In that stage **all four participants including you** will bid for a reward.

After all participants have made their decisions, your earnings for the period are calculated in the similar way as in part 2.

If you receive the reward:
Earnings = Endowment + Reward – Your Bid = 120 + 120 – Your Bid
If you do not receive the reward:
Earnings = Endowment – Your Bid = 120 – 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 120 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.

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

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

<u>Example of the Random Draw</u>

This is a hypothetical example used to illustrate how the computer is making a random draw. 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.

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

At the end of the experiment we will randomly choose **5 of the 30** periods for actual payment in **Part 3** using a bingo cage. You will sum the total earnings for these 5 periods and convert them to a U.S. dollar payment, as shown on the last page of your record sheet.

Are there any questions?

INSTRUCTIONS FOR PART 4

The fourth part of the experiment consists of only **1** decision-making period. The rules for **part 4** are the same as the rules for **part 3**. At the beginning of the period, you will be randomly and anonymously placed into a group of **4 participants**. You will be given an initial endowment of **120** francs. You will use this endowment to bid in order **to be a winner**. 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 becomes a winner. Thus, your chance of becoming a winner is given by the number of francs you bid divided by the total number of francs all 4 participants in your group bid. The only difference is that in part 4 the winner **does not receive the reward**. Therefore, the reward is worth **0** francs to you and the other three participants in your group. After all participants have made their decisions, your earnings are calculated.

Earnings = Endowment – Your Bid = 120 – Your Bid

After all participants have made their decisions, your earnings will be displayed on the outcome screen. Your earnings will be converted to cash and paid at the end of the experiment.

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