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Do campaign spending limits diminish competition? An experiment

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Abstract

This paper experimentally investigates the effect of limits on campaign expenditure and outcome in an electoral contest where two candidates, an incumbent and a challenger, compete for office in terms of the amount of campaign expenditure. The candidates are asymmetric only in that the incumbent wins the contest in case of a tie. Theory predicts that in the presence of such asymmetry spending limits put the challenger at a disadvantage and tightening the limits leads to further entrenchment of the incumbent. The experimental results confirmed the theoretical predictions.

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1 Introduction

There has been a long debate about whether to impose ceilings on campaign spending during elections. Proponents of such a legislation claim that limits on campaign spending prevent an unrelenting escalation in expenditure and ensure that any qualified but financially disadvantaged citizens can still exercise their rights to seek and run for public office.[1] Meanwhile, opponents argue that campaign spending limits lead to further entrenchment of incumbents because they deprive challengers of their opportunities to overcome established incumbency advantages, such as deeper political experience, greater name recognition, and easier access to campaign finance.

Whether spending limits favor or work against challengers rests largely on various types of asymmetry lying between candidates (see, for example, Meirowitz, 2008). This paper focuses on asymmetry that kicks in when one of the candidates has some incumbency advantage. Two candidates, an incumbent and a challenger, compete for office in terms of the amount of campaign spending, and whoever spends more wins the election. They are asymmetric only in that the majority of voters favors the incumbent in case of a tie. A partial list of the possible sources of this type of asymmetry includes greater name recognition, more political experience, policy commitments, and voters' status-quo bias. Thus, the challenger has to outspend the incumbent to win the election whereas the incumbent only needs a tie.

The goal of this paper is to experimentally investigate the effect of spending limits on campaign expenditure and outcome in the presence of asymmetry in question. An electoral contest is modeled as a two-person all-pay auction with complete information, discrete strategy space, and common minimum and maximum spending levels.[2] Equilibrium analysis shows that there exists a unique equilibrium in mixed strategies. Under equilibrium play, the incumbent spends and wins more in expectation than the challenger, and a decrease in the common spending limit lowers not only the expected expenditure levels of both candidates but also the challenger's chance of winning. The model demonstrates that spending limits put the challenger at a disadvantage, and that tightening the limits gets her position even worse.

The approach undertaken to test the accuracy of theoretical predictions for actual behavior is experimental (Davis and Holt, 1993; Friedman and Sunder, 1994;

[1]For example, according to the 1992 Royal Commission on Electoral Reform and Party Financing report, spending limits "constitute a significant instrument for promoting fairness in the electoral process. They reduce the potential advantage of those with access to significant financial resources and thus help foster a reasonable balance in debate during elections. They also encourage access to the election process." See Chapter 4 of "A History of the Vote in Canada" in Resource Centre at the Elections Canada's website. URL: `http://elections.ca/home.aspx`. (Last accessed: April 16, 2012).

[2]Many economic, social, and political contests can be formulated under the framework of all-pay auction. A key feature of this framework is the irrevocability of resources spent to get ahead of rivals; each contestant forfeits her resources, regardless of whether or not she wins the contest. A partial list of examples with this feature entails lobbying and influence seeking activities (Hillman and Samet, 1987), competitions for monopoly positions (Ellingsen, 1991), electoral competitions (Snyder, 1989), and rationing by waiting in line (Holt and Sherman, 1982). For an illuminating review of the literature, see Konrad (2009).

Kagel and Roth, 1995).[3] By and large, the opportunities are severely limited for examining the behavioral relevance of theoretical predictions derived from highly stylized models with using field data which may have been collected for other purposes. The experimental approach allows for full control over the nature and degree of incumbency advantage, number of players, value of the prize, minimum and maximum expenditure levels, and richness of feedback information. For the purpose of the current paper, this approach is a more convincing source of data than any other empirical methods.

The paper proceeds as follows. Section 2 formally presents the model, derives the equilibrium, and discusses its implications. Section 3 presents a research hypothesis and the experimental design. Section 4 summarizes the results. Section 5 concludes.

2 Theory

2.1 Model

There are two risk-neutral candidates, an incumbent and a challenger, indexed by i and c, respectively. Hereafter, $j \in \{i, c\}$ is used to refer to a generic player and $-j$ the other player. They compete over a single, symmetrically valued prize r. Each candidate simultaneously chooses her level of irrevocable expenditure e_i from the common set $E = \{0, 1, \ldots, l\}$, where l denotes a common spending limit. In order to be considered for winning the prize, each candidate has to spend at least m. Thus, the expenditure level of m can be thought as a minimum requirement for participation in the contest.[4] Hereafter, the parameters l, m, and r are assumed to integer values such that $0 < m < l < r$.

When both candidates satisfy the minimum expenditure level, the incumbent wins the prize if $e_i \geq e_c$ whereas the challenger wins the prize if $e_c > e_i$. Formally, the incumbent's contest success function is:

$$f_i(e_i, e_c) = \begin{cases} 1 & \text{if } e_i \geq m \text{ and } e_i \geq e_c \\ 0 & \text{otherwise} \end{cases}$$

The challenger's contest success function is:

$$f_c(e_c, e_i) = \begin{cases} 1 & \text{if } e_c \geq m \text{ and } e_c > e_i \\ 0 & \text{otherwise} \end{cases}$$

[3]This work adds to a growing literature that uses laboratory experiments to examine theoretical implications of all-pay auction models (Davis and Reiley, 1998; Potters et al., 1998; Rapoport and Amaldoss, 2000; Amaldoss and Jain, 2002; Barut et al., 2002; Rapoport and Amaldoss, 2004; Gneezy and Smorodinsky, 2006; Noussair and Silver, 2006; Sacco and Schmutzler, 2008; Hörisch and Kirchkamp, 2010; Lugovskyy et al., 2010; Faravelli and Stanca, 2011). For a survey of experimental research on all-pay auctions, see Dechenaux et al. (2012).

[4]A minimum expenditure requirement has been discussed by Hillman and Samet (1987) in the context of all-pay auctions and by Schoonbeek and Kooreman (1997) in the context of Tullock's rent-seeking contests.

These contest success functions exhibit asymmetry in that ties are always broken in favor of the incumbent.[5] Candidate j's preferences are represented by the expected value of the payoff function given by

$$u_j(e_j, e_{-j}) = r \cdot f_j(e_j, e_{-j}) - e_j.$$

2.2 Equilibrium Analysis

The game possesses no pure-strategy equilibrium because for any pure-strategy profile one of the candidates has an incentive to unilaterally deviate from her part of the strategy profile. Suppose to the contrary that there exists a pure-strategy equilibrium (e_i^*, e_c^*). First, consider the case that $e_i^* = e_c^*$. Then, the challenger wants to unilaterally deviate to $e_c = \max\{m, e_i^*+1\}$ when $e_i^* = e_c^* < l$ and 0 when $e_i^* = e_c^* = l$. Next, consider the case that $e_i^* \neq e_c^*$. Then, when $e_c^* < e_i^* < l$, the challenger is better off deviating to $e_c = \max\{m, e_i^* + 1\}$. Otherwise, the incumbent is better off deviating to $e_i = \max\{m, e_c^*\}$.

In the mixed extension of the game, denote by $\sigma = (\sigma_i, \sigma_c)$ a profile of mixed strategies. σ_j is candidate j's mixed strategy, i.e., a probability distribution over E, and $\sigma_j(e)$ is the probability assigned by σ_j to a pure strategy $e \in E$. Then:

Proposition 1. *There exists a unique equilibrium in mixed strategies (MSE)* $\sigma^* = (\sigma_i^*, \sigma_c^*)$ *characterized by*

$$\sigma_i^*(e) = \begin{cases} 0 & \text{if } e \in \{0, \dots, m-1\} \\ \frac{m+1}{r} & \text{if } e = m \\ \frac{1}{r} & \text{if } e \in \{m+1, \dots, l-1\} \\ 1 - \frac{l}{r} & \text{if } e = l \end{cases} \tag{1}$$

and

$$\sigma_c^*(e) = \begin{cases} 1 - \left(\frac{l-m}{r}\right) & \text{if } e = 0 \\ 0 & \text{if } e \in \{1, \dots, m\} \\ \frac{1}{r} & \text{if } e \in \{m+1, \dots, l\} \end{cases} \tag{2}$$

with associated equilibrium payoffs $r - l$ *for the incumbent and* 0 *for the challenger.*[6]

Given the unique equilibrium it is straightforward to compute the expected expenditure of each candidate and her chances of winning the prize in equilibrium. For given l, m, and r, denote by $\mu_i^*(l, m, r)$ and $\theta_i^*(l, m, r)$ candidate j's expected expenditure and probability of winning in equilibrium, respectively. Each candidate's expected expenditure is computed as follows:

$$\mu_i^*(l, m, r) = m\left(\frac{m+1}{r}\right) + \frac{1}{r}\sum_{e=m+1}^{l-1} e + l\left(1 - \frac{l}{r}\right) = l - \left(\frac{l(l+1) - m(m+1)}{2r}\right)$$

[5] More general asymmetric contest success functions have already been studied in two-person all-pay auctions with complete information (Konrad, 2002; Meirowitz, 2008) and with incomplete information (Lien, 1990; Clark and Riis, 2000; Feess et al., 2008).

[6] The proof of this proposition is relegated to Appendix A in the supplemental material.

for the incumbent and

$$\mu_c^*(l,m,r) = \frac{1}{r}\sum_{e=m+1}^{l} e = \frac{l(l+1)-m(m+1)}{2r}$$

for the challenger. Note that $\mu_c^*(l,m,r) < \frac{l}{2}$ because

$$\mu_c^*(l,m,r) = \frac{l(l+1)-m(m+1)}{2r}\frac{l}{2}\cdot\frac{l+1}{r} - \frac{m(m+1)}{2r} \leq \frac{l}{2}\cdot 1 - \frac{m(m+1)}{2r} < \frac{l}{2}.$$

Since $\mu_i^*(l,m,r) = l - \left(\frac{l(l+1)-m(m+1)}{2r}\right)$, $\mu_i^*(l,m,r) > \mu_c^*(l,m,r)$. Therefore, the incumbent spends more than the challenger in expectation.

In equilibrium, the incumbent never stays out of the contest, i.e., $\sigma_i^*(0) = 0$. Thus,

$$\theta_i^*(l,m,r) = 1 - \theta_c^*(l,m,r) - \sigma_i^*(0)\cdot\sigma_c^*(0) = 1 - \theta_c^*(l,m,r).$$

Each candidate's probability of winning is computed as follows:

$$\theta_c^*(l,m,r) = \frac{1}{r}\left(\frac{m+2}{r} + \frac{m+3}{r} + \cdots + \frac{l}{r}\right) = \frac{l(l+1)-m(m+1)}{2r^2} \tag{3}$$

for the challenger and

$$\theta_i^*(l,m,r) = 1 - \left(\frac{l(l+1)-m(m+1)}{2r^2}\right)$$

for the incumbent. It follows from $\theta_c^*(l,m,r) = \frac{\mu_c^*(l,m,r)}{r} < \frac{l}{2r}$ and $r > l$ that $\theta_c^*(l,m,r) < \frac{1}{2}$. Thus, the incumbent wins more often than the challenger in expectation.

2.3 Comparative Statics Analysis

How does a change in the spending limit influence each player's expected expenditure and probability of winning the prize? To answer this question, consider two distinct spending limits l_1 and l_2 such that $0 < l_1 < l_2$. Then,

$$\begin{aligned}
&\mu_i^*(l_2,m,r) - \mu_i^*(l_1,m,r) \\
&= l_2 - \left(\frac{l_2(l_2+1)-m(m+1)}{2r}\right) - l_1 + \left(\frac{l_1(l_1+1)-m(m+1)}{2r}\right) \\
&= \frac{l_2(2r-l_2-1)}{2r} + \frac{m(m+1)}{2r} - \frac{l_1(2r-l_1-1)}{2r} - \frac{m(m+1)}{2r} \\
&= \frac{(l_2-l_1)(2r-l_2-1)-l_1(l_2-l_1)}{2r} \\
&= \frac{(l_2-l_1)[(r-l_2)+(r-l_1)-1]}{2r} \\
&\geq \frac{1\cdot 2}{2r} \\
&> 0.
\end{aligned}$$

Treatment		Incumbent		Challenger	
		Expenditure	Winning Rate	Expenditure	Winning Rate
LL	Observed	5.984	0.868	2.166	0.132
($l = 8$, $r = 15$)	Predicted	5.667	0.844	2.333	0.156
HL	Observed	6.711	0.712	4.043	0.286
($l = 13$, $r = 15$)	Predicted	7	0.6	6	0.4
LH	Observed	6.196	0.891	2.098	0.109
($l = 8$, $r = 20$)	Predicted	6.25	0.913	1.75	0.087
HH	Observed	8.316	0.812	3.467	0.188
($l = 13$, $r = 20$)	Predicted	8.5	0.775	4.5	0.225

Table 1: Observed and predicted mean expenditures and winning rates by treatment and role.

Thus, the incumbent's expected expenditure decreases as l decreases. Similarly, $\mu_c^*(l_2, m, r) - \mu_c^*(l_1, m, r) > 0$. Therefore, the challenger's expected expenditure also decreases as l decreases.

A decrease in the spending limit decreases the challenger's probability of winning because by equation (3) $\theta_c^*(l_2, m, r) - \theta_c^*(l_1, m, r) > 0$ for $0 < l_1 < l_2$. This implies that a decrease in the spending limit increases the incumbent's probability of winning and thereby deteriorates fairness regarding the chance of winning.

3 Experimental Design

3.1 Research Hypothesis and Treatments

The comparative statics analysis suggests the following qualitative hypothesis pertaining to aggregate behavior:

Hypothesis: A decrease in the spending limit

1. decreases the mean expenditures of incumbents and challengers, respectively, and
2. increases the winning rate of incumbents and decreases that of challengers.

To evaluate the hypothesis, this study employed a two-by-two factorial experimental design that set $m = 1$ and that varied the values of l and r. These two parameters took two levels each, $l \in \{8, 13\}$ and $r \in \{15, 20\}$, which resulted in a total of four treatments. They are referred to as *LL* ($l = 8$ and $r = 15$), *HL* ($l = 13$ and $r = 15$), *LH* ($l = 8$ and $r = 20$), and *HH* ($l = 13$ and $r = 20$). Table 1 outlines the theoretical predictions under equilibrium behavior.

3.2 Procedure

A total of two hundred fifty-six student subjects from various fields of study at the Friedrich Schiller University Jena were recruited via the ORSEE software (Greiner, 2004). They were divided into eight cohorts of thirty two subjects each, two cohorts participating in each of the four treatments *LL*, *HL*, *LH*, and *HH*. A session invited only one cohort with no subject participating in more than one session. All eight sessions were conducted in the experimental laboratory of the Max Planck Institute of Economics in Jena, Germany, with thirty-two PCs connected in a network. The experiment was programmed and conducted with the software z-Tree (Fischbacher, 2007).[7] A session lasted about 90 minutes, including reading instructions and paying subjects.

Upon arrival at the laboratory, each subject was asked to draw a marked chip from a box that determined her seating. Thirty-two subjects were seated in individual cubicles separated from one another by partitions. Any form of communication between subjects was strictly forbidden throughout the session, and questions were answered individually by the experimenter. After all subjects being seated, they were asked to read written instructions silently at their own pace. Once all of them indicated readiness for the experiment by clicking on an appropriate button on the computer screen, the experimenter read the instructions aloud so that all information became common knowledge. Then, subjects were given nine control questions designed to check their understanding of the instructions.[8]

Each session consists of sixty rounds (iterations) of the same two-person asymmetric all-pay auction. Prior to the first round, the computer randomly formed four groups of eight subjects each. Group composition remained the same so that no interaction between groups took place throughout the session. Then, for each group the computer randomly assigned four subjects to the role of the incumbent and the remaining four subjects to the role of the challenger. In order to avoid any social implications, these roles were labeled "X" and "Y ," respectively. Subjects retained one role throughout the session. Each subject was privately informed of her role and conversion rate.

The sequence of each round was identically structured in all treatments. At the beginning of a round, each subject was randomly paired with another subject in her group who was assigned the opposite role (i.e., a random matching protocol).[9] Once a round began, the computer exhibited a decision screen that displayed a list of $l + 1$ different numbers of tokens, namely, $0, 1, 2, \ldots, l - 1, l$. Each subject received an endowment of 14 points every round and was then asked to decide how many tokens to buy at the rate 1 point = 1 token. It was carefully explained in the instructions that points spent to buy tokens would be non-refunded. The instruc-

[7] A complete set of the data is available upon request.

[8] For the English instructions and control questions for treatment *LL*, see Appendix B in the supplemental material.

[9] In general, this protocol does not rule out the possibility of the same two subjects interacting with each other in two consecutive rounds. However, it was impossible for any subject to associate the identities of other subjects with their decisions throughout the session.

tions also presented the payoff matrix. Once every subject completed submission of her decision, a results screen informed each subject of the number of tokens she purchased, her opponent's decision, outcome and payoff (in points) for the current round, and current balance (i.e., total points she had accumulated so far).

At the end of a session, a summary screen displayed the total points subjects had accumulated and the corresponding earnings in euros. For subjects assigned to the role of X, the points were converted to euros at the rate of 97 points = €1 in treatments *LL* and *HH*, 74 points = €1 in treatment *HL*, and 120 points = €1 in treatment *LH*. For subjects assigned to the role of Y, the conversion rates were 65 points = €1 in all the treatments.

It is instructive to note two design features. First, the present experimental design allowed for repeated play. The reason was to let subjects to gain a considerable amount of experience. Past experimental studies that involved mixed-strategy equilibria have reported that the behavior of subjects converged to equilibrium play as they gained more experience (see Camerer, 2003, Chapter 3). For example, Potters et al. (1998) reported that 30 rounds of play were not enough for subjects to reach the unique equilibrium in mixed strategies that assign equal probability to each strategy. One method to induce experience is to allow subjects to play repeatedly under a fixed matching protocol. This method, however, facilitates tacit collusion between subjects. Another disadvantage of this method is that it does not retain the one-shot nature of the game. Thus, a random matching protocol was invoked that is less susceptible to tacit collusion and concurrently approximates the one-shot game.

Second, role-specific conversion rates were private information. Subjects in one role knew their own conversion rate but not the conversion rate for the other role. With a uniform conversion rate, the final earnings would significantly differ between the two roles under equilibrium play, particularly in treatment *LH*. The use of private role-specific conversion rates was intended to minimize interpersonal payoff comparisons which may arouse subjects to maximize relative gain. The conversion rates were calibrated so that each subject, according to the equilibrium benchmark, would on average earn €13.50 without a €2.50 show-up bonus, regardless of which treatment and which role she was assigned. The mean of individual payoffs for subjects assigned to the role of X was €12.92 in treatment *LL*, €14.13 in treatment *HL*, €12.63 in treatment *LH*, and €13.34 in treatment *HH*, respectively, without a €2.50 show-up bonus. The corresponding value for subjects assigned to the role of Y was €12.77 in treatment *LL*, €12.85 in treatment *HL*, €12.98 in treatment *LH*, and €12.85 in treatment *HH*, respectively.[10]

4 Results

Prior to presenting main results, two features of the present statistical analysis warrant brief discussion. First, the analysis confines attention to the behavior in the last 30 rounds. As mentioned earlier, previous experimental literature suggests that

[10]When the experiment was conducted (November 2010), the EUR/USD currency exchange rate ranged approximately from $1.35 to $1.38.

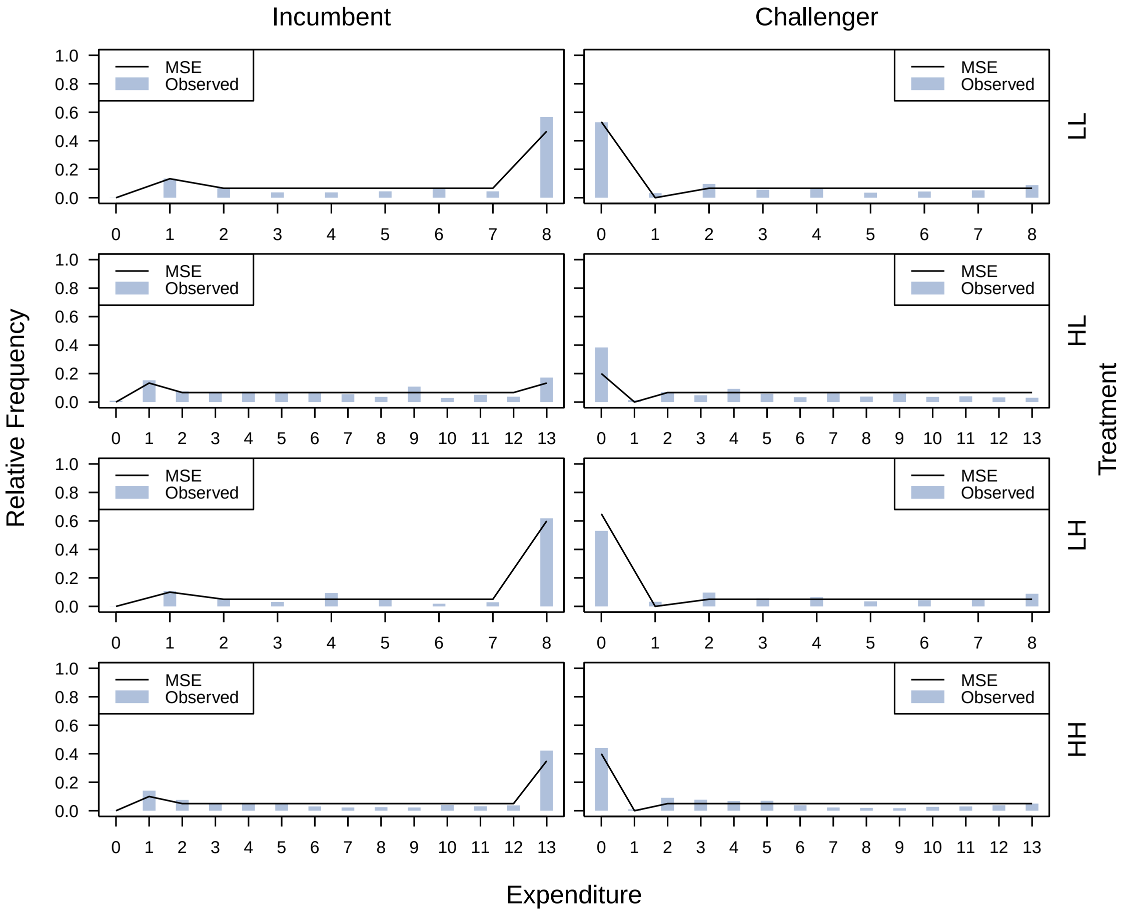

Figure 1: Mixed-strategy equilibrium and the observed relative frequency of expenditures by treatment and role.

it may take a considerable amount of experience for subjects to reach equilibrium play. Analyzing the last 30 rounds of play would give equilibrium theory its best shot in successfully predicting subjects' behavior. Second, the data comprise eight independent observations per treatment. Since subjects repeatedly interacted with each other within a group under rich information feedback, the assumption that all observations were independent does not hold. Therefore, each group constitutes one independent observation, and statistical tests are based on *group-level* measurement of the relevant variables.

Figure 1 displays side by side the unique mixed-strategy equilibrium and the observed relative frequency distribution of expenditures by treatment and role. The figure shows that the equilibrium solutions fared the spending behavior of both candidates remarkably well.

Table 1 summarizes the observed and predicted mean expenditures and winning rates by treatment and role. These observed values are computed across eight (independent) group mean expenditures. An eyeball inference suggests that the mean

Role	*LL* vs. *HL*	*LH* vs. *HH*
Incumbent	Reject ($p = 0.0474$)	Reject ($p = 0.0000$)
Challenger	Reject ($p < 0.0001$)	Reject ($p = 0.0012$)

Table 2: Pairwise comparisons of mean expenditures between two treatments with the one-sided permutation test at the 5% significance level.

expenditures of incumbents were almost in line with the predicted values. As predicted, the observed mean expenditures decreased as the spending limit decreased. This observation was formally tested by using the one-sided permutation test. The results are summarized in Table 2. The null hypothesis of no effect was soundly rejected in each of the four permutation tests (2 roles $\times$ 2 pairs of comparisons).

Now, turn attention to the winning rates. Theory predicts that the probability of no winner is 0. The actual number of games that did not find a winner was only four out of 3840 games ($\approx 0.1\%$) and thereby it suffices to focus only on the winning rates of incumbents.[11] Table 1 displays that as predicted, the observed winning rates of incumbents increased as the spending limit decreased. The one-sided permutation test soundly rejected the null hypothesis of no effect in each of the two permutation tests ($p < 0.05$ for both *LL* vs. *HL* and *LH* vs. *HH*). The research hypothesis was fully supported by the data.

5 Conclusion

Past theoretical and empirical studies on campaign spending limits indicated that various types of asymmetry lying between candidates would determine whether or not spending limits level the playing field. This paper confines attention to asymmetry that arises in case of a tie due to some kind of incumbency advantage and experimentally examines how limiting the amount of campaign spending affects candidates' spending behavior and outcome in the presence of such asymmetry. The data supported the qualitative hypothesis that as the common spending limit decreased, both candidates decreased their mean expenditures in a way that incumbents won more often than before. Thus, an decrease in the common spending limit led to further entrenchment of incumbents.

Note that the present model abstracts from realism in several aspects; a single symmetrically valued prize, an identical set of expenditure levels, an identical spending limit, and complete information. The practice of such simplification obviously undermines the external validity of findings. Yet, it served to promote subjects' understanding of the experimental environment and reduce noise in the data. Relaxing these assumptions is left for future research.

[11]For the last 30 rounds, there were 960 games per treatment.

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