

# Sequential versus Simultaneous Election Contests: An Experimental Study<sup>\*</sup>

Zeynep B. Irfanoglu<sup>a</sup>, Shakun D. Mago<sup>b</sup> and Roman M. Sheremeta<sup>c</sup>

<sup>a</sup>Department of Agricultural Economics, Purdue University,  
403 W. State St., West Lafayette, IN 47906-2056, USA

<sup>b</sup>Department of Economics, Robins School of Business, University of Richmond,  
1 Gateway Road, Richmond, VA 23173, USA

<sup>c</sup>Argyros School of Business and Economics, Chapman University,  
One University Drive, Orange, CA 92866, USA

August 27, 2010

## Abstract

This experimental study compares sequential and simultaneous multi-battle election contests. We find substantial evidence of a “New Hampshire effect” in the sequential contests, 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 theory, sequential contest generate substantially higher expenditure than simultaneous contest. This is mainly because losers of the first battle do not decrease their expenditure in the second battle; and winners of the first battle substantially increase their expenditure in the second battle, instead of decreasing their expenditure as predicted. We also find that, with repetition of the experiment, subjects learn to behave more in line with equilibrium predictions. However, even in the last periods of the experiment their behavior is substantially different from predictions.

*JEL Classifications:* C72, C91, D72

*Keywords:* multi-battle contest, experiments, risk aversion, over-dissipation

---

Corresponding author: Roman M. Sheremeta; E-mail: sheremet@chapman.edu

\*We thank Tim Cason, Andrew Healy, James Konow, Rebecca Morton, Stergios Skaperdas, seminar participants at Loyola Marymount University, University of California Irvine and participants at the International Economic Science Association conference for helpful comments. Any remaining errors are ours.

## 1. Introduction

The nomination process for 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 incumbent President Harry S. Truman in the primary, leading Truman to abandon his campaign. Another President forced from running for re-election by 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 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, pg. 8). According to political pundits, the dominant reasoning 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 New Hampshire 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 primary. Similarly, a

comeback by John Kerry in the 2004 New Hampshire 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.<sup>1</sup> 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 in addition derives a wide array of political and economic benefits from that position, led many states to move up the date of their primaries.<sup>2</sup> '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-

---

<sup>1</sup>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, pg. 107). 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.

<sup>2</sup>A recent 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, pg 11). 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 the sequential contest, such as the current presidential primaries, to the simultaneous contest, as reflected in a counterfactual national primary.<sup>3</sup> In contrast to the literature on voters’ participation (Morton and Williams, 1999; Battaglini et al., 2007), our theoretical framework is based on a recent contest model by 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 certain 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.<sup>4</sup> In case of sequential primary contest, theory predicts that candidates expend disproportionately large amounts in the earlier districts compared to 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” (Klumpp and Polborn 2006, pg. 1075). 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.<sup>5</sup> 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, and this probability

---

<sup>3</sup> Our experiment compares two extreme benchmarks: completely sequential contests and completely simultaneous contests. 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, New Hampshire etc.) followed by days such as “Super Tuesday” where a number of states vote simultaneously. Klumpp and Polborn (2006, pg. 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.

<sup>4</sup> The crucial difference between voters’ participation model (Morton and Williams, 1999; Battaglini et al., 2007) and contest model (Tullock, 1980; Snyder, 1989; Klumpp and Polborn, 2006) is that in 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.

<sup>5</sup> Another reason, commonly discussed in political science literature, for a “New Hampshire Effect” is information aggregation, i.e. in sequential voting later voters can use early outcomes to make better informed decisions that reflect their true preferences (Morton and Williams, 1999, 2000; Battaglini et al., 2007).

increases as the total number of battles in the contest increases. In contrast, simultaneous contest lead to complete rent dissipation if the number of battles is sufficiently large. An important consequence of this temporal design difference is that sequential contest is predicted to induce lower expected expenditure than simultaneous contest. The theoretical finding that sequential elections minimize wasteful campaign expenditure might explain why political parties prefer sequential organization of the primaries.<sup>6</sup>

Consistent with the theory, in the laboratory we find substantial evidence of “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 contest generate substantially higher expenditure than the equivalent simultaneous contest. This is mainly because losers of the first battle do not decrease their expenditure in the second battle; and winners of the first battle substantially increase their expenditure in the second battle, instead of decreasing their expenditure as predicted. We also find that, with repetition of the experiment, subjects learn to behave more in line with equilibrium predictions. However, even in the last periods of the experiment their behavior is substantially different from predictions.

## **2. Literature Review**

The theoretical literature on multi-battle contests originated with seminal work by Fudenberg et al. (1983) and Snyder (1989).<sup>7</sup> Fudenberg et al. (1983) model R&D competition as a sequential multi-battle contest, while Snyder (1989) models political campaigning as a

---

<sup>6</sup> Battaglini et al. (2007) study sequential and simultaneous voting and find that “a sequential voting rule 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.”

<sup>7</sup> 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.

simultaneous multi-battle contest. Building on this, subsequent papers investigate 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; Budd et al., 1993; Baik and Lee, 2000; Szentes and Rosenthal, 2003; Klumpp and Polborn, 2006; Roberson, 2006; Kvasov, 2007; Konrad and Kovenock, 2009).

Most of the experimental literature on contest theory focus on single-battle contests (Davis and Reilly, 1998; Potters et al., 1998; Gneezy and Smorodinsky, 2006; Sheremeta, 2010a; Sheremeta and Zhang, 2010). In contrast, experimental studies on multi-battle contests are rather scarce. There are only several recent studies on a simultaneous multi-battle contest. Avrahami and Kareev (2009) and Chowdhury et al. (2009) find that individual behavior largely conforms to the equilibrium predictions of multi-battle simultaneous contests. However, these studies are based on constant-sum Colonel Blotto game (Borel, 1921), where players cannot over-dissipate. Experimental studies on sequential multi-battle contests include Zizzo (2002) and Sheremeta (2010c). Zizzo (2002) examines patent race of Harris and Vickers (1987) and finds that, as the contest approaches the end, contestants compete more aggressively than predicted. Contrary to the theoretical prediction, the leader does not expend more effort than the follower. Sheremeta (2010c) finds that the multi-stage contest of Gradstein and Konrad (1999) induces higher expenditure than the theoretically equivalent one-stage contest. Similar to Zizzo (2002), Sheremeta (2010c) also concludes that there is substantially more over-dissipation in the later stage of the competition.<sup>8</sup> To the best of our knowledge, there is no study in the experimental literature comparing simultaneous and sequential multi-battle contests.

---

<sup>8</sup> Other related studies on multi-stage contests are done by Parco et al. (2005) and Amegashie et al. (2007).

### 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. There are  $n = 3$  battles in the contest. If  $x_i$  and  $y_i$  denote the amount of resources expenditures by players  $X$  and  $Y$  in battle  $i$ , then following Tullock (1980), the probabilities of winning battle  $i$  by players  $X$  or  $Y$  are defined by contest success functions (CSF):

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

The parameter  $r$  in these CSFs 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 a prize which is equally valued by both players at  $v$ . 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:

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

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  $n = 3$ .

#### 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  $x_3 = y_3 = 0$ . If this is not the case, i.e., if each player has won one of previous two battles and the winner of the contest is going to be determined according to the result of the third battle, then player  $X$ 's expected payoff 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  $x_3$ :

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

Player  $Y$ 's expected payoff can be determined analogously. In the unique, symmetric subgame-perfect Nash equilibrium, the expenditures are  $x_3^* = y_3^* = v/4$  and the expected payoffs are  $E(\pi_{X3}) = E(\pi_{Y3}) = E(\pi_3) = v/4$ .

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:

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

In the Nash equilibrium of this subgame, players choose expenditures  $x_3^* = 9v/64$  and  $y_3^* = 3v/64$  which yields 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  $X$  maximizes the following expected payoff:

$$E(\pi_{X1}) = \frac{x_1}{x_1+y_1}E(\pi_{X2}) + \frac{y_1}{x_1+y_1}E(\pi_{Y2}) - x_2 \quad (5)$$

Player  $Y$ 's expected payoff can be determined analogously. The equilibrium expenditures and expected payoffs are  $x_1^* = y_1^* = 21v/128$  and  $E(\pi_{X1}) = E(\pi_{Y1}) = E(\pi_1) = 23v/128$ , respectively.

### 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 battle is determined and the player who wins at least 2 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  $X$  maximizes the following expected payoff:

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

Player  $Y$ 's optimization problem can be determined analogously. In the unique Nash equilibrium, both players make the same expenditures in all battlefields, i.e.  $x_i = y_i = v/8$  for all  $i$ .<sup>9</sup>

## 4. Experimental Environment

### 4.1. Experimental Design and Hypotheses

---

<sup>9</sup> The solution to this game can also be found in Friedman (1958).

Although our experiment simplifies the political contest substantially, we believe it captures some of the more salient features of sequential and simultaneous contests. We employ two treatments: SEQ and SIM. In the SEQ treatment two players compete in a sequential multi-battle contest, while in the SIM treatment two players compete in a simultaneous multi-battle contest. Table 1 summarizes the equilibrium predictions in the SEQ and SIM treatments for  $v = 100$ ,  $r = 1$  and  $n = 3$ . These predictions suggest the following three hypotheses:<sup>10</sup>

**Hypothesis 1:** In SEQ treatment, win in the first battle generates momentum for the winner, or “New Hampshire effect.”

In 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. 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 battle outcome is known. In the second battle, winner of the first 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.

[Table 1 about here]

**Hypothesis 2:** In SIM treatment, expenditures are uniformly distributed across all three battles.

Since all three battles are identical in the simultaneous contest, both players make the same expenditures of 12.5 in each battle.

**Hypothesis 3:** Total expected expenditure in SEQ treatment is lower compared to SIM treatment.

---

<sup>10</sup> Note that all three hypotheses hold for any  $v > 0$ ,  $r \in (0,1]$  and  $n \geq 3$ . However, we chose specific parameters of  $v = 100$ ,  $r = 1$  and  $n = 3$  so that it would be easier for subjects to understand the experimental environment.

In the SEQ treatment the total expected expenditure by a player is 32.4, and in the SIM treatment the total expected expenditure by a player is 37.5. However, while in the latter treatment, expenditures are uniformly distributed across all three battles (12.5 in each of the 3 battles), in the SEQ treatment, expenditures are predicted to be more intensely concentrated in the initial battles.<sup>11</sup>

## 4.2. Experimental Procedures

A total of 72 subjects participated in six sessions (12 subjects per session). All subjects were undergraduate students at Chapman University, and were inexperienced in this decision-making environment. No one participated in more than one session. The experimental sessions were run using computer interface z-Tree (Fischbacher, 2007). Throughout the session no communication between subjects was permitted, and all choices and information were transmitted via computer terminals.<sup>12</sup>

Each experimental session corresponded to 20 periods of play in one of the two treatments. Thus, 3 sessions featured SEQ treatment and 3 sessions featured SIM 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 the experiment, subjects completed a computerized multiple choice quiz to verify their understanding of the instructions.<sup>13</sup> 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

---

<sup>11</sup> 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 total unconditional expected expenditure is 12.5.

<sup>12</sup> 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 rather diverse.

<sup>13</sup> Subjects also made 15 choices in simple lotteries, similar to Holt and Laury (2002), at the beginning of the experiment.

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 for a prize of 100 francs. All subjects were informed that by increasing their bids, they would increase their chance of winning; and that regardless of who wins the prize, all subjects would have to pay their bids. In the SIM treatment subjects were asked to make bids in three boxes simultaneously. They were not allowed to bid more than 100 francs in any box. After subjects submitted their bids, the computer displayed own bid, the opponent's bid, the winner of each box, and the overall winner. In the SEQ 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, the opponent's bid, and the winner of the box 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.

At the end of the experiment, 2 out of 20 periods in part two were randomly selected for payment. The sum of the earnings for these 2 periods was exchanged at rate of 25 francs = \$1. Additionally, all subjects received an initial endowment of \$20 to cover potential losses. 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 for both SEQ and SIM treatments. In a contest with three battles and a prize of 100 francs, the average total expenditure in the SEQ and SIM treatments is 60.8 and 38.1, respectively. While the observed and the

equilibrium expenditures in the SIM treatment are not significantly different (38.1 versus 37.5); the observed expenditure in the SEQ treatment is significantly higher than predicted (60.8 versus 32).<sup>14</sup>

**Finding 1:** Average total expenditure in SIM treatment conforms to the theoretical predictions, but there is significant amount of over-dissipation in the SEQ treatment.

[Table 2 about here]

Given that the experiment lasted for 20 periods, it is reasonable to examine how expenditure evolves over the length of the experiment. Camerer (2003) argues that subjects can learn to play the equilibrium strategies with experience. Figures 1 and 2 show that in both SEQ and SIM treatments, the total expenditure decreases over time. For instance, in SEQ treatment the average total expenditure in period 1 is 85.6 and it drops to 53.2 in the last period. Similarly, in SIM treatment 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 at the conventional level of significance ( $p$ -value  $< 0.01$ ). The result that over-dissipation decreases with repetition in the direction of equilibrium play is also consistent with previous experimental findings in contest literature (Davis and Reilly, 1998; Parco et al.; 2005; Gneezy and Smorodinsky, 2006; Sheremeta 2010a, 2010c).

**Finding 2:** Subjects in SEQ and SIM treatments decrease their expenditure over time.

[Figure 1 about here]

[Figure 2 about here]

---

<sup>14</sup> To support these conclusions we estimated simple panel regressions for each treatment, where the dependent variable is the total effort 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 effort in the SEQ treatment is significantly higher than predicted ( $p$ -value  $< 0.01$ ) and for the SIM treatment it is not different from the prediction ( $p$ -value = 0.65).

Comparing across treatments, the average expenditure in the SEQ treatment is significantly higher than in the SIM treatment (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  $< 0.01$ ).<sup>15</sup> This finding rejects the theoretical prediction, stated in Hypothesis 3, that aggregate expenditure is higher in the simultaneous contest relative to the sequential contest.

**Finding 3:** Average total expenditure is significantly higher in the SEQ treatment compared to the SIM treatment.

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

The two potential explanations for the difference between expenditures in sequential and simultaneous contests that we discuss in the following section are based on the sunk cost fallacy and non-pecuniary utility of winning.

## 5.2. SEQ Treatment

Theory predicts that in the SEQ treatment the winner of the first battle should win the overall contest with probability 0.875. In the lab, we find that the winner of the first battle wins the overall contest with probability 0.8. More specifically, this happened 74 percent of the time

---

<sup>15</sup> 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.

in the first five periods and 86 percent of the time in the last five periods (c.f. Figure 3). Thus, our data provide support for the “New Hampshire effect” (Hypothesis 1), i.e. the winner of the early primaries has a substantially higher probability of winning the party nomination.

**Finding 4:** In SEQ treatment, the winner of the first battle wins the overall contest with probability 0.8.

[Figure 3 about here]

[Figure 4 about here]

However, it is important to emphasize that although the result of New Hampshire effect is supported in the SEQ treatment, the rationale underlying the effect is not observed in the data. More specifically, theory predicts that because of the New Hampshire effect, 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). 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 (c.f. Figure 4). Similarly, winner of the first battle increases his expenditure from 26.7 in the first battle to 28.5 in the second battle, with about 82% of expenditures being higher than the equilibrium prediction of 14.1 (c.f. Figure 4). This increase in expenditure is significant for both players (p-value < 0.01). Moreover, the aggressive over-dissipating 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).<sup>16</sup> Although this over-dissipation is inconsistent with the theoretical predictions of the model, it can explain why SEQ treatment generates much higher total expenditure than SIM treatment (Finding 3).

---

<sup>16</sup> The statistical tests are based on the estimation of a panel regression, similar to footnotes 11 and 12.

Aggressive play by both players also explains why the sequential contests last longer than expected. Contrary to theory, which predicts that in the SEQ treatment the 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 battle 2 being decisive battle is increasing with the repetition of the experiment. For example, in the first five periods 48 percent of the contests conclude after two battles; and this proportion increased to 70 percent in the last five periods of the experiment.

**Finding 5:** In SEQ treatment, over-dissipation is observed in all three battles. Contrary to prediction, expenditure by both subjects increases 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 significant over-dissipation observed in the SEQ treatment. 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 costs, and therefore ignores them. However, evidence from various behavioral studies suggests otherwise (Friedman et al. 2007). 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.<sup>17</sup> A simple random effect regression finds that there is a positive relationship between expenditure in battle 3 and total expenditure in the previous two battles (p-value < 0.05). Extending it temporally, sunk cost hypothesis would

---

<sup>17</sup> Similar predictions could be generated by assuming loss-aversion, i.e. subjects who spent more in previous battles will spend more in the current battle to avoid potentially substantial losses. Loss-aversion could also be a potential explanation on why the losers of the first battle do not decrease their expenditure level, but instead are trying to reduce the probability of losing by increasing their expenditure.

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. Finally, yet another evidence supporting this hypothesis emerges from the comparison between expenditure in battle 1 and expenditure in battle 3. Players are symmetric at the beginning of the contest, in battle 1, and if the contest continues, in battle 3. This implies that both players should expend the same expenditure in these battles. However, we find that in battle 1, winner exerts significantly greater expenditure than the loser (26.68 versus 17.78,  $p$ -value  $< 0.05$ ). In contrast, expenditures of the winner and the loser of the second battle in battle 3 are very similar (33.2 versus 31.7,  $p$ -value = 0.73).

The reduced probability of the contest ending in battle 2 and the resulting over-dissipation is closely associated with increased expenditure in battle 2, by both battle 1 winner and battle 1 loser (Finding 5). Since this increased expenditure is not grounded in standard equilibrium explanation, we postulate that subjects may derive additional non-pecuniary utility from winning itself. More specifically, 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-dissipation (Schmidt et al., 2004; Parco et al., 2005; Sheremeta, 2010b, 2010c).<sup>18</sup> Parco et al. (2005, pg. 328) argue that this non-pecuniary gain “may particularly apply to inexperienced

---

<sup>18</sup> One potential problem with using non-pecuniary utility of winning as an explanation for over-dissipation in sequential contest is that the same utility of winning would predict over-dissipation in the simultaneous contest, which we do not observe.

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 far greater than predicted (4.7), indicating that winning never loses its charm completely.

Utility of winning may also provide insight into why over-dissipation rates are significantly higher in sequential contests compared to simultaneous contests. Sheremeta (2010c) shows 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 three times (when each battle winner is announced) while in the simultaneous contest such utility is received only once (when the overall winner is announced).<sup>19</sup>

### **5.3. SIM Treatment**

Next, we conduct a similar equilibrium comparison of expenditure pattern in the SIM treatment. Theory predicts that subjects allocate equal expenditure across the three battles. 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 SIM treatment employed a uniform expenditure strategy. Most subjects varied their expenditure *between* battles, with

---

<sup>19</sup> Another explanation for over-dissipation is simply that subjects commit errors, partly because of bounded rationality and partly because of the probabilistic nature of lottery CSFs. Bullock and Rutstrom (2007) show how quantal response equilibrium (McKelvey and Palfrey, 1995) which accounts for individual errors, can explain some of the over-dissipation observed in a lottery-based political competition. Studies on individual behavior also provide ample evidence that subjects misperceive probabilities in a systematic way - they assign over-weight to lower probability of winning and under-weight to higher probability of winning (Prelec, 1998, Wu and Gonzales, 1996; Tversky and Kahneman, 1992). This misperception and the resulting errors are explored by Parco et al. (2005) and Amaldoss and Rapoport (2009) as an explanation for observed over-dissipation in lottery contests.

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. Obviously, in equilibrium, the magnitude of dispersion should be zero. While 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 5 about here]

[Figure 6 about here]

Figure 6 displays the distribution of expenditure *within* each battle over all 20 periods of the SIM treatment. 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. More explicitly, expenditure in an individual battle is less than 5 or more than 20, on average, 24 percent and 12 percent of the time. This dichotomy in expenditure is similar to previous experimental findings in all-pay auction literature, wherein subjects choose either very low expenditure or moderately high expenditure more often than predicted (Gneezy and Smorodinsky, 2006). Second, despite the large variance, the overall distribution of expenditure is remarkably similar in the three battles. That is, there is no allocation bias such as that observed in Chowdhury et al. (2009), 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 6:** Subjects in the SIM treatment 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.

## 6. Conclusion

In this study we use laboratory experiment to compare sequential and simultaneous contests. Our experiment is based on the recent model of Klumpp and Polborn (2006). In this contest 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 substantial evidence of “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 contest generate substantially higher expenditure than the equivalent simultaneous contest. This is mainly because losers of the first battle do not decrease their expenditure in the second battle; and winners of the first battle substantially increase their expenditure in the second battle, instead of decreasing their expenditure as predicted. Lastly, we find that subjects learn to behave more in line with equilibrium predictions with repetition of the experiment.

Although the analogies between our laboratory experiment and naturally-occurring political contests are imperfect, we believe that our findings provide valuable insights. In particular, the finding that sequential contest induces higher expenditure (and thus more inefficiency) than simultaneous contest is both interesting and puzzling. Previous theoretical and empirical research on sequential and simultaneous voting provides evidence in favor of

sequential system (Morton and Williams, 1999, 2000; Klumpp and Polborn, 2006; Battaglini et al., 2007).<sup>20</sup> On the contrary, the findings of our experiment show that simultaneous contest should be preferred over sequential contest because it generates substantially lower expenditure and thus better efficiency. Therefore, our findings provide evidence that attempts, such as ‘Frontloading’ and ‘Super Tuesday’, to make presidential nomination process more like the simultaneous contest may indeed lead to more efficient political contest.

---

<sup>20</sup> However, the empirical evidence is not as clear. Battaglini et al., (2007), for example, find that a sequential voting rule is more efficient than simultaneous voting in some information environments, but sequential voting is also more inequitable. Therefore, the conclusion about the benefits of sequential over simultaneous voting is not as clear and it depends on how one weighs efficiency versus equity.

## References

- Avrahami, J., & Kareev, Y. (2009). Do the Weak Stand a Chance? Distribution of Resources in a Competitive Environment. *Cognitive Science*, 33, 940-950.
- Amegashie, J.A., Cadsby, C.B., & Song, Y. (2007). Competitive burnout: Theory and experimental evidence. *Games and Economic Behavior*, 59, 213-239.
- Battaglini, M., Morton, R.B., & Palfrey, T.R. (2007). Efficiency, equity and timing of voting mechanisms. *American Political Science Review*, 101, 409-424.
- Baye, M., Kovenock, D., & de-Vries, C.G. (1996). The all-pay auction with complete information. *Economic Theory*, 8, 291-305.
- Baik, K. and Lee, S. (2000). Two-stage rent-seeking contests with carryovers. *Public Choice*, 103, 285-296.
- Borel, E. (1921). La theorie du jeu les equations integrales a noyau symetrique. *Comptes Rendus del Academie*. 173, 1304-1308; English translation by Savage, L. (1953). The theory of play and integral equations with skew symmetric kernels. *Econometrica*, 21, 97-100.
- Borel, E., & Ville, J. (1938). Application de la theorie des probabilities aux jeux de hasard. Paris: Gauthier-Villars 1938; reprinted in Borel E., C'eron, A.: *Theorie mathematique du bridge a la portee de tous*. Paris: Editions Jacques Gabay 1991.
- Busch, A., and Mayer, W. (2004). The Front-Loading Problem. In: Mayer, W. (Eds.), *The making of the presidential candidate*. Rowman and Littlefield Publishers, Inc, USA, 83-132.
- Chowdhury, S.M., Kovenock, D., & Sheremeta, R.M. (2009). An Experimental Investigation of Colonel Blotto Games. Purdue University, Working Paper.
- Davis, D., & Reilly, R. (1998). Do too many cooks spoil the stew? An experimental Analysis of rent-seeking and the role of a strategic buyer. *Public Choice*, 95, 89 – 115.
- Friedman, L. (1958). Game-theory Models in the Allocation of Advertising Expenditure, *Operations Research*, 6, 699-709.
- Fudenberg, D., Gilbert, R., Stiglitz, J., & Tirole, J. (1983). Preemption, leapfrogging and competition in patent races, *European Economic Review*, 22, 3-31.
- Gneezy, U., & Smorodinsky, R. (2006) All-pay auctions – an experimental study. *Journal of Economic Behavior and Organization*, 61, 255 – 275.
- Gradstein, M., & Konrad, K.A. (1999). Orchestrating rent seeking contests. *Economic Journal*, 109, 536-45.
- Gross, O., & Wagner, R. (1950). A continuous Colonel Blotto game.' RM-408, RAND Corp., Santa Monica.
- Harris, C., & Vickers, J. (1985). Perfect equilibrium in a model of a race. *Review of Economic Studies*, 52, 193-209.
- Harris, C., & Vickers, J. (1987). Racing with uncertainty. *Review of Economic Studies*, 54, 1-21.
- Holt, C.A. & Laury, S.K. (2002). Risk Aversion and Incentive Effects. *American Economic Review*, 92, 1644-1655.
- Klumpp, T., & Polborn, M.K. (2006). Primaries and the New Hampshire effect. *Journal of Public Economics*, 90, 1073-1114.
- Konrad, K.A., & Kovenock, D. (2009). Multi-battle contests. *Games Economic Behavior*, 66, 256-274.
- Kvasov, D. (2007). Contests with limited resources. *Journal of Economic Theory*, 136, 738-748.
- Leininger, W. (1991). Patent competition, rent dissipation, and the persistence of monopoly: the role of research budgets. *Journal of Economic Theory*, 53, 146-172.

- Mayer, W. (2004). The Basic Dynamics of Contemporary Nomination Process. In: Mayer, W. (Eds.), *The making of the presidential candidate*. Rowman and Littlefield Publishers, Inc, USA, 83-132.
- Morton, R.B., & Williams, K.C. (1999). Information Asymmetries and Simultaneous versus Sequential Voting. *American Political Science Review*, 93, 51-67.
- Morton, R.B., & Williams, K.C. (2000). *Learning by Voting: Sequential Choices in Presidential Primaries and Other Elections*. Ann Arbor, MI: University of Michigan Press.
- Nitzan, S. (1994). Modeling rent-seeking contests. *European Journal of Political Economy*, 10, 41-60.
- Parco J., Rapoport A., & Amaldoss W. (2005). Two-stage Contests with Budget Constraints: An Experimental Study. *Journal of Mathematical Psychology*, 49, 320-338.
- Potters, J., de Vries, C.G., & Van Winder, F. (1998). An experimental examination of rational rent-seeking. *European Journal of Political Economy*, 14, 783 – 800.
- Roberson, B. (2006). The Colonel Blotto Game. *Economic Theory*, 29, 1-24.
- Sheremeta, R.M. (2010a). Contest Design: An Experimental Investigation. *Economic Inquiry*, forthcoming.
- Sheremeta, R.M. (2010b). Expenditures and Information Disclosure in Two-Stage Political Contests. *Journal of Conflict Resolution*, forthcoming.
- Sheremeta, R.M. (2010c). Experimental Comparison of Multi-Stage and One-Stage Contests. *Games and Economic Behavior*, 68, 731-747.
- Sheremeta, R.M., & Zhang, J. (2010). Can Groups Solve the Problem of Over-Bidding in Contests? *Social Choice and Welfare*, 35, 175-197.
- Snyder, J. (1989). Election goals and the allocation of campaign resources. *Econometrica*, 57, 630–660.
- Szentes, B., & Rosenthal, R.W. (2003). Beyond chopsticks: Symmetric equilibria in majority auction games. *Games and Economic Behavior*, 45, 278-295.
- Tullock, G. (1980). Efficient Rent Seeking. In James M. Buchanan, Robert D. Tollison, Gordon Tullock, (Eds.), *Toward a theory of the rent-seeking society*. College Station, TX: Texas A&M University Press, pp. 97-112.
- Zizzo, D.J. (2002). Racing with Uncertainty: A Patent Race Experiment. *International Journal of Industrial Organization*, 20, 877–902.

**Table 1: Equilibrium Predictions (SEQ and SIM Treatments)**

Treatments	SEQ	SIM
Final prize, $v$	100	100
Number of battles, $n$	3	3
Exponent, $r$	1	1
Equilibrium predictions		
Expected expenditure in B1	16.4	12.5
Expected expenditure in B2 by B1 winner	14.1	12.5
Expected expenditure in B2 by B1 loser	4.7	-
Expected expenditure in B3	25.0	12.5
Probability of contest ending in B2	0.75	-
Expected average expenditure	32.0	37.5
Expected payoff	18.0	12.5

**Table 2: Summary Statistics (SEQ and SIM Treatments)**

Treatments	SEQ		SIM	
Final prize, $v$	100		100	
Number of battles, $n$	3		3	
Exponent, $r$	1		1	
	Equilibrium	Actual	Equilibrium	Actual
Expenditure in B1	16.4	22.2 (0.6)	12.5	12.8 (0.4)
Expenditure in B2 by B1 winner	14.1	28.5 (0.9)	12.5	13.0 (0.3)
Expenditure in B2 by B1 loser	4.7	23.5 (1.0)	-	-
Expenditure in B3 by B2 winner	25.0	33.2 (1.5)	12.5	12.3 (0.4)
Expenditure in B3 by B2 loser	25.0	31.7 (1.5)	-	-
Probability of contest ending in B2	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: Expenditure across all periods (SEQ Treatment)

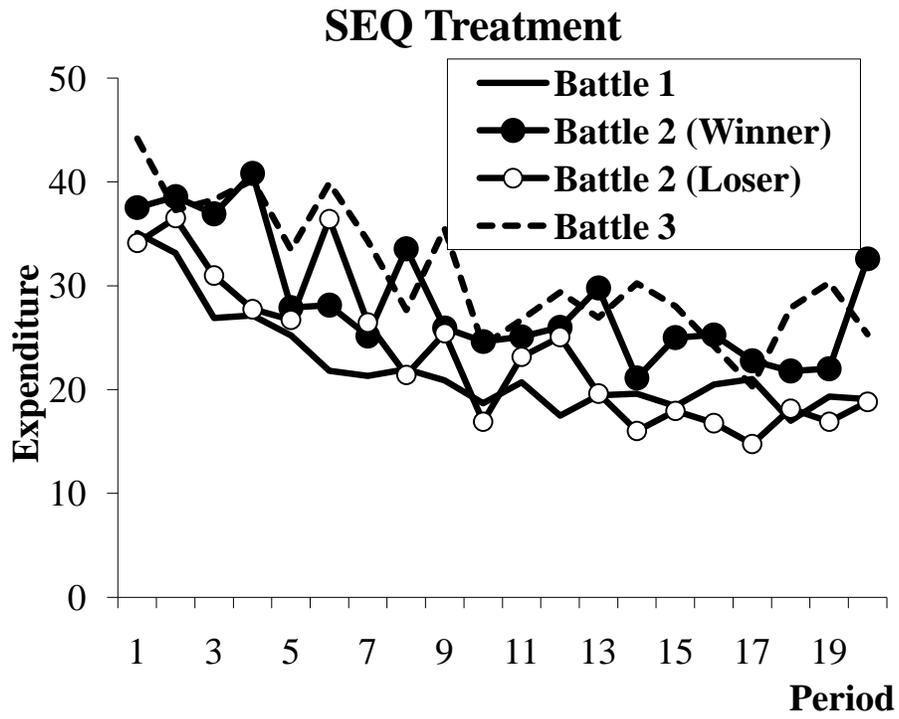


Figure 2: Expenditure across all periods (SIM Treatment)

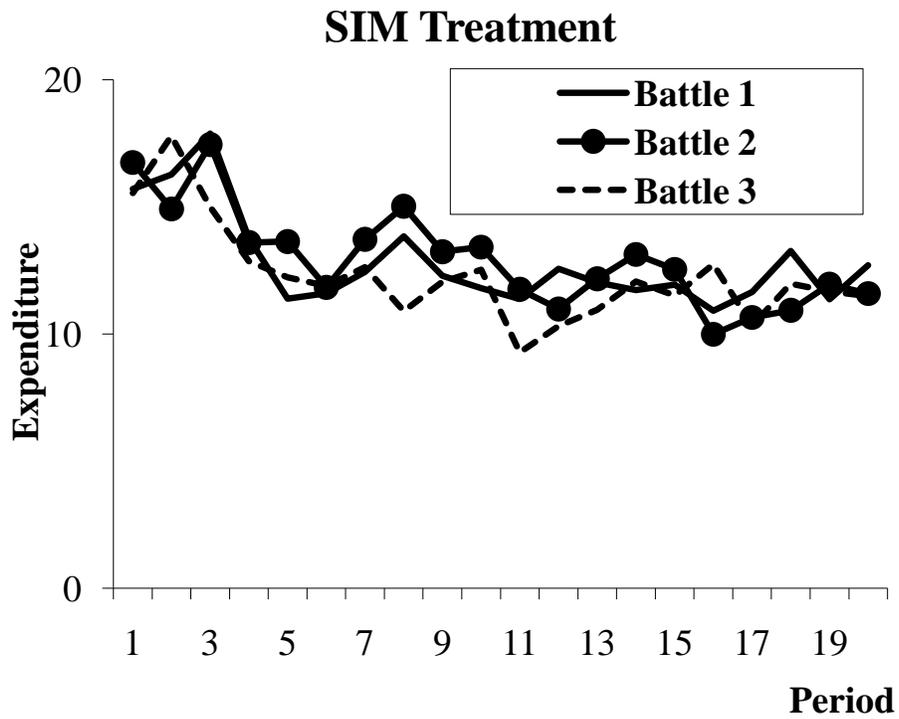


Figure 3: Distribution of Expenditure across Three Battles (SEQ Treatment)

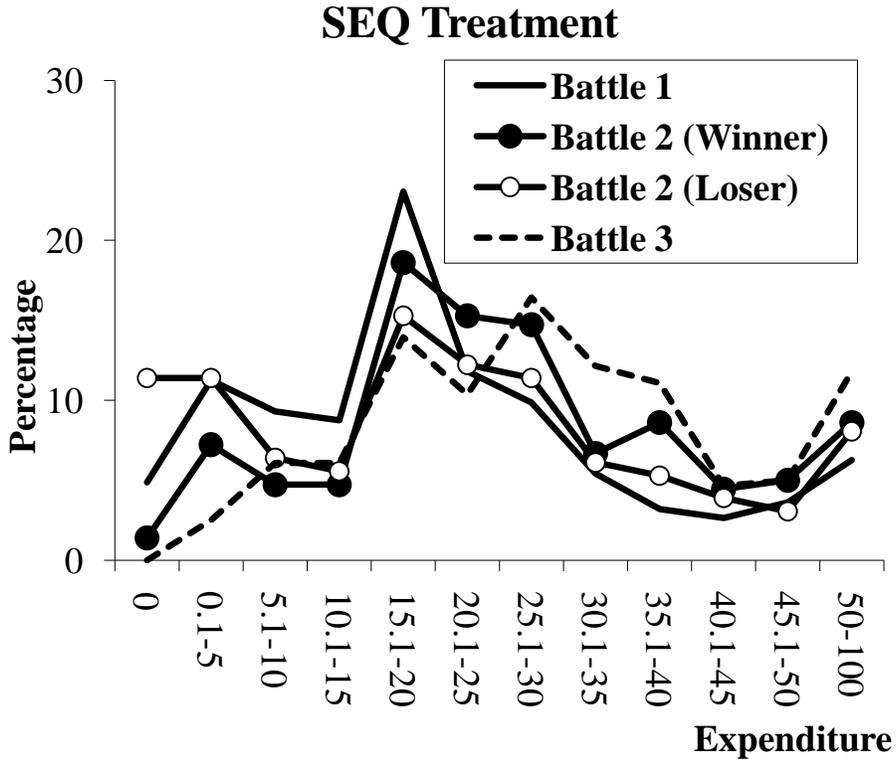


Figure 4: Probability of Ending and Winning the Contest (SEQ Treatment)

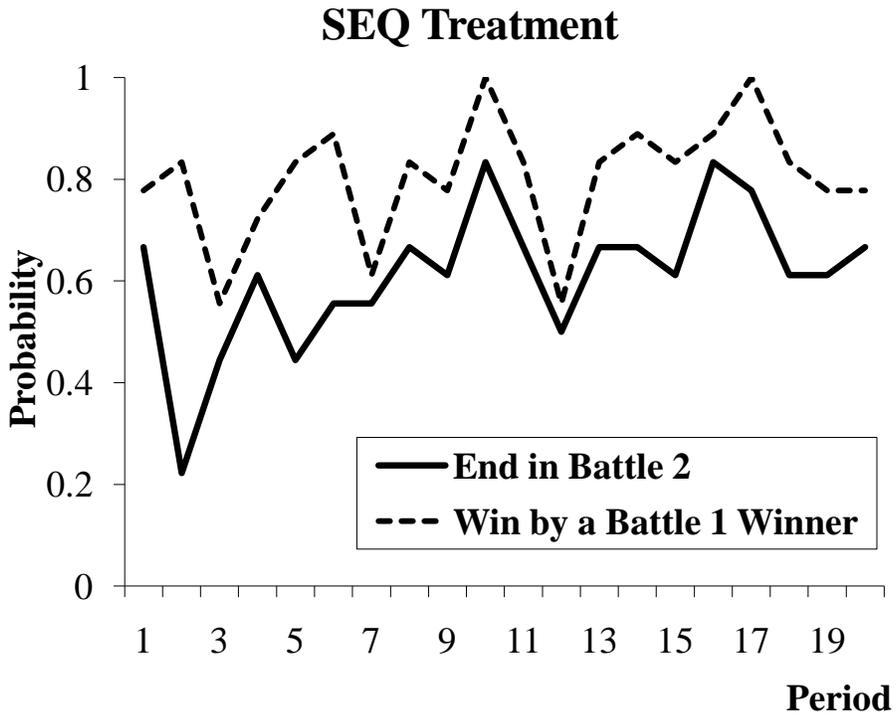


Figure 5: Average Difference in Expenditure across Three Battles (SIM Treatment)

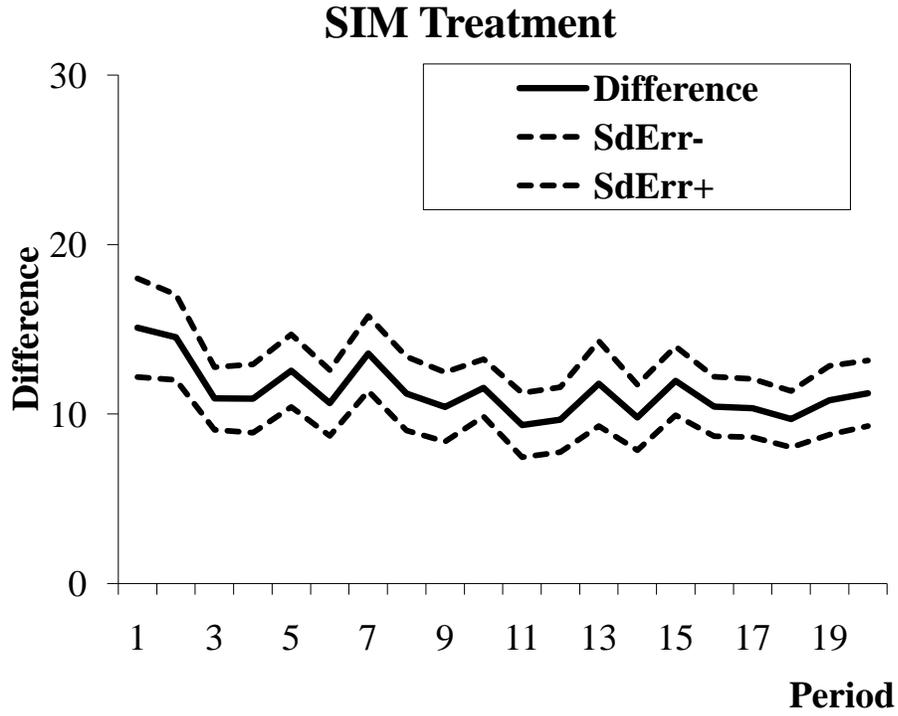


Figure 6: Distribution of Expenditure within Each Battle (SIM Treatment)

