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Zeynep B. Irfanoglu

Shakun D. Mago

Roman M. Sheremeta
Chapman University

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Zeynep B. Irfanoglu [a]
Shakun D. Mago [b]
Roman M. Sheremeta [c,*]

[a] Department of Agricultural Economics, Purdue University,
403 W. State St., West Lafayette, IN 47906-2056, USA
[b] Department of Economics, Robins School of Business, University of Richmond,
1 Gateway Road, Richmond, VA 23173, USA
[c] Weatherhead School of Management, Case Western Reserve University
and the Economic Science Institute, Chapman University
11119 Bellflower Road, Cleveland, OH 44106, U.S.A.

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Abstract

This experimental study compares sequential and simultaneous election contests. Consistent with the theory, we find evidence of the "New Hampshire effect" in the sequential contests, i.e., the winner of the first electoral battle wins the overall contest with much higher probability than the loser of the first battle. However, contrary to the theory, sequential contests generate higher expenditure than the simultaneous contests. This is mainly because in the sequential contests losers of the first battle do not decrease their expenditure in the second battle while winners of the first battle increase (instead of decreasing) their expenditure in the second battle. We discuss the implications of our findings both for policy makers and social scientists.

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* Corresponding author: Roman Sheremeta, sheremet@chapman.edu
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1. Introduction

The nomination process for the U.S. presidential election consists of a series of nationwide primary elections, beginning with the New Hampshire primary. Since long, primary election held in this small New England state has been a major testing ground for candidates of both the Republican and the Democratic party. Its significance became entrenched in the quadrennial election politics in 1952, when Estes Kefauver defeated the incumbent President Harry S. Truman in the primary, leading Truman to abandon his campaign. Another President forced from running for re-election by the New Hampshire voters was Lyndon Johnson, who managed only a 49-42 percent victory (and fewer delegates) over Eugene McCarthy in 1968 and consequently withdrew from the race. In 1984, five of the eight major candidates of the Democratic presidential nomination dropped off the race in weeks following the New Hampshire primary. In 1988, all but one of George Bush's Republican opponents withdrew soon after the primary; and in 1992, number of Democratic party candidates dwindled from five to two after the primary (Busch and Mayer, 2004). According to political pundits, the dominant reason for this displacement is the sequential structure of the primary elections which creates an asymmetry between the winner and the loser of the first primary.

Just as candidates who do poorly in the New Hampshire primary frequently drop out; the lesser-known, underfunded candidates who do well in this primary suddenly become serious contenders to win the party nomination, garnering tremendous momentum both in terms of media coverage and campaign funding. In 1992, Bill Clinton, a little known governor of Arkansas did surprising well, and was labeled "Comeback Kid" by the national media. This extra attention helped his campaign gain increased visibility in later primaries. In 2000, John McCain emerged as George Bush's principal challenger only after an upset victory in New Hampshire. A similar comeback by John Kerry in the 2004 primary had a decisive effect on the presidential nomination process. Controlling for other factors, Mayer (2004) finds that a win in the New Hampshire primary increases a candidate's expected share of total primary votes by a remarkable 26.6 percent.[1] Thus, simply by being the first primary, New Hampshire can either break the candidature of the loser or revive the campaign of the winner. Given its obvious importance, candidates respond accordingly - by spending a significant portion of their campaign budget on these early primaries. In 1980 Republican primary, Ronald Reagan and George Bush spent 75 percent of their budget in states with early primaries, although they accounted for less than 20 percent in the overall delegate count (Malbin, 1985). In 2004 Democratic primary, Howard Dean's campaign went almost bankrupt after the New Hampshire primary.

The perception that New Hampshire plays a pivotal and perhaps a disproportionately large role in the presidential election (and thereby derives a wide array of political and economic benefits from that position) led many states to move up the date of their primaries.[2] 'Frontloading' is the name given to a recent trend in the presidential nomination process in which more and more states schedule their primaries near the beginning of the delegate selection process. Clustering of primaries took a huge leap forward in 1988 with the formation of 'Super Tuesday' when 16 states held their primaries on a single day in March. By 2008, 24 states held their primary on Super Tuesday held in the first week of February. In 2004, James Roosevelt, co-

[1] In a multi-candidate race, even a second-place finish in New Hampshire primary increases a candidate's final vote by 17.2 percent (Mayer, 2004). However, the winner of New Hampshire primary has not always won his party's nomination, as demonstrated by Republicans Harold Stassen in 1948, Henry Lodge in 1964, Pat Buchanan in 1996, and John McCain in 2000 and Democrats Estes Kefauver in 1952 and 1956, Paul Tsongas in 1992, and Hillary Clinton in 2008.

[2] A report by the Library and Archives of New Hampshire's political tradition estimates that the total economic impact of 2000 primary on the state's economy was $264 million. New Hampshire also receives a diverse array of 'special policy concessions' as a result of its privileged position in the presidential nomination process (Busch and Mayer, 2004). Originally held in March, the date of the New Hampshire primary has been moved up repeatedly to maintain its status as first (a tradition since 1920). In fact, New Hampshire state law requires that its primary must be the first in the nation.

chair of the Democratic Party Rules Committee proclaimed, “We are moving towards a *de facto* national primary.”

In this study we use experiments to compare *sequential* contest, such as the current presidential primaries, to *simultaneous* contest, as reflected in a counterfactual national primary.[3] Our theoretical framework is based on Klumpp and Polborn (2006). In this political contest model, candidates have to win the majority of a number of electoral districts in order to obtain a prize. As in Tullock (1980) and Snyder (1989), candidates can influence the probability of winning an electoral district by their choice of campaign expenditure in that district. In case of sequential contest, theory predicts that candidates expend disproportionately larger amounts in the earlier districts than in the later districts. Relating it to the empirical observation of the U.S. primary process, this difference in expenditure is attributed to the “New Hampshire effect.” That is, the outcome of the first election creates asymmetry between ex-ante symmetric candidates in terms of their incentive to spend in the next district, which in turn, endogenously increases the probability that the first winner will win in subsequent districts and attain the final prize – party nomination. For example, in a sequential contest with three districts (battles), the winner of the first battle wins the overall contest with probability of 0.875.[4] Furthermore, the intense concentration of expenditure in the initial battles entails that there is a 0.75 probability that the contest will end in only 2 battles. In contrast, in case of simultaneous contest, candidates spend equal amounts in all 3 battles and it leads to complete rent dissipation if the number of battles is sufficiently large. Thus, an important consequence of this temporal design difference is that the

[3] Our experiment compares two extreme benchmarks: a completely sequential contest to a completely simultaneous contest. Present day primary system, however, has a mixed temporal structure. The nomination process starts with a series of sequential elections held in various states (Iowa caucus, New Hampshire primary, etc.) followed by days such as “Super Tuesday” where a number of states vote simultaneously. Klumpp and Polborn (2006, p. 1076) state that the results of a completely sequential contest can apply to a mixed temporal contest, as long as the latter begins with at least a few sequential battles.

[4] This probability increases as the total number of battles in the contest increases.

sequential contest is predicted to induce lower expenditure than the simultaneous contest. The theoretical finding that sequential elections minimize wasteful campaign expenditure might explain why political parties prefer the sequential organization of the primaries.[5]

Our theoretical construct necessarily simplifies the election campaign process, both to allow for analytical tractability and to facilitate the experimental investigation. Nevertheless, we believe that it captures some of the most salient features of sequential and simultaneous election contests, and allows us to analyze the impact of these features both on the likelihood of winning and the overall expenditure level. Consistent with the theory, in the laboratory we find evidence of the New Hampshire effect in the sequential contest, i.e., the winner of the first battle wins the overall contest with much higher probability than the loser of the first battle. However, contrary to the theory, sequential contests generate higher expenditure than simultaneous contests. This is mainly because in the sequential contests losers of the first battle do not decrease their expenditure in the second battle while winners of the first battle increase (instead of decreasing) their expenditure in the second battle. Finally, we find that although subjects learn to behave more in line with equilibrium predictions, their behavior is substantially different from predictions even in the last few periods of the experiment.

[5] The contest model is complementary to the voters' participation model (Morton and Williams, 1999; Battaglini et al., 2007). In the voters' participation model the probability of winning an electoral district by a candidate depends on the number of votes received, while in the contest model such a probability depends on the relative campaign expenditure by each candidate in that district. The complementarity between the two models arises because one of the reasons for the New Hampshire effect that is commonly discussed in political science is information aggregation, which is implicit in voting models. For instance, Morton and Williams (1999) compare sequential and simultaneous voting and find that in sequential voting later voters use early outcomes to infer information about asymmetric candidates, and thus make better informed choices that reflect their true preferences. Battaglini et al. (2007) find that sequential voting aggregates information better than simultaneous voting and is more efficient in some information environments, but sequential voting is inequitable because early voters bear more participation costs. By assuming that both candidates are symmetric and by abstracting from costly voter participation decision, we are able to isolate on how candidates' relative expenditure alone determines the likelihood of winning current and future electoral districts. That is, we examine New Hampshire effect resulting solely from candidates' campaign expenditure decisions.

Our findings have important implication both for policy makers and social scientists. In particular, the finding that sequential contests induce higher expenditure (and thus more inefficiency) than simultaneous contests is both interesting and puzzling. Previous theoretical and empirical research on sequential and simultaneous voting provides mixed evidence in favor of sequential system (Morton and Williams, 1999, 2000; Klumpp and Polborn, 2006). Battaglini et al. (2007), for example, find that a sequential voting rule is more efficient but less equitable than simultaneous voting in some information environments. We show that, on the contrary, simultaneous contest dominates sequential contest because it generates substantially lower expenditure. Thus, we provide evidence that attempts such as 'Frontloading' and 'Super Tuesday' that make presidential nomination process more like the simultaneous contest may indeed lead to a more efficient and significantly less costly electoral process.

2. Literature Review

The *theoretical* literature on multi-battle contests originated with seminal work by Fudenberg et al. (1983) and Snyder (1989).[6] Fudenberg et al. (1983) model R&D competition as a sequential multi-battle contest, while Snyder (1989) models political campaigning as a simultaneous multi-battle contest. Building on these models, subsequent papers investigated the ramification of various factors such as the sequence ordering of decisions, number of battles, asymmetry between players, effect of carryover, effect of uncertainty, the impact of discount factor and intermediate prizes (Harris and Vickers, 1985, 1987; Leininger, 1991; Baik and Lee, 2000; Szentes and Rosenthal, 2003; Roberson, 2006; Kvasov, 2007; Konrad and Kovenock,

[6] One may even cite the original formulation of a Colonel Blotto game by Borel (1921) as a starting point of the multi-battle contest literature.

2009). We conduct an experimental examination of the theoretical model by Klumpp and Polborn (2006) which analyzes the differing temporal structure of the multi-battle contest.

Most of the *experimental* studies on contest theory focus on single-battle contests; for a comprehensive review of the literature see Dechenaux et al. (2014). However, recently, there has been an increased interest in examining multi-battle contests. Experimental studies on *simultaneous* multi-battle contests have examined how different factors such as budget constraint, information, contest success function, asymmetry in resources and battles impact individual behavior (Avrahami and Kareev, 2009; Horta-Vallve and Llorente-Saguer, 2010; Kovenock et al., 2010; Arad, 2012; Arad and Rubinstein, 2012; Chowdhury et al., 2013; Mago and Sheremeta, 2014). Experimental studies on *sequential* multi-battle contests have examined the impact of contest structure, carryover, fatigue, intermediate prizes and luck on behavior in dynamic contests (Zizzo, 2002; Schmitt et al., 2004; Ryvkin, 2011; Deck and Sheremeta, 2012; Mago and Sheremeta, 2012; Mago et al., 2013).[7] Most of these studies find support for the comparative statics predictions, but often report significant over-expenditure of resources (also known as overbidding or over-dissipation) relative to the Nash equilibrium prediction (Dechenaux et al., 2014).

In contrast to the aforementioned studies, our experimental study is the first to compare sequential and simultaneous multi-battle contest structures. Consistent with the previous studies, we find evidence of significant over-expenditure relatively to Nash equilibrium in both contests. However, our most surprising result is the reversal of the comparative statics prediction of Klumpp and Polborn (2006) – we find that contrary to prediction, the sequential contest generates higher expenditure than the simultaneous contest. This is surprising because, as

[7] Related to the studies on sequential multi-battle contests are the studies examining multi-battle elimination contests (Parco et al., 2005; Amegashie et al., 2007; Sheremeta, 2010a, 2010b; Altmann et al., 2012; Höchtl et al., 2014).

mentioned above, almost all contest experiments in the literature find strong support for the comparative statics predictions even if the precise quantitative predictions are refuted. We discuss a number of possible explanations for this finding in Section 5, including the sunk cost fallacy and the non-monetary utility of winning.

3. Theoretical Model

We consider a game in which two risk-neutral players, X and Y, compete in a multi-battle contest for an exogenously determined and commonly known prize, v. There are n battles in the contest. x_i and y_i denote the amount of resource expenditures by players X and Y in battle i, and following Tullock (1980), the probabilities of winning battle i by players X or Y are defined by contest success functions:

$$p_{Xi}(x_i, y_i) = \frac{x_i^r}{x_i^r + y_i^r} \quad \text{and} \quad p_{Yi}(x_i, y_i) = \frac{y_i^r}{x_i^r + y_i^r} \tag{1}$$

The parameter r in these contest success functions can be interpreted as the 'marginal return to lobbying outlays' (Nitzan, 1994). When $r = 1$, as assumed in this study, we have a 'lottery' contest wherein a player's probability of winning the battle depends on his expenditure relative to the total expenditure.

The player who wins a majority of the battles, i.e., at least $(n + 1)/2$ battles wins the overall contest and receives the prize v. Therefore, the net payoff of X (similarly to Y) is equal to the value of the prize (if he wins) minus the total expenditure he has spent during the contest:

$$\pi_X = \begin{cases} v - \sum_{i=1}^{n} x_i & \text{if } X \text{ wins the contest} \\ -\sum_{i=1}^{n} x_i & \text{otherwise} \end{cases} \tag{2}$$

The battles in the contest can proceed in two ways: *sequentially* or *simultaneously*. We describe the theoretical predictions for both these cases with parameter values set at $r = 1$ and

$n = 3$. It is important to emphasize that all the comparative statics predictions derived in this simplified version of the model hold for any $r \in (0,1]$ and $n \geq 3$ (Klumpp and Polborn, 2006). However, for our experiment we chose specific parameters of $r = 1$ and $n = 3$ to simplify the experimental environment and to facilitate greater subject comprehension.

3.1. Sequential Multi-Battle Contest

In the sequential multi-battle contest, players simultaneously choose expenditure levels x_1 and y_1 in the first battle. After determining the winner of the first battle, they move on to the second battle where they choose expenditures, x_2 and y_2. Players continue to compete until one player accumulates the requisite two victories. Following Klumpp and Polborn (2006) the solution concept we consider is the subgame perfect Nash equilibrium. Using backward induction, we begin our examination with the final and decisive third battle. Note that if one of the players has already won the previous two battles there is no need to continue competing in the third battle and thus expenditures are $x_3^* = y_3^* = 0$. However, if each player has won one of previous two battles then the winner of the contest is determined by the result of the third battle. In such a case, player X's expected payoff (analogously for player Y) is equal to the probability of player X winning the third battle $p_{X3}(x_3, y_3)$ times the prize valuation v minus cost of expenditure x_3:

$$E(\pi_{X3}) = p_{X3}(x_3, y_3)v - x_3 = \frac{x_3}{x_3 + y_3}v - x_3 \qquad (3)$$

In the unique, symmetric subgame perfect Nash equilibrium, the expenditures are $x_3^* = y_3^* = v/4$ and the expected payoffs are $E^*(\pi_{X3}) = E^*(\pi_{Y3}) = E^*(\pi_3) = v/4$. Note that the equilibrium expenditure in the final decisive battle is same as in a single-battle contest.

Going backwards to the second battle, suppose player X is leading the contest by winning the first battle. Therefore, players are necessarily asymmetric, wherein player X needs to win only one more battle to win the contest, while player Y needs to win two battles. In this case, players X and Y have the following expected payoffs:

$$E(\pi_{X2}) = \frac{x_2}{x_2+y_2}v + \frac{y_2}{x_2+y_2}E^*(\pi_3) - x_2 \quad \text{and} \quad E(\pi_{Y2}) = \frac{y_2}{x_2+y_2}E^*(\pi_3) - y_2 \qquad (4)$$

In the Nash equilibrium of this subgame, players choose expenditures $x_2^* = 9v/64$ and $y_2^* = 3v/64$ which yield them expected payoffs $E^*(\pi_{X2}) = 43v/64$ and $E^*(\pi_{Y2}) = v/64$.

Finally, going one step back to the first battle, the players are symmetric again. Both players need to accumulate two battle victories to win the contest. In this case, Player X (analogously player Y) maximizes the following expected payoff:

$$E(\pi_{X1}) = \frac{x_1}{x_1+y_1}E^*(\pi_{X2}) + \frac{y_1}{x_1+y_1}E^*(\pi_{Y2}) - x_1 \qquad (5)$$

In the Nash equilibrium of this subgame, players choose expenditures $x_1^* = y_1^* = 21v/128$ and earn the expected payoffs $E^*(\pi_{X1}) = E^*(\pi_{Y1}) = E^*(\pi_1) = 23v/128$. Aggregating across all three battles, the equilibrium total expenditure is $41v/128$.

3.2. Simultaneous Multi-Battle Contest

In the simultaneous multi-battle contest, players simultaneously choose expenditure levels x_i and y_i for all battles $i = 1, 2, 3$. Then, the winner of each individual battle is determined and the player who wins at least two battles wins the overall contest and obtains the prize. Note that each battle of the multi-battle contest is an 'independent' lottery contest. Therefore, Player X (analogously player Y) maximizes the following expected payoff:

$$E(\pi_X) = \left[\binom{3}{3}\left(\frac{x}{x+y}\right)^3 + \binom{3}{2}\left(\frac{x}{x+y}\right)^2\left(\frac{y}{x+y}\right)\right]v - 3x = \left[\left(\frac{x}{x+y}\right)^3 + \frac{3x^2y}{(x+y)^3}\right]v - 3x \quad (6)$$

In the unique Nash equilibrium, both players make the same expenditure in all battles, i.e., $x_i^* = y_i^* = v/8$ for all i.[8] Aggregating across all three battles, the equilibrium total expenditure is $48v/128$.

4. Experimental Environment

4.1. Experimental Design and Hypotheses

We employ two treatments: *sequential* and *simultaneous*. In the *sequential* treatment two players compete in a sequential multi-battle contest, while in the *simultaneous* treatment two players compete in a simultaneous multi-battle contest. Table 1 summarizes the equilibrium predictions in the sequential and simultaneous treatments for $v = 100$, $r = 1$ and $n = 3$. Based on these predictions we provide the following three hypotheses:

Hypothesis 1: Total expected expenditure in the sequential contest is lower compared to the simultaneous contest.

The expected total expenditure by a player in the sequential contest is 32.4, and in the simultaneous contest is 37.5.

Hypothesis 2: In the sequential contest, winner of the first battle is more likely to win the overall contest, or the "New Hampshire effect."

In the sequential contest, the outcome of the first battle creates asymmetry between ex-ante symmetric players. This asymmetry endogenously triggers differing expenditure levels in the subsequent battles and generates momentum for the winner of the first battle. Since it is less likely for the loser of the first battle to win the contest, the absolute level of expenditures fall sharply after the outcome of the first battle is known. In the second battle, winner of the first

[8] The solution to this game can also be found in Friedman (1958).

battle exerts three times more expenditure than the loser. As a result, sequential contest ends after two battles with probability 0.75, and the winner of the first battle wins the overall contest with probability 0.875.

Hypothesis 3: In the simultaneous contest, expenditures are uniformly distributed across all three battles.

Since all three battles are identical in the simultaneous contest, both players make the same expenditure of 12.5 in each battle. This is in sharp contrast to the sequential contest where expenditures are predicted to be more intensely concentrated in the first battle.[9]

4.2. Experimental Procedures

A total of seventy two subjects participated in six sessions (12 subjects per session). All subjects were undergraduate students at Chapman University and inexperienced in this decision-making environment. No one participated in more than one session. The experimental sessions were run using computer software z-Tree (Fischbacher, 2007). Throughout the session, no communication between subjects was permitted, and all choices and information were transmitted via computer terminals.[10] At the beginning of each session, subjects received an initial endowment of $20 to cover potential losses.

Each experimental session corresponded to 20 periods of play in one of the two treatments. Thus, three sessions featured the sequential treatment and three sessions featured the simultaneous treatment. Subjects were given the instructions, available in the Appendix, at the beginning of the experiment, and these were read aloud by the experimenter. Before the start of

[9] In the sequential contest, the total expected expenditure by both players in the first battle is 32.8; in the second battle is 18.8; and since the third battle is likely to occur with probability 0.25, the unconditional expected expenditure in the third battle is 25.

[10] Our subject pool comprised a large number of females (67%), and the median age was 19. Although on average, most subjects had taken two Business and Economics classes; their declared 'major' field of study is diverse.

the experiment, subjects completed a computerized multiple choice quiz to verify their understanding of the instructions.[11] The experiment started only after all subjects completed the quiz and explanations were provided for any incorrect answers. In every period, subjects were randomly and anonymously placed into 6 groups with 2 players in each group. To keep the terminology neutral, in the instructions we describe the task as one of making bids in boxes and the player who wins 2 boxes gets the prize of 100 experimental francs. All subjects were informed that increasing their bid would increase their chance of winning; and that regardless of who wins the prize, all subjects would have to pay their bids. In the simultaneous treatment subjects were asked to make bids in three battles simultaneously. They were not allowed to bid more than 100 francs in any battle.[12] Money spent on bidding was subtracted from the initial endowment of $20 that was given to the subjects to cover potential losses. After subjects submitted their bids, the computer displayed own bids, opponent's bids, winner of each battle, overall winner and own final payoff. In the sequential treatment subjects made their bidding decision sequentially, either in two or three rounds (with bids not exceeding 100 francs in any round). At the end of each round, the computer displayed own bid, opponent's bid, and the winner of the battle in that round. The period ended when one of the subjects in the group won two rounds. At the end of each period, subjects were randomly re-grouped to form a new two-person group.

[11] Subjects also made 15 choices in simple lotteries, similar to Holt and Laury (2002), at the beginning of the experiment. These were used to elicit their risk aversion preferences, and subjects were paid for one randomly selected choice.

[12] 100 francs is substantially higher than the highest possible equilibrium bid, but we decided not to constrain individual bidding to be consistent with the theoretical model which assumes no budget constraints. Additionally, we wanted to avoid potential unintended behavioral consequences since enforcing even non-binding budget constraints can unexpectedly affect subjects' behavior (Price and Sheremeta, 2011; Sheremeta, 2011).

At the end of the experiment, 2 out of 20 periods were randomly selected for payment.[13] The sum of the earnings for these 2 periods was exchanged at rate of 25 experimental francs = US$1. On average, the experimental sessions lasted for about 60 minutes, and subjects earned $21 which was paid anonymously and in cash.

5. Results

5.1. General Results

Table 2 presents the aggregate mean expenditure and payoff in both sequential and simultaneous contests. The average total expenditure is 60.8 in the sequential contest and 38.1 in the simultaneous contest. While the observed expenditure in the simultaneous contest is not significantly different from the equilibrium predictions (38.1 versus 37.5, p-value = 0.65), the observed expenditure in the sequential contest is significantly higher than predicted (60.8 versus 32, p-value < 0.01).[14] Moreover, this over-expenditure in the sequential contest is observed in all three battles.

Finding 1: Average total expenditure in the simultaneous contest conforms to the theoretical predictions, but there is significant over-expenditure in the sequential contest.

The experiment lasted for 20 periods and it is relevant to examine how expenditure evolves over the length of the experiment. Figures 1 and 2 show that in both sequential and simultaneous contests, the total expenditure decreases over time. For instance, in the sequential contest the average total expenditure in period 1 is 85.6 and it drops to 53.2 in the last period.

[13] We chose to select only 2 periods for payment in order to avoid intra-experimental income effects (McKee, 1989).

[14] To support these conclusions we estimated simple panel regressions for each treatment, where the dependent variable is the total expenditure and the independent variables are a constant and a period trend. The model included a random effects error structure, with the individual subject as the random effect, to account for the multiple decisions made by individual subjects. The standard errors were clustered at the session level. Based on a standard Wald test conducted on estimates of a model, we found that expenditure in the sequential contest is significantly higher than predicted (p-value < 0.01) and for the simultaneous contest it is not different from the prediction (p-value = 0.65).

Similarly, in the simultaneous contest the average total expenditure drops from 48.0 to 35.8. A panel regression of the total expenditure on a time trend shows that this negative relationship is significant (p-value < 0.01). The result that over-expenditure decreases with repetition in the direction of equilibrium play is also consistent with previous experimental findings on single-battle contests (Davis and Reilly, 1998; Fonseca, 2009; Sheremeta and Zhang, 2010; Price and Sheremeta, 2014; Chowdhury et al., 2014; Mago et al., 2014).

Comparing across treatments, the average expenditure in the sequential contest is higher than in the simultaneous contest (60.8 versus 38.1). A panel regression of total expenditure on the treatment dummy variables and a time trend indicates that this difference is significant (p-value < 0.01).[15] This finding rejects *Hypothesis 1* that the aggregate expenditure is higher in the simultaneous contest relative to the sequential contest.

Finding 2: Average total expenditure is significantly higher in the sequential contest than in the simultaneous contest.

It is important to emphasize that the magnitude of the difference between the two treatments is quite substantial. The sequential contest generates 60% higher expenditure than the simultaneous contest, instead of the predicted 20% lower expenditure. As a result of this over-expenditure, the observed average payoff in the sequential contest is negative and lower than predicted (-10.9 versus 18). On the other hand, the average payoff in the simultaneous contest is positive and very close to predicted (11.9 versus 12.5).

Next, we take a closer look separately at sequential and simultaneous contests to explain the observed deviations from the theory.

[15] A random effects error structure accounted for the multiple decisions made by individual subjects and standard errors were clustered at the session level to account for the session effects.

5.2. Sequential Contests

Theory predicts that in the sequential contest the winner of the first battle should win the overall contest with probability 0.875. In the experiment, we find that the winner of the first battle wins the overall contest with probability 0.8, which is significantly higher than the probability of winning by the loser of the first battle (p-value < 0.01).[16] This happened 74% of the time in the first five periods and 86% of the time in the last five periods (see Figure 3). Thus, our data provide support for the New Hampshire effect stated as *Hypothesis 2*, i.e., the winner of the early primaries (first battle) has a significantly higher probability of winning the party nomination (the overall contest).

Finding 3: In the sequential contest, the winner of the first battle wins the overall contest with probability 0.8.

However, it is important to note that although the New Hampshire effect is supported in principle, the rationale underlying the effect is not observed in the data. More specifically, the theory motivating the New Hampshire effect entails that the loser of the first battle should be discouraged in the second battle and thereby reduce his expenditure substantially (from 16.4 to 4.7), and given this, the winner of the first battle should also reduce his expenditure in the second battle (from 16.4 to 14.1). Contrary to these predictions, we find that the loser of the first battle does not decrease his expenditure in the second battle (17.8 in battle 1 versus 23.5 in battle 2), with about 79% of expenditures being higher than the equilibrium prediction of 4.7 (see Figure 4). Similarly, winner of the first battle increases his expenditure from 26.7 in the first battle to

[16] To support this conclusion we estimated a simple panel regression for the sequential treatment, where the dependent variable is the probability of winning the overall contest and the independent variables are a constant, a period trend and a dummy variable of whether the player won the first battle. The model included a random effects error structure, with the individual subject as the random effect, to account for the multiple decisions made by individual subjects. Based on estimation results, the dummy variable for win in the first battle is significant (p-value < 0.01).

28.5 in the second battle, with about 82% of expenditures being higher than the equilibrium prediction of 14.1. This increase in expenditure is significant for both players (p-value < 0.01). Moreover, the aggressive over-expenditure behavior carries over to the decisive third battle. In the final battle, average expenditure by both players is higher than the theoretical prediction of 25 (p-value < 0.01).[17] Although this over-expenditure is inconsistent with the theoretical predictions of the model, it can explain why the sequential contest generates much a higher total expenditure than the simultaneous contest (Finding 2).

Aggressive play by both players also explains why the sequential contest lasts longer than expected. Contrary to the theoretical prediction that the sequential contest should end in the second battle with probability 0.75, Figure 4 shows that on average the contest ends in the second battle with probability 0.61. There is some evidence of learning since the likelihood of second battle being the decisive one is increasing with the repetition of the experiment. For example, in the first five periods 48% of the contests conclude after two battles; and this proportion increased to 70% in the last five periods of the experiment.

Finding 4: In the sequential contest, over-expenditure is observed in all three battles. Contrary to prediction, expenditures by both subjects increase in battle 2 compared to battle 1. This results in lower probability of the contest ending in the second battle.

There are several possible explanations for this significant over-expenditure observed in the sequential contest.[18] One explanation is that subjects fall prey to the sunk cost fallacy. The payoff maximization problem underlying the multi-battle sequential contest equilibrium regards the expenditure in previous battles as sunk cost, and therefore ignores them. However, evidence

[17] The statistical tests are based on the estimation of a panel regression, similar to footnotes 13, 14 and 15. Details are available upon request.
[18] Sheremeta (2013, 2014) provides an overview of possible explanations for the over-expenditure phenomena in single-battle contests, including bounded rationality, utility of winning, other-regarding preferences, and judgmental biases.

from various behavioral studies suggests otherwise. Friedman et al. (2007) state that there are at least two distinct psychological mechanisms that might create an irrational regard for sunk cost. One mechanism is cognitive dissonance (Festinger, 1957) or self-justification (Aronson, 1968), which induces people who have sunk resources into an unprofitable activity to irrationally revise their beliefs about the profitability of an additional expenditure, in order to avoid the unpleasant acknowledgment that they made a mistake. In our experiment, subjects who get to the third battle have already made some expenditures in the previous two battles. If the sunk cost hypothesis is true, it will entail that subjects who expend more in battles 1 and 2 are also more likely to expend more in the final decisive battle – to increase their chance of winning the prize and recoup some of their expenditure. A simple random effect regression finds that there is a positive relationship between the expenditure in battle 3 and the total expenditure in the previous two battles (p-value < 0.05). Extending it temporally, sunk cost hypothesis would also imply that the observed decline in expenditure in battles 1 and 2 over periods is associated with a similar decline in expenditure in battle 3. Data summarized in Figure 1 clearly supports this conjecture. Second mechanism underlying sunk cost relates to the prospect theory - specifically to a fixed reference point and loss-aversion (Kahneman and Tversky, 1979). This postulates that subjects who spent more in previous battles should spend more in the current battle to avoid potential losses. Loss-aversion could also explain why losers of the first battle do not decrease their expenditure, but instead, increase their expenditure, trying to reduce the probability of future loss.

The reduced probability of the contest ending in battle 2 and the resulting over-expenditure is largely driven by the increased expenditure in battle 2, by both battle 1 winner and battle 1 loser (Finding 4). Since this increased expenditure is not grounded in standard equilibrium explanation, we postulate that subjects may derive additional non-pecuniary utility from winning itself (Sheremeta, 2013, 2014). Based on the assumption that subjects only care about their monetary prize, standard equilibrium theory predicts that battle 1 loser will suffer from a dramatic decrease in his continuation value for the next battle, and accordingly expend less in battle 2. However, if we incorporate winning as a component in the subject's utility function, the decline in continuation value is not so dramatic, and battle 1 loser will have an incentive to expend more in battle 2. This explanation is in line with a number of previous experimental studies that have employed non-pecuniary utility of winning as an explanation for persistent over-expenditure (Parco et al., 2005; Sheremeta, 2010a, 2010b; Cason et al., 2011, 2012; Price and Sheremeta, 2011, 2014; Brookins and Ryvkin, 2014; Mago et al., 2014). Parco et al. (2005, pg. 328) argue that this non-pecuniary gain "may particularly apply to inexperienced subjects for whom winning is a reward by itself." Accordingly, in the experiment, we find that expenditure in battle 2 by battle 1 loser declines from 28.3 in the first 10 periods to 18.7 in the last 10 periods. Note that while this decline is significant, the average expenditure by battle 1 loser continues to be far greater than predicted (4.7), indicating that winning does not lose its charm completely.

Utility of winning may also provide insight into why over-expenditure rates are significantly higher in sequential contests compared to simultaneous contests (Finding 2). Both Parco et al. (2005) and Sheremeta (2010b) suggest that the utility of winning is increasing in the number of battles. Although the number of battles is identical in both simultaneous and sequential contest, in the sequential contest subjects can receive this non-pecuniary utility up to two times (when each battle winner is announced) while in the simultaneous contest such utility is received only once (when the overall winner is announced).

5.3. Simultaneous Contests

Next, we conduct an equilibrium comparison of expenditure pattern in the simultaneous contest. Theory predicts that subjects allocate equal expenditures across the three battles (*Hypothesis 3*). Our data reveals that although the average expenditure in all three battles is close to the predicted level of 12.5 (Table 2), none of the subjects who participated in the simultaneous contest employed a uniform expenditure strategy. Most subjects varied their expenditure *between* battles, with difference from the mean expenditure across all three battles averaging at a steep 11.3. Figure 5 displays the average difference from the mean expenditure across all three battles in a given period. A lower magnitude of dispersion implies a more uniform expenditure strategy and obviously, in equilibrium, the magnitude of dispersion should be zero. We find that although there is some evidence that the dispersion of expenditure across the three battles decreases in the first five periods of the experiment; on the whole, the average difference in expenditure remains positive and significant over the entire length of the experiment.

Figure 6 displays the distribution of expenditure *within* each battle over all 20 periods of the simultaneous contest. Two things stand out. First, subjects' expenditures are distributed over the entire strategy space, which is clearly inconsistent with play at a unique pure strategy Nash equilibrium. While a large majority of the expenditure is centered close to the equilibrium prediction of 12.5, there is also substantial variation in expenditure. Expenditure in an individual battle is less than 5 or more than 20, on average, 24 percent and 12 percent of the time. Second, despite the large variance, the overall distribution of expenditure is remarkably similar in the three battles indicating no preferential bias across battles.[19]

[19] That is, there is no allocation bias such as that observed in Colonel Blotto games (Chowdhury et al., 2013), where players who read and write from left to right horizontally in their native language tend to allocate greater expenditure to the battles on the left.

Finding 5: Subjects in the simultaneous contest do not employ a uniform expenditure strategy. There is substantial dispersion in expenditure both between-battles in a given period and within-battles over time.

This dispersion in expenditure (both between-battles and within-battles) alludes to a strategy akin to guerilla warfare. To win the overall contest, a player needs to win a minimum of two battles. She does not derive any additional utility from winning all three battles. This entails that players can randomly select and focus their expenditure on just two battles. We find that the average minimum expenditure in a battle is 7.51, almost half the prediction of 12.5. Indeed, almost 22 percent of time, expenditure in one of the battles is less than or equal to 1. Similarly, expenditure in the remaining two battles averages at 15.28, and exceeds the equilibrium prediction more than 58 percent of the time. This guerilla warfare strategy (i.e., incomplete and inequitable coverage of battles) can also explain why the overall expenditure in the simultaneous contest is close to the theoretical predictions (Result 1), while it is well documented that in a single-battle contest subjects consistently overbid relative to predictions (see Dechenaux et al. 2014).

6. Conclusion

In this study we use laboratory experiment to compare sequential and simultaneous contests, where candidates have to win the majority of a number of electoral districts (sequentially or simultaneously) in order to obtain a prize. Candidates influence the probability of winning an electoral district by their choice of campaign expenditure in that district. Consistent with the theory, in the laboratory we find evidence of the "New Hampshire effect" in the sequential contest, i.e., the winner of the first battle wins the overall contest with much higher probability than the loser of the first battle. However, contrary to the theory, sequential contests generate substantially higher expenditure than simultaneous contests. This is mainly because in sequential contests, contrary to predictions, losers of the first battle do not decrease their expenditure in the second battle while winners of the first battle increase (instead of decreasing) their expenditure in the second battle. Finally, we find that although subjects learn to behave more in line with equilibrium predictions, their behavior is substantially different from predictions even in the last few periods of the experiment.

Analogies between our laboratory environment and the naturally-occurring political contests are imperfect. For instance, we assume that both contestants are symmetric and do not account for factors such as name recognition, time of announcing candidacy, or nature of campaigns. We also ignore the carryover effect of winning (Schmitt et al., 2004), bandwagon effect (Callander, 2007) and the conditional promise of additional funding upon winning the primary. However, these factors do not detract from our findings. The New Hampshire effect holds even if players are asymmetric in the sense that one is a better campaigner or has assured win in certain districts (Klumpp and Polborn, 2006). In fact, the exogenous ex-ante asymmetry is further strengthened in sequential contests by the endogenous ex-post asymmetry, almost creating a 'preemption effect.' Similarly, bandwagon theory and carryover effect provide additional rationale for momentum to shift forward to earlier battles, thereby reinforcing our results. By contrasting sequential and simultaneous multi-battle contests in the simplest possible framework using laboratory data, which is untainted from the various complicating factors that plague field data, we provide direct empirical evidence in support of Klumpp and Polborn's model. A theory that performs well in the lab may not have complete external validity, but it does pass what Smith (1982) refers to as a "nontrivial test."

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Table 1: Equilibrium Predictions in Sequential and Simultaneous Contests

Treatments	Sequential	Simultaneous
Final prize, *v*	100	100
Number of battles, *n*	3	3
Exponent, *r*	1	1
	Equilibrium	Equilibrium
Expenditure in battle 1	16.4	12.5
Expenditure in battle 2 by battle 1 winner	14.1	12.5
Expenditure in battle 2 by battle 1 loser	4.7	-
Expenditure in battle 3	25.0	12.5
Probability of contest ending in battle 2	0.75	-
Expected total expenditure	32.0	37.5
Expected payoff	18.0	12.5

Table 2: Average Statistics

Treatments	Sequential		Simultaneous	
Final prize, *v*	100		100	
Number of battles, *n*	3		3	
Exponent, *r*	1		1	
	Equilibrium	Actual	Equilibrium	Actual
Expenditure in battle 1	16.4	22.2 (0.6)	12.5	12.8 (0.4)
Expenditure in battle 2 by battle 1 winner	14.1	28.5 (0.9)	12.5	13.0 (0.3)
Expenditure in battle 2 by battle 1 loser	4.7	23.5 (1.0)	-	-
Expenditure in battle 3 by battle 2 winner	25.0	33.2 (1.5)	12.5	12.3 (0.4)
Expenditure in battle 3 by battle 2 loser	25.0	31.7 (1.5)	-	-
Probability of contest ending in battle 2	0.75	0.61 (0.02)	-	-
Average total expenditure	32.0	60.8 (1.5)	37.5	38.1 (0.9)
Average payoff	18.0	-10.9 (2.1)	12.5	11.9 (1.8)

Standard error of the mean in parentheses.

Figure 1: Average Expenditure over 20 Periods in the Sequential Contest

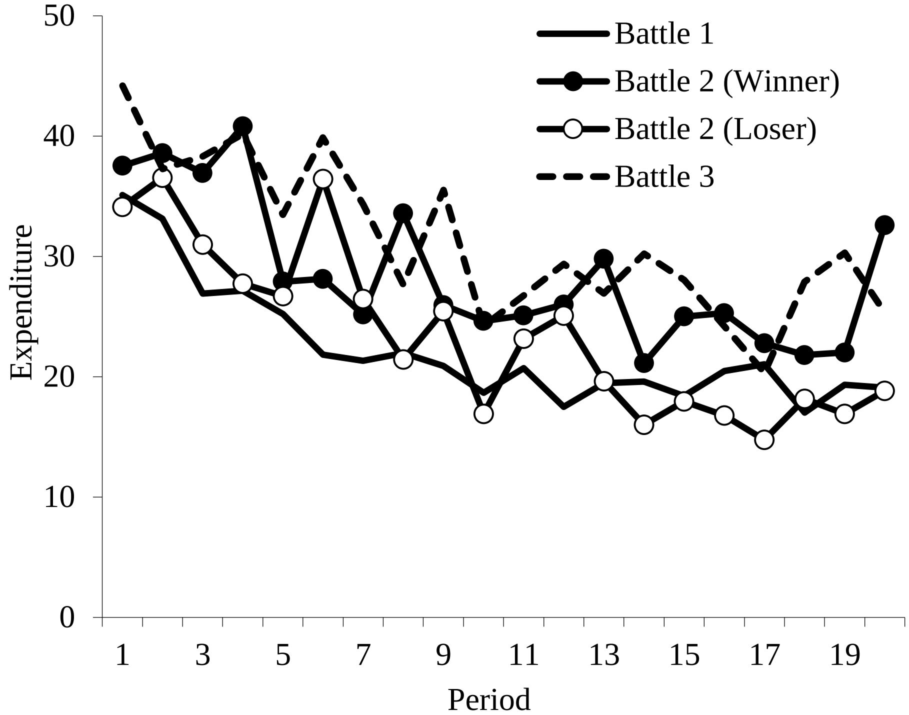


Figure 2: Average Expenditure over 20 Periods in the Simultaneous Contest

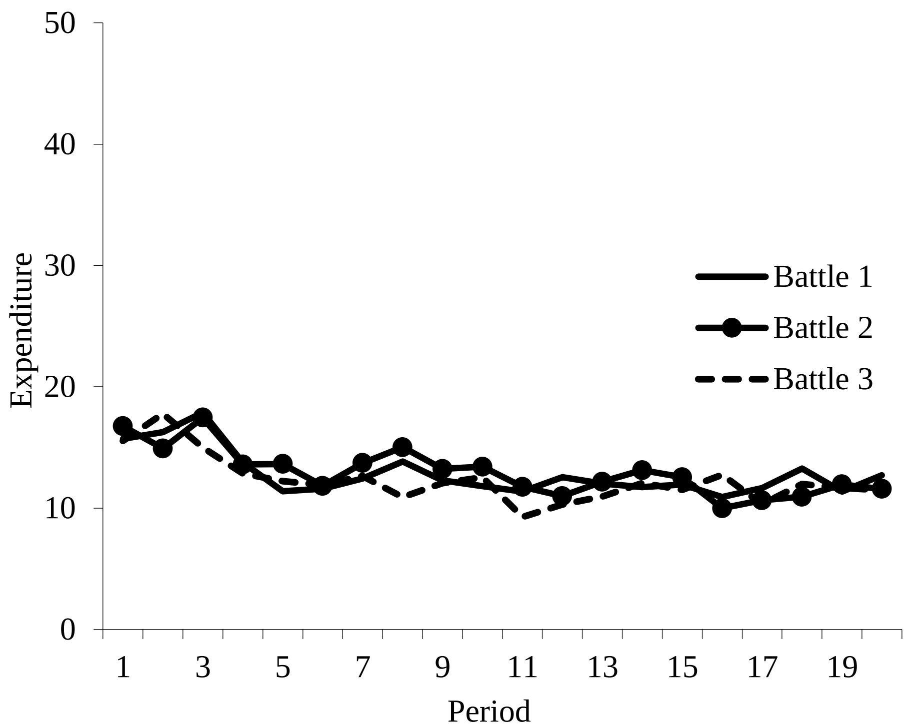


Figure 3: Probability of Ending and Winning the Sequential Contest

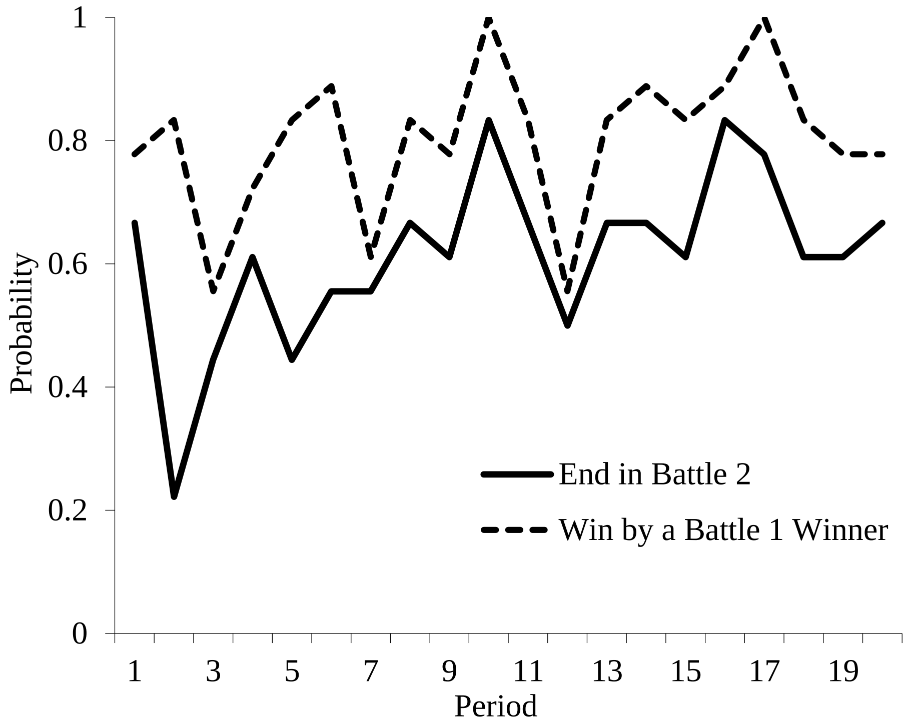


Figure 4: Distribution of Expenditure in the Sequential Contest

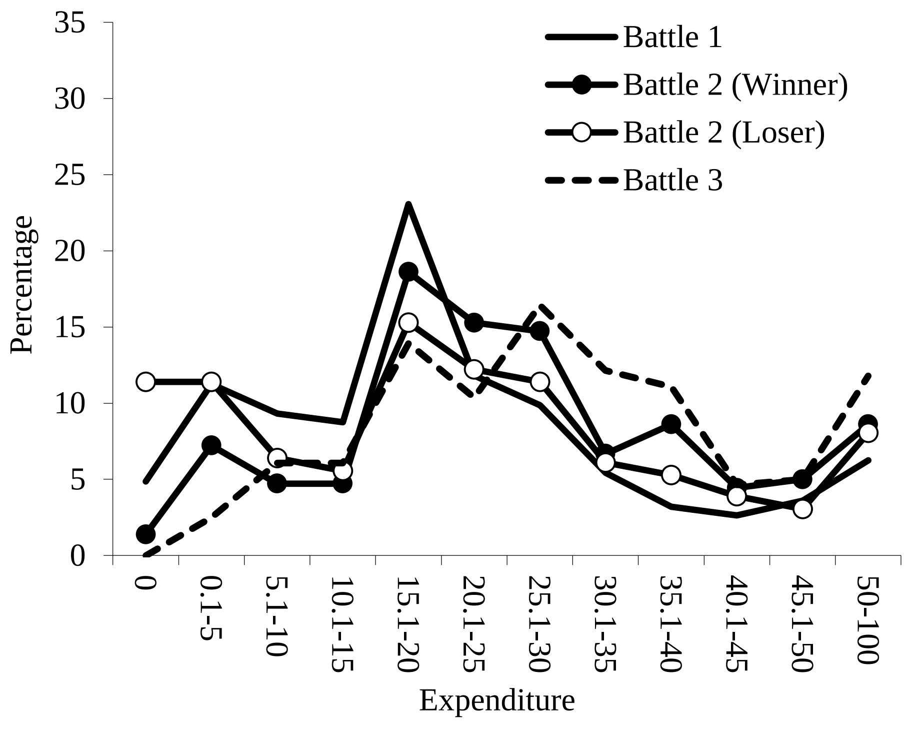


Figure 5: Average Difference from the Mean Expenditure across Three Battles in the Simultaneous Contest

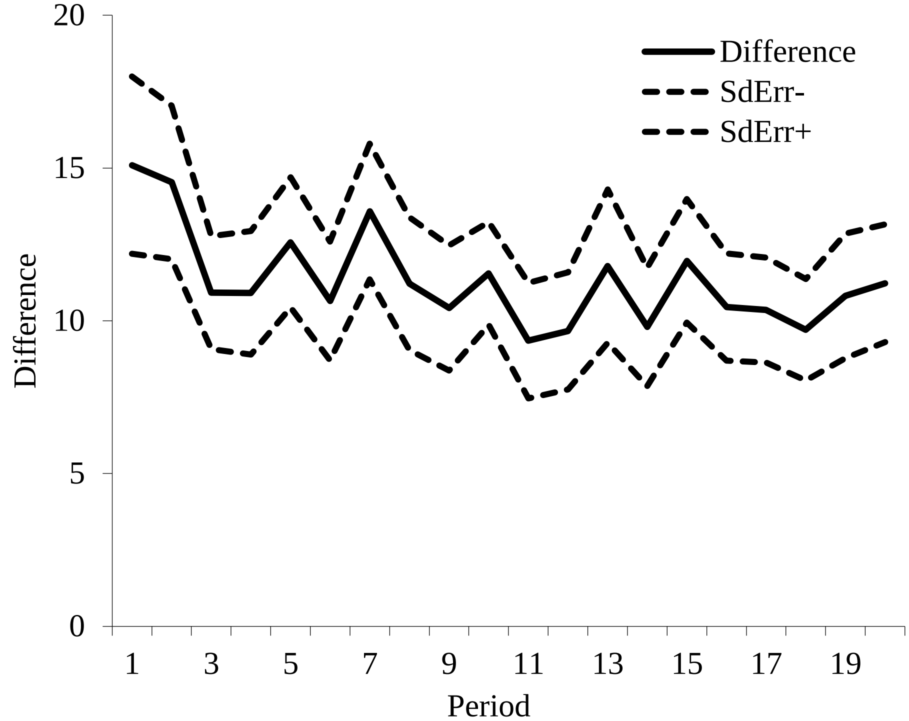
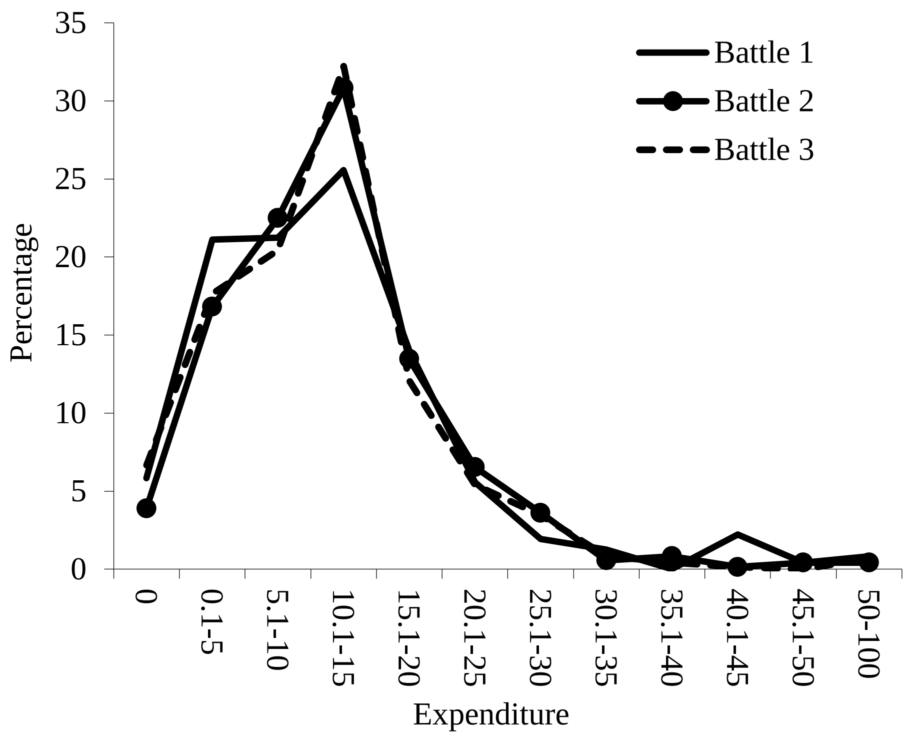


Figure 6: Distribution of Expenditure in the Simultaneous Contest



Appendix – Instructions for the Simultaneous Treatment

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 two 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 of the experiment is francs. These francs will be converted to U.S. Dollars at a rate of _25_ francs to _1_ dollar. You have already received a **$20.00** participation fee (this includes your show-up fee of $7.00). Your earnings from both Part 1 and Part 2 of the experiment will be incorporated into your participation fee. 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

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 only **one line** will be randomly selected for payment. Each line is equally likely to be selected, and you do not know which line will be selected 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 selected for payment.

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.

While you have all the information in the table, we ask you that you input all your 15 decisions into the computer. The actual earnings for this part will be determined at the end of part 2, and will be independent of part 2 earnings.

Are there any questions?

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	

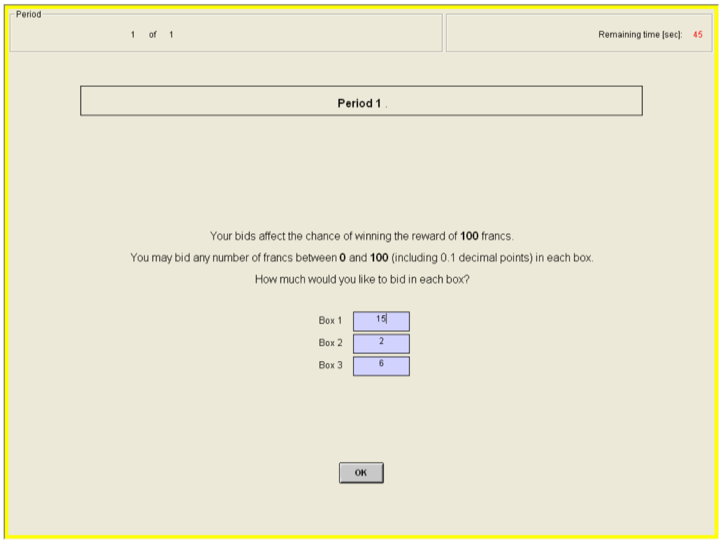
INSTRUCTIONS FOR PART 2

YOUR DECISION

The second part of the experiment consists of **20** decision-making periods. The 12 participants in today's experiment will be randomly re-matched every period into 6 groups with 2 participants in each group. Therefore, the specific person who is the other participant in your group will change randomly after each period. The group assignment is anonymous, so you will not be told which of the participants in this room are assigned to your group

Each period you and the other participant in your group will simultaneously make bids (any number, including 0.1 decimal points) in three boxes. Your bid in each box cannot **exceed 100 francs**. The more you bid, the more likely you are to win a particular box. This will be explained in more detail later. The participant who wins at least two boxes receives **the reward of 100 francs**. Your total earnings depend on whether you receive the reward or not and how many francs you spent on bidding. An example of your decision screen is shown below in Figure 1:

Figure 1 – Decision Screen



CHANCE OF WINNING A BOX

The more you bid in a particular box, the more likely you are to win that box. The more the other participant bids in the same box, the less likely you are to win that box. Specifically, for each franc you bid in a particular box you will receive one lottery ticket. At the end of each period the computer **draws randomly** one ticket among all the tickets purchased by you and the other participant in the group. The owner of the drawn ticket wins. Thus, your chance of winning a particular box is given by the number of francs you bid in that box divided by the number of francs you and the other participant bid in that box.

$$\text{Your chance of winning a box} = \frac{\text{Your Bid in That Box}}{\text{Your Bid in That Box + The Other Participant's Bid in That Box}}$$

In case both participants bid zero in the same box, the computer determines randomly who wins that box.

Example: This is an example to illustrate how the computer makes a random draw of lottery tickets. Suppose, in a given round participant 1 bids 10 francs in box 1 and participant 2 bids 20 francs in box 1. Therefore, the computer assigns 10 lottery tickets to participant 1 and 20 lottery tickets to participant 2. Then the computer randomly draws **one lottery ticket out of 30 tickets** (10 + 20 = 30). As you can see, participant 2 has **higher chance**, **0.67 = 20/30**, while participant 1 has **lower chance**, **0.33 = 10/30**, of winning box 1.

In the sheet attached to these instructions, you will find a probability table. This table will give you some idea of how your bid and the other participant's bid affect your chance of winning. For instance, suppose you bid 50 francs and the other participant bid 30 francs then your chance of winning the box is 0.63. Note that as stated before, your chance of winning increases as your bid increases relative to the other participant's bid. So if you bid 70 francs and the other participant is still bidding 30 francs, your chance of winning increases to 0.70. To assist you with calculation of more precise numbers, we will provide you with the Excel calculator in each round. You may use the calculator to find the chance of winning for any combination of your bid and the other participant's bid. We will have a few practice rounds with the Excel calculator before the start of the experiment.

YOUR EARNINGS

Your earnings depend on whether you receive the reward or not and how many francs you spent on bidding. The participant who wins at least two boxes receives **the reward of 100 francs**. Regardless of who receives the reward, both participants will have to pay their bids in each box. Thus, the period earnings will be calculated in the following way:

Earnings of the participant who won at least two boxes are =

= 100 - (bid in box 1) - (bid in box 2) - (bid in box 3)

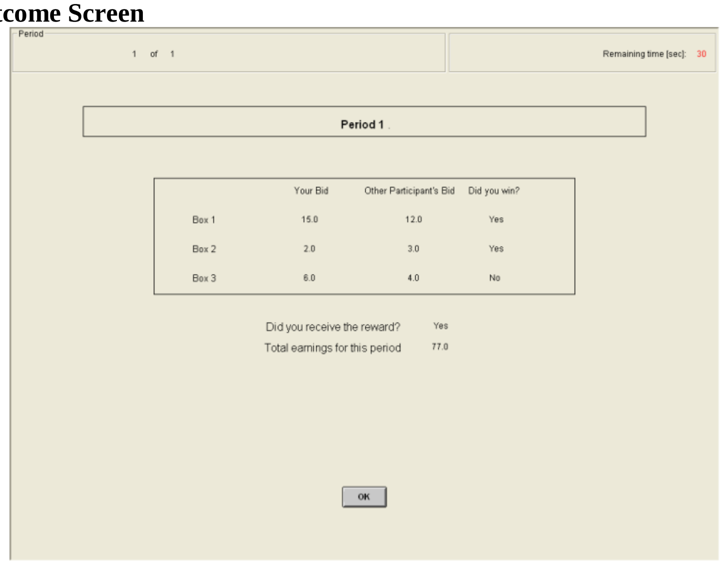
Earnings of the participant who less than two boxes are =

= 0 - (bid in box 1) - (bid in box 2) - (bid in box 3)

END OF THE PERIOD

After both participants make their box bids, the computer will make a random draw for each box separately and independently. The random draws made by the computer will decide which boxes you win. The computer will calculate your period earnings based on whether you received the reward or not and how many francs you spent on bidding in each box. Both participants will observe the outcome of the period – your bid in each box, other participant's bids in each box, winner of each box, and your earnings from that period, as shown in Figure 2. Once the outcome screen is displayed you should record your results for the period on your **Personal Record Sheet** under the appropriate heading. You will be randomly re-matched with a different participant at the start of the next period.

Figure 2 – Outcome Screen



END OF THE EXPERIMENT

At the end of the experiment we will use the bingo cage to randomly select 2 out of 20 periods for actual payment. Depending on the outcome in a given period, you may receive either positive or negative earnings. You will sum the total earnings for these 2 periods and convert them to a U.S. dollar payment, as shown on the last page of your personal record sheet. Remember you have already received a **$20.00** participation fee (equivalent to **500 francs**). If your earnings from this part of the experiment are positive, we will add them to your participation fee. If your earnings are negative, we will subtract them from your participation fee.

Questionnaire

1. *True / False* You will be randomly re-matched with a different participant at the start of each new period.
2. *True / False* Each period you will make bids in three boxes.
3. *True / False* The participant who wins 2 out of 3 boxes receives the reward.
4. *True / False* The more you bid in a particular box, the more likely you are to win that box.
5. *True /* False You will pay your bid only if you receive a reward, otherwise not.
6. If you win 0 boxes your payoff is ______________________ - your bids in the three boxes.
   a. 100
   b. 0
7. If you win 2 boxes your payoff is ______________________ - your bids in the three boxes.
   a. 100
   b. 0
8. If you win 1 box your payoff is ______________________ - your bids in the three boxes.
   a. 100
   b. 0