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The Citizen Candidate Model: An Experimental Analysis

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Abstract. Citizen candidate models represent a significant advance in the analysis of public choice. They provide added realism to models of endogenous policy formation, relate the number of candidates to the benefits and costs associated with electoral competition and support equilibria with differentiated candidate positions, even with a multidimensional policy space. In this paper, experimental methods are utilized to test two of the model's equilibrium predictions. The results support the prediction that an increase in the net benefits to winning an election increases the number of citizens entering electoral contests. When the net benefits to winning an election are low, the results support the prediction that the only candidate has the median preference. Further, the results suggest that when net benefits are high, two members of the electorate with preferences close to and symmetric about the median enter the election, although convergence to this equilibrium takes time. Because entry is costly, having multiple candidates lowers group payoffs and may be seen as inefficient.

1. Introduction

Citizen candidate models represent a significant advance in the analysis of public choice. A limitation of previous research involves the exogenous specification of the number of candidates or parties. Osborne and Slivinski (1996) and Besley and Coate (1997) developed an electoral framework where the number of candidates is an endogenous feature of equilibrium outcomes. The approach highlights the importance of non-policy-related benefits and costs associated with electoral competition, and their influence on citizen decisions to enter electoral contests. In contrast to the prediction of candidate convergence developed in the seminal work of Downs (1957), the citizen candidate model has equilibria with differentiated candidates, and, as Besley and Coate (1997) shows, equilibria to the model exist even when the policy space is multidimensional.

Testing the citizen candidate model using existing data may be difficult. The results depend on the positioning of citizen ideal points, as well as other parameters that may be difficult to estimate. The application of experimental methods is particularly appropriate because the informational requirements, while difficult to satisfy in the naturally occurring world, can be precisely controlled in the lab. This paper contributes to the citizen candidate literature by developing an experimental methodology used to test two of the model's equilibrium predictions. Investigating the citizen candidate framework in an experimental setting also helps to identify what makes people run in elections and how this is related to efficiency.

The Osborne-Slivinski variant of the citizen candidate model can be summarized as follows:

1. Individuals have preferences over a unidimensional policy space, characterized by a most preferred point. Utility from the policy variable is a decreasing function of the distance between a citizen's ideal point and the actual policy implemented. Specifically, if a citizen's ideal point is x and the policy implemented is w, utility takes the form $-|x - w|$.
2. In the first stage of the policy determination process, all citizens simultaneously decide whether to become a candidate for office (E), or not (N). Entrants must pay a cost C to run in the election, and receive a benefit B if they win. If no citizen becomes a candidate, all citizens receive a "default" payoff of $-\infty$.
3. Once the set of entry decisions is made, an election is held, and a winner of the electoral contest is determined. Voting is assumed to be "sincere" in the sense that citizens vote for the candidate whose ideal point is closest to their own.
4. The winner of the election implements his or her own, commonly known, ideal point.

Implementation of the winner's favorite policy in the final stage is a dominant strategy. Attempts to commit to any other policy would not be credible. The default payoff of $-\infty$ is sufficient to guarantee entry by at least one citizen. In the presence of entry by at least one citizen, three payoffs are possible. If a citizen chooses N, and the winner has ideal point w, the payoff is

$$-|x - w|.$$

If a citizen becomes a candidate and loses the election, the payoff is

$$-C - |x - w|.$$

If a citizen becomes a candidate and wins, the payoff is

$$B - C.$$

The basic approach used by Osborne and Slivinski differs in some significant ways from the Besley–Coate variant of the model. Specifically, Besley and Coate present a more general framework, allowing for

1. A multidimensional issue space
2. A discrete number of citizens
3. Utility functions that depend on the policy variable *and* identity of the policymaker
4. Differences in citizen skills with respect to policy implementation
5. Voting behavior that is sophisticated
6. A default policy, x_0, associated with the possibility that no citizen becomes a candidate.

Although the conditions associated with having more than two candidates in equilibrium differ in the models, those associated with one and two-candidate equilibria are similar. Results from Osborne and Slivinski (1996) include

Proposition 1. (*One-candidate equilibria under plurality rule*). *There is a one-candidate equilibrium if and only if* $\mathrm{B} \leq 2\mathrm{C}$. *If* $\mathrm{C} \leq \mathrm{B} \leq 2\mathrm{C}$ *then the candidate's ideal position is the median while if* $\mathrm{B} < \mathrm{C}$, *then it may be any position within the distance* $(\mathrm{C} - \mathrm{B})/2$ *of the median.*

Proposition 2. (*Two-candidate equilibria under plurality rule*).
(2i) *A two-candidate equilibrium exists if and only if* $\mathrm{B} \geq 2(\mathrm{C} - \varepsilon^h)$, *where* ε^h *is the highest value of* ε *such that no third candidate can enter at the median* (μ) *and win.*
(2ii) *In any two-candidate equilibrium, candidates' ideal positions are* $\mu - \varepsilon$ *and* $\mu + \varepsilon$ *for* ε *between 0 and* ε^h.
(2iii) *An equilibrium in which the candidates' positions are* $\mu - \varepsilon$ *and* $\mu + \varepsilon$ *exists if and only if* $\varepsilon > 0, \quad \varepsilon \geq \mathrm{C} - \mathrm{B}/2, \mathrm{C} \geq |\mu - \mathrm{s}|$ *(where* s *is the position between the candidates such that a citizen entering at* s *does not affect the vote total for the other two candidates) and either* $\varepsilon < \varepsilon^h$ *or* $\varepsilon = \varepsilon^h \leq 3\mathrm{C} - \mathrm{B}$.

An important characteristic of Proposition 2 is the multiplicity of equilibria. This feature is common to both the Osborne–Slivinski and Besley–Coate models. In an experimental setting, this raises the issue of equilibrium selection, and how subjects' beliefs influence entry decisions. These topics are addressed in detail later.

Generating an experimental design that precisely replicates one of the models is complicated. In the Osborne–Slivinski framework, it is difficult to implement the continuum of ideal points, and enforce the default payoff of $-\infty$. In the Besley–Coate framework, the general structure of the utility function, differences in the skill associated with policy implementation and the multidimensional policy space are difficult to replicate in a simple way. As such, the experimental design developed below combines elements from both models. The basic approach is to modify the Osborne–Slivinski framework to allow for a discrete number of citizens and a finite default payoff. The utilized design focuses on the characteristics associated with the one- and two-candidate equilibria that are common to both models.

This research is connected to a long history of experimental studies of rational choice models of politics (good surveys are Palfrey (1991) and Kinder & Palfrey (1993)). For example, Down's prediction of candidate convergence has been studied in McKelvey and Ordeshook (1990, 1993), Williams (1991) and Plott (1991). Results from these studies of two-candidate elections are generally supportive of the theory, although convergence occurs over time and may be slower if there is incomplete information about candidate or voter preferences. Morton (1993) uses an experimental design in which two candidates have policy preferences and varies the information available to candidates concerning voter ideal points. She finds divergence in candidate positions when there is uncertainty about voter ideal points (which is consistent with theoretical models developed by Wittman, 1977, 1983, 1991), but the degree of divergence is not as great as theory predicts. In contrast to the design utilized in this paper, these studies rely on an exogenously determined number of candidates or parties. Also, subject payoffs for the design below are related to whether a subject enters and wins an election, as well as the policy implemented. As such, candidates have both an electoral and policy related motivation.

Because the citizen candidate approach focuses on citizen entry decisions, this research is also related to previous experimental work on binary choice participation games. For example, market entry games, where payoffs depend on the number of participants choosing to enter, have been studied by Kahneman (1988), Ochs (1990) and Sundali, Rapoport and Seale (1995). The results from these experiments suggest that subjects are able to coordinate entry decisions in a manner that is consistent with the expected profits from entry. In contrast, however, Fischbacher and Thoni (1999) find over-entry when a monetary prize is awarded to a randomly selected entrant, and Camerer and Lovallo (1999) find over-entry when payoffs depend on skill-based competition among entrants. The results from these two papers are consistent with those presented later.

The presence of multiple equilibria connects this research with the coordination games modeled in Van Huyck, Battalio and Rankin (1997) and Van Huyck, Battalio and Beil (1990), among others. These studies demonstrate the difficulties subjects often have in achieving coordination, and that subjects may learn to coordinate over time. The majority of experimental research on coordination games, as well as that on market entry games, use a symmetric payoff structure. The design utilized below leads to an interesting coordination game with asymmetric payoffs, and the results suggest coordination is costly and (consistent with previous research) evolves over the course of the experiment. The remainder of the paper is organized as follows. The next section discusses the experimental design, the following two sections present the results, and the last section concludes.

2. Experimental Design

Subjects for the 10 experimental sessions were paid volunteers recruited from Introductory Economics and Political Science classes at American University. Prior to volunteering, subjects were told that they would participate in a decision-making exercise and be paid in cash an amount that depended on the decisions of the experimental participants. In addition, subjects were paid \$10 for keeping their experiment appointment. All earnings were paid, in private, to subjects at the end of their experimental session. Five of the sessions were conducted using a "high cost" parameterization for the design, and five sessions were conducted under a "low cost" parameterization. Each session had five subjects, and lasted for about 45 min. Average subject earnings for the high and low cost parameterizations (including the \$10 "show-up" fee) were \$22.80 and \$23.94, respectively.

At the beginning of the experimental session, subjects were given instructions (reproduced in the Appendix) that can be summarized as follows. At the beginning of each of 10 rounds of the experiment, participants were assigned to one of the ideal points depicted as follows:

|-------------|--------------|-------------------|-------------------|------------------------|---|

15 30 50 70 95

Ideal points were assigned so that in each round one participant occupied each ideal point. For each round the median ideal point was 50. Subjects, in addition to being informed of their own ideal point, were told that in each round one participant would be located at each of the ideal points. Over the course of the experiment, assignment of ideal points was manipulated so that each subject played each ideal point twice, once in the first five rounds and once in the second five rounds (although this was not revealed to the subjects). Subjects were endowed with "cash earnings" of \$18, and informed that their final cash earnings would be influenced by two factors.

First, earnings were influenced by whether a participant nominated her point for consideration by the group, and if so whether her point was chosen as the "winning point." In each round, each participant chose (simultaneously) whether to nominate her ideal point for consideration by the group. This was done by writing YES (if they chose to nominate their point) or NO (otherwise) on a piece of paper. Once each participant made a decision, the set of nominated points was announced to the group. If a participant chose to nominate her point, a fee ($3 or $1.50, depending on the parameterization used for the session) was deducted from her cash earnings. If a participant nominated the winning point, she was awarded a benefit of $3.05. The winning point was determined by the following process. The number of votes for each of the nominated points was tallied, under the imposed condition that each subject voted "sincerely" in the sense that his or her vote was for the nominated point closest to his or her own ideal point. If more than one nominated point was closest, the vote was determined by a random draw. The sole decision the subjects made in each round was whether to nominate their ideal point. Subjects did not actually cast a vote; the experimenter calculated the number of votes for each nominated point. Implementing sincere voting makes the design consistent with the Osborne–Slivinski model, and focuses the analysis on nominating decisions. Once the votes were tallied, and the winning point determined (ties were broken by a random draw), the location of the winning point was announced to the group. If no subject chose to nominate her ideal point, the winning point was determined by a random draw. In this case, no subject was charged the entry fee or received the benefit associated with nominating the winning point. Although this implementation is at odds with the Osborne–Slivinski model (which utilizes a default payoff of $-\infty$), it is consistent with the Besley–Coate framework, and avoids the difficulties associated with charging subjects a large amount when no subject becomes a candidate.

Second, payoffs were influenced by the position of the winning point. In particular, each participant's earnings were lowered by $|x - w|$ cents, where x represents the participant's ideal point, and w is the winning point. For example, a subject assigned ideal point 15 would lose 15 cents if 30 was the winning point, 35 cents if 50 was the winning point, 55 cents if 70 was the winning point, and 80 cents if 95 was the winning point. At the end of each round, subjects recorded their assigned ideal point, nominating decision, the position of the winning point and adjustments to their cash earnings on a sheet provided by the experimenter.

The values for B and C were chosen to replicate the conditions associated with one and two-candidate equilibria to the citizen candidate model. For the high cost parameterization, the value for B ($3.05) was slightly larger than the value for C ($3.00), which leads to a one-candidate equilibrium. For the second (low cost) parameterization, I chose to cut the value of C in half (to $1.50), while maintaining all other elements of the high cost parameterization. This simple change creates a much richer strategic environment that includes a two-candidate equilibrium. For both parameterizations, a pure strategy Nash equilibrium exists with the subject assigned the median ideal point (50) choosing YES, and all others choosing NO. This equilibrium is "payoff dominant" in the sense that it maximizes group earnings. The implementation of 50

Table 1. Summary of experimental designs

Parameters	"High" cost	"Low" cost
B	\$3.05	\$3.05
C	\$3.00	\$1.50
Equilibrium predictions	Single candidate with ideal point 50	Single candidate with ideal point 50 Two candidates with ideal points 30 and 70 Mixed strategy equilibrium with entry by 30, 50 and 70
Experimental sessions	A, B, C, D, E	F, G, H, I, J

minimizes the losses associated with the policy related payoffs and results in a participant (at 50) capturing the surplus associated with winning (\$.05 or \$1.55 depending on the parameterization). For the low cost parameterization, there is a second pure strategy equilibrium having two candidates at 30 and 70, as well as an equilibrium in mixed strategies with positive entry probabilities for subjects assigned 30, 50 and 70. The existence of multiple equilibria when $B > 2C$ creates an interesting coordination game, described in detail later. Table 1 provides a summary of the utilized parameter values, and lists the equilibrium predictions and sessions conducted under each design.

3. Results for High Cost Parameterization

Figure 1 displays the number of entrants by ideal point for the sessions with $C = \$3.00$.

The one-candidate pure strategy Nash equilibrium prediction (only the subject with ideal point 50 enters in each round) is consistent with 86% of the observed decisions. Of the 250 decisions made by subjects, only 35 were inconsistent with this prediction (entry with ideal point 15, 30, 70 and

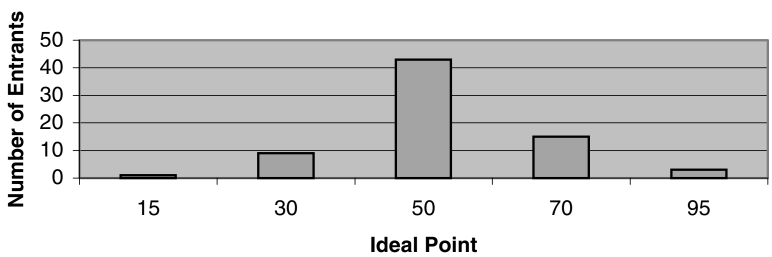

Figure 1. Cumulative entry decisions: Design 1.

*Table 2. Binomial test for random play and EPW (*p*-values in parentheses)*

Ideal point	Observed entry proportion	Hypothesized value: Random play	Hypothesized value: EPW
15	0.02	0.5 (.000)	0.188 (.001)
30	0.18	0.5 (.000)	0.437 (.000)
50	0.86	0.5 (.000)	0.75 (.039)
70	0.3	0.5 (.007)	0.437 (.067)
95	0.06	0.5 (.000)	0.125 (.227)

95 or failure to enter with ideal point 50). However, there was significant entry by subjects with ideal points 30 and 70. Previous experimental research on binary choice participation games where a monetary prize is awarded to an entrant either randomly (see Fischbacher and Thoni, 1999) or through “skill-based” competition among entrants (see Camerer and Lovallo, 1999) reports excess entry relative to the Nash prediction. While entry by subjects with ideal points 30 and 70 is not consistent with the Nash prediction, excessive entry may be a feature of experimental play of binary choice entry games. This suggests that subjects may be using strategies that are not mutual best responses. Two alternative hypotheses about subject play are tested. First, it is clear from the data that subject decisions were not consistent with random play. Table 2 presents the results of a Binomial test of the null hypothesis that subjects entered with probability $^1/_2$. For each ideal point, this hypothesis can be rejected at the .05 level of significance. A second alternative is that a subject’s propensity to enter is a function of the number of ways in which the entry decisions of other subjects allow that subject’s ideal point to win. Table 2 also contains the results of a Binomial test of the null hypothesis that subject’s entered with their probability of winning (EPW) *under the assumption that other players in the middle (30, 50 and 70) would enter with probability $^1/_2$, and that other subjects with ideal points on the outside (15 and 95), would not enter*. Specifically, random entry by participants assigned to 30, 50 and 70, coupled with non-entry by the participant at 95, results in a win for the subject at 15 (should he or she enter) with probability .1875. This reflects the probability that each of the middle players stays out of the race (which occurs with probability 1/8) and the probability that 50 and 70 enter, while 30 stays out (also occurring with probability 1/8). This second case results in a tie between 15 and 70, which implies 15 wins with probability $^1/_2$. Under this alternative behavioral assumption, the entry probabilities for subjects with ideal point 30, 50, 70 and 95 are .4375, .75, .4375 and .125, respectively. The null hypothesis of EPW can be rejected for ideal points 15, 30 and 50 at the

5% level of significance. However, EPW cannot be rejected at the 5% level for ideal points 70 (p-value, .067), and 95 (p-value, .227).[1]

Theory predicts that in each round, a subject's entry decision will depend on his or her expectations regarding the entry decisions of the other subjects. As there were five separate experimental sessions, it may be the case that expectations and entry decisions varied by session.[2] Table 3 presents the results of two logistic regressions used to assess the extent of "session" effects. The dependent variable was a dummy taking the value 1 if a subject entered, and 0 otherwise. The independent variables included dummies for ideal point (one each for 30, 50, 70 and 95), experimental session (one each for experiments A, B, C and D, the first through fourth experiments for this design) and whether the subject's decision was a "Best Reply." This variable takes the value 1 if the subject's entry decision was a best response to the pattern of entry decisions that prevailed in the *preceding* period, and 0 otherwise. Including this variable lowers the sample size from 250 to 225, because one observation (entry decision in period 1) is lost for each of the five participants in each of the five sessions. The baseline case for each regression model was a subject with ideal point 15 who participated in the fifth experimental session.

For Model 1, the coefficients on the session variables are not statistically significant. However, while the coefficients on 30 and 70 are positive and significant (which is consistent with Figure 1), the coefficients on best reply and ideal point 50 are not significant, and the coefficient on best reply has the

Table 3. Logistic regression output

	Model 1		Model 2	
	B	Sig.	*B*	Sig.
Thirty	2.21069	.0459		
Fifty	13.24222	.5121		
Seventy	3.151735	.0037		
Ninety-five	1.17495	.3224		
A	−1.13759	.1409	−1.63565	.00885
B	−0.25805	.7122	−0.95016	.10285
C	0.832418	.1824	0.79765	.10681
D	−1.00287	.1652	−0.72673	.20352
Best reply	−7.04438	.7269	2.804316	2.10E-10
Constant	−3.68646	.0008	−1.36413	.00032
% Correct[a]	87.6		78.2	
Nagelkerke R^2	0.631		0.333	
N	225		225	

[a]Percent correct based on a cut value of .5.

wrong sign. These are classic signs of multicollinearity. Essentially, in most rounds of most sessions, the best response to the pattern of decisions in the previous round had the subject with ideal point 50 enter, and subjects with other ideal points stay out. As such, the best reply variable is similar to the dummy variable for ideal point 50, and induces collinearity. Intuitively, ideal point is important to the extent that it determines a subject's best reply. Model 2 drops the ideal point dummy variables (this reduces both the Nagelkerke R^2 and the percent of correct predictions). In this case, the coefficient on best reply is significant and in the expected direction. Also, the coefficient on session A is significant.[3] The significance of the best reply variable suggests that the assumptions underlying the Nash prediction may be more appropriate than the other behavioral assumptions described earlier (random play or EPW).

Further, the experimental results can be used to assess the efficiency of this institution in terms of the share of the potential surplus captured by participants. The maximum earnings for subjects in each round occurred when only 50 entered. The change in cash earnings in this case would be −\$1.15 per round. Thus, over 10 rounds, the minimum amount subjects could lose was \$11.50. In connection with their endowments of \$18, this implies maximum group earnings for each experiment were \$78.50. As there were five sessions, the maximum level for subject earnings (Π_{max}) under this design was \$392.50. Actual earnings (Π_{act}) were \$319.90 (meaning that relative to the best case scenario, they lost an additional \$72.60). Thus, subjects captured 81.5% of the possible surplus. This measure is somewhat misleading, however, because it does not control for what subjects could be expected to earn relative to other behavioral specifications. For example, random entry by all participants would result in expected per round losses of \$6.00. This implies that aggregate expected surplus under random play (Π_{rand}) would be \$150. The following index can be used to assess the efficiency of subject decisions relative to random play:

$$E = (\Pi_{\text{act}} - \Pi_{\text{rand}})/(\Pi_{\text{max}} - \Pi_{\text{rand}})$$

Note that $E = 1$ if $\Pi_{\text{act}} = \Pi_{\text{max}}$, 0 if $\Pi_{\text{act}} = \Pi_{\text{rand}}$ and is negative if $\Pi_{\text{act}} < \Pi_{\text{rand}}$. Using this measure, for the high cost parameterization, $E = .70$. Under the alternative assumption that players enter according to the probability they can win, expected surplus (Π_{epw}) is 237.121. Substituting Π_{epw} for Π_{rand} in the formula above results in $E = .533$. As such, subjects in the experiment were able to capture a greater share of the surplus than would be expected under either of the other behavioral specifications. However, the decrease in E associated with changing the baseline case shows that the clearest determinant of surplus lost is related to entry costs (which are lower, in expectation, under EPW than random play). To highlight this point, note that the largest "policy"-related loss for the group occurs when 95 is implemented. Total policy-related losses in this case are 2.15, while the loss associated with one excess entrant is 3.00.

4. Results for Low Cost Parameterization

For the low cost parameterization, the value of C was changed to \$1.50. This simple change complicates the decision environment, because it introduces a two-candidate equilibrium and at least one equilibrium in mixed strategies (in addition to the payoff dominant equilibrium in which 50 is the only entrant). A second equilibrium in pure strategies has only subjects with ideal points 30 and 70 become candidates. In this case the outcome of the election depends on the vote of 50, which is determined by a random draw. In expectation, the payoff to candidates associated with the B and C parameters is $1/2 * 3.05 - 1.50 = .025$. For the candidates, entry also increases the policy-related payoff because it makes possible the implementation of the candidate's ideal point. Entry by any other subject would result in a loss, and may lower the policy-related portion of payoffs for the entrant. In a sense, the existence of multiple equilibria (a common feature of citizen candidate models) creates a coordination game between players with ideal points 30, 50 and 70. For 50, entry is a best reply if one of the subjects at 30 or 70 fails to enter. For either 30 or 70, entry is a best reply if 50 stays out, or if 50 enters and the subject on the opposite side of 50 also enters. While 30 and 70 prefer the two-candidate outcome, 50 prefers the single-candidate equilibrium. The asymmetry of subject positions and payoffs is a novel feature associated with this coordination game.

Further, the existence of two pure strategy equilibria gives rise to an equilibrium in mixed strategies. The following entry probabilities constitute a mixed strategy Nash equilibrium to the game: $p_{15} = p_{95} = 0$, $p_{30} = p_{70} = .73439$, and $p_{50} = .6315$, where p_x is the probability that a subject with ideal point x enters. Dynamic pressures around the mixed strategy probabilities push subject play towards one of the pure strategy equilibria. For example, holding p_{50} constant, an increase in p_{70} (relative to the mixed strategy probability) increases the expected payoff to entry for the subject with ideal point 30. This is because an increase in p_{70} makes the two-candidate equilibrium payoff more likely and lowers the payoff to staying out for the subject at 30 (she is more likely to get $-.40$ (the payoff when 70 wins) than $-.28$ (the payoff when 50 wins)). Also, a decrease in p_{50} (holding p_{70} constant) increases the expected payoff to entry for a subject with ideal point 30, because it increases the probability that he or she wins the election outright (which occurs when neither 50 nor 70 enter). Similar dynamic pressures apply to subjects with ideal point 70. When 30 enters with probability above the mixed strategy or when 50 enters with probability less than the mixed strategy equilibrium, 70 should enter more often. For subjects with ideal point 50, an increase in the probability of

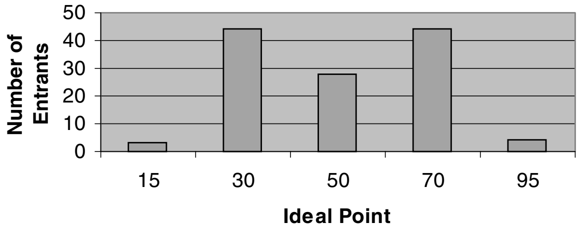

Figure 2. Cumulative entry decisions: Design 2

entry for either 30 or 70, relative to the mixed strategy probabilities, lowers the expected payoffs to entry, because it makes it more likely that 50 is "bracketed" by candidates, and loses. To summarize, if 30 or 70 start out above their equilibrium probabilities, 50 should enter less. This makes 30 and 70 even more likely to enter, and pushes the play towards the two-candidate equilibrium. Alternatively, if 30 and 70 start below their equilibrium probabilities, 50 should enter more often, which reinforces the direction of movement towards the one-candidate equilibrium. In other words, both pure strategy equilibria have unambiguous basins of attraction away from the mixed strategy equilibrium. As such, if subjects begin the experimental session with different beliefs about how other subjects will play, dynamic pressures may lead them to one of the pure strategy equilibria over the course of the experiment.

Figure 2 displays the number of entrants by ideal point the low cost parameterization.

Similar to the results from the high cost parameterization, subjects with ideal point 15 or 95 rarely entered. For the low cost parameterization, however, subjects with ideal point 30 and 70 entered much more frequently, and subjects with ideal point 50 entered less often. Entry by subjects with each of the middle ideal points suggests experimental play was not consistent with one of the pure strategy equilibria (in which either 50 or both 30 and 70 do not enter). Table 4 presents the results of binomial tests of the hypotheses that subject play was random, consistent with EPW, and that subjects entered according to the mixed strategy probabilities.

*Table 4. Binomial tests for random play, EPW, and mixed strategy (*p*-values in parentheses)*

Ideal point	Observed entry proportion	Hypothesized value: Random play	Hypothesized value: EPW	Hypothesized value: Mixed strategy
15	0.06	0.5 (.000)	0.188 (.020)	
30	0.88	0.5 (.000)	0.437 (.000)	0.734 (.007)
50	0.56	0.5 (.322)	0.75 (.005)	0.632 (.362)
70	0.88	0.5 (.000)	0.437 (.000)	0.734 (.007)
95	0.08	0.5 (.000)	0.125 (.469)	

The hypothesis of random play can be rejected for each ideal point other than 50 (subjects assigned 50 entered 56% of the time), and the EPW hypothesis can be rejected for ideal points other than 95. The mixed strategy hypothesis, while consistent with the entry decisions of subjects assigned ideal point 50, can be rejected for subjects with ideal point 30 and 70.[4] In contrast with the results from the high cost parameterization (which support the one-candidate equilibrium prediction), aggregate subject decisions for the low cost parameterization are not consistent with the equilibrium predictions described earlier. This may not be surprising, given the coordination problems associated with the decision environment; subjects probably had different expectations about each other's play at the beginning of the experimental sessions.

Fortunately, examining changes in subject play over the course of the experiment provides more insight into subject behavior. Specifically, it suggests that subject beliefs about play started in the basin of attraction for the two-candidate equilibrium, and converged to the two-candidate equilibrium over time. Table 5 presents the entry decisions grouped over the first and last five rounds of the experiment for each ideal point, as well as two statistical tests used to see whether subject behavior was different in the last five rounds than in the first five.

The results of both the t-test and the Wilcoxon test suggest that play by subjects with ideal points 30, 50 and 70 changed over the course of the experiment. Subjects with ideal points 30 and 70 entered more often during the last five rounds, while subjects with ideal point 50 entered less frequently. The intuition behind this result is straightforward. Over the first five rounds, subjects with ideal point 30 or 70 entered about 76% of the time (which is higher than their mixed strategy probabilities). As such, 50 had about a 43% chance of winning should he or she enter. Since the expected payoff to entering (about $-.3$) was less than the expected payoff associated with staying out of the election ($-.2$), it is not surprising that 50 entered less frequently over the remainder of the experiment. That is the direction his or her beliefs/expected payoffs were pushing him or her. Similar pressures (resulting in an increase in entry) prevailed for subjects with ideal points 30 and 70. Because subjects assigned ideal points 30 or 70 entered frequently during the first five rounds,

Table 5. Subject entry decisions 1st five rounds vs. last five rounds low C

	15	30	50	70	95
1st five rounds	2	19	18	20	1
Last five rounds	1	25	10	24	3
Paired sample t-test (p-values)	.327	.011	.008	.042	.327
Wilcoxon signed ranks test (p-values)	.317	.014	.011	.046	.317

Table 6. Logistic regression output for low cost parameterization

	Model 1	
	B	Sig.
Thirty	0.808809	1.99E-06
Fifty	0.701036	5.33E-05
Seventy	0.839951	2.36E-06
Ninety-five	0.824117	0.425727
F	0.657156	0.727674
G	0.666764	0.965438
H	0.659823	0.797999
I	0.655421	0.797247
Best reply	0.528879	0.000395
Constant	0.775033	8.62E-05
% Correct[a]	87.1	
Nagelkerke R^2	0.668	
N	225	

[a]Percent correct based on a cut value of .5.

they were able to coordinate their entry decisions over the final rounds (for which entry occurred 49 times in 50 opportunities). This pattern of play is consistent with the basins of attraction argument described earlier, and does not appear to have varied with experimental session. A logistic regression using entry as the dependent variable and maintaining the independent variables discussed under the high cost parameterization was utilized to assess the extent of session effects. The results are presented in Table 6.

The ideal point coefficients, as well as the best reply coefficient, have the expected signs and significance results. The session coefficients are not statistically significant, suggesting experimental session did not play a significant role in subject decision making.[5]

In terms of the efficiency index, the maximum earnings for subjects in each round occurred when only 50 entered. The change in cash earnings in this case is \$.35 per round. Thus over 10 rounds, subjects could win a maximum of \$3.50. In connection with the endowments of \$18, this implies maximum group earnings for each session were \$93.50. As there were five sessions, the maximum level for subject earnings under this design was \$467.50. Subjects actually earned \$348.60 (meaning that relative to the best case scenario, they lost \$118.90). This implies subjects captured 74.5% of the available surplus. Using the efficiency index described in the high cost parameterization, and under the baseline of random play, the value for E was .102. Under the assumption that subjects enter according to their probability of winning, the value for E is $-.282$. Thus, while subjects fared marginally better than they would have under random play, they did worse than would be expected under entry according to the probability of winning. This reinforces the notion that the main determinant of subject earnings was the value of entry costs. Lowering the cost of entry resulted in more subjects becoming candidates, which more than offset the lower cost associated with each entrant. Although earnings for the group would have been higher if they coordinated on the one-candidate equilibrium, the payoff-maximizing outcome did not serve as a focal point for individual decision making. Instead, frequent entry by subjects assigned ideal points 30 and 70 in early rounds of the experiment highlighted the strategic considerations. In each round, individual payoffs were higher for subjects assigned ideal points 30 and 70 when both entered, bracketing the median candidate and having a chance to win the election. In this case, successfully resolving the coordination problem in the latter rounds of the experiment actually served to reduce group payoffs.

5. Conclusion

The citizen candidate approach provides added realism to models of endogenous policy formation, and represents a significant advance over the traditional median voter model. The prediction of candidate divergence under high net benefits is supported by casual observation of many electoral contests. Unfortunately, a more rigorous examination of the model using existing data is complicated by its precise informational requirements, but it remains an important model to test. This paper utilizes experimental methods to test two equilibrium predictions of the citizen candidate model. To my knowledge, this is the first set of such experiments. While the experimental design is a simple modification of the Osborne–Slivinski framework, it captures the relevant features of one- and two-candidate equilibria that are common to both Osborne and Slivinski (1996) and Besley and Coate (1997). The following conclusions are supported by the research.

Equilibrium predictions from the citizen candidate model suggest that an increase in the net benefit associated with winning an electoral contest should increase the number of candidates. This prediction is supported by the data. For the high cost parameterization, entry was observed 28.4% of the time, while the percentage of entrants for the low cost parameterization was 49.2%. The point predictions associated with the high cost parameterization are generally supported. The pure strategy Nash equilibrium prediction, which has only the median citizen become a candidate, is consisted with 86% of observed subject decisions. While subjects with other ideal points, particularly those at 30 and 70, entered more often than the theoretical prediction, this "over-entry" is consistent with other experimental studies of binary choice participation games.

One aspect of the citizen candidate approach, studied under the low cost parameterization, involves the multiplicity of equilibria when the net benefits to winning are large. The parameterization utilized for these sessions generated two equilibria in pure strategies (one of which had divergent candidate positions) and at least one mixed strategy equilibrium. Importantly, the pure strategy equilibria had clear basins of attraction away from the mixed strategy equilibrium. Subject play under this parameterization suggests convergence to the two-candidate equilibrium over the course of the experiment. Convergence to equilibrium over time is a feature of many experimental papers, including several on coordination games. In this case, subjects with ideal points 30 and 70 entered above their mixed strategy probabilities early in the experimental session, which may have focused expectations on the two-candidate equilibrium. Over the final five rounds of the experiments, this resulted in greater entry by subjects at 30 and 70, and less by subjects with the median ideal point. This pattern of entry decisions does not appear to have varied by session, and can be seen to support the two-candidate equilibrium prediction.

One implication of the experimental results involves the efficiency associated with this institution in terms of the surplus captured by subjects. For the high cost parameterization, subjects did better than would be expected under random play or EPW. However, for the low cost parameterization, subjects fared only marginally better than they would have been expected under random play, and actually did worse than would be expected under EPW. Although policy implications from the experiments may be limited because they rely on the use of a very controlled setting, the results suggest that having a large number of candidates may be inefficient from an economic perspective. Intuitively, when campaigning is expensive, increased choice amongst candidates comes at a cost. In my view, future research should be devoted to the relaxation of the sincere voting assumption (which implies future designs should support more than two candidates in equilibrium, because sincere voting with two candidates is sophisticated). It would also be interesting to vary the relative weights attached to the policy and non-policy-related benefits associated with electoral competition (perhaps by using different parameters for the policy-related payoffs). However, results from the experiment reported earlier can be viewed as generally supportive of the one- and two-candidate equilibrium predictions from the citizen candidate approach.

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Notes

1. Over the course of each session, each subject played each ideal point twice, and as such contributed two entry decisions to the calculation of each entry proportion. This may call into question the assumption of independent observations required for a Binomial test. Looking at the results from the last five rounds, over which each subject contributes a single entry decision per ideal point, generates similar results.
2. Because subjects engaged in multiple rounds of the experiment, it is also important to consider whether learning played a role in subject decisions. Using a paired samples t-test, or a non-parametric Wilcoxon test, the null hypothesis of no difference between subject play in the first and last five rounds of the experiment cannot be rejected at the 5% level of significance for any of the ideal points. This suggests that for the high cost parameterization, subject learning did not significantly affect experimental play. The role of learning is addressed in more detail under the results for the low cost parameterization.
3. Including variables for period effects does not substantively affect the regression results. If subject behavior converges to the equilibrium prediction over time, it is important to interact period with ideal point, because the effect should differ by ideal point. Intuitively, this effect is picked up by the best response variable. Including period effects and interaction terms, however, lowers the degrees of freedom associated with the regression results. Other, more complex, specifications of the best reply variable are possible. For example, subjects may consider the pattern of entry decisions that prevailed not only in the preceding period, but in other earlier periods as well. Modeling the best reply variable as the percentage of previous periods in which entry is a best reply (a modified version of "fictitious" play) does not substantively affect the regression results. Finally, each subject made 10 entry decisions, which raises the issue of independence. The inclusion of dummy variables for each of the 25 subjects (to control for subject specific effects) does not qualitatively affect any of the model estimates. The signs of the estimated coefficients and significance results remain as reported in Table 4, and no dummy variable on subject is statistically significant.
4. Looking at decisions over last five rounds results in similar conclusions. The hypothesis of random play can be rejected for ideal points 15, 30, 70 and 95, but not for 50. Results for the test of EPW are the same as those in the table. Interestingly, however, the hypothesis that subject play is consistent with the mixed strategy probabilities can be rejected for each of the ideal points over the last five rounds. This reinforces the notion that subject play was moving towards the two-candidate equilibrium over the course of the experiment.
5. As was the case for the high cost parameterization, including period effects does not change the qualitative results. Adding a period variable, interacted with each ideal point, generates coefficient estimates that are marginally significant (p-values around .1), and have the expected signs (the interaction variable coefficients are positive for ideal points 30 and 70, and negative for ideal point 50). Including a more complex variant of the best response variable or dummy variables for each subject does not substantively affect the results. No specification generated session coefficients that were statistically significant.

Appendix: Instructions (High Cost Parameterization)

You are about to participate in an economics experiment that involves making decisions. If you read the following instructions carefully and make good decisions, you may earn a considerable amount of money. This money will be paid to you privately at the end of the experiment.

In this experiment, one of five competing alternatives will be chosen by majority rule. The alternatives are represented by points on the blackboard.

At the beginning of *each* of 10 rounds, you will be assigned one of these alternatives as your "ideal point." You will choose whether to nominate this point for consideration of the group, according to a process described later, at the beginning of each of the 10 rounds. Once all participants have chosen whether to nominate their ideal points, a point will be selected according to a process described later. Your ideal point is the alternative that, if chosen by the group, maximizes your earnings.
Your earnings will be influenced by two factors:

1. The distance between the winning alternative and your ideal point.
2. Whether you choose to nominate your ideal point, and whether it is selected as the winner.

You begin the experiment with "cash earnings" of $18 (this does *not* include the $10 "show up" fee). At the end of each round, your cash earnings are updated as follows:

1. The distance between your ideal point and the point selected by the group is SUBTRACTED from your earnings.
2. If you nominate your ideal point, $3.00 is SUBTRACTED from your earnings.
3. If you nominate the winning point, $3.05 is ADDED to your earnings.
4. If no participant nominates his/her ideal point, the winning point will be determined by a random draw among the set of ideal points. In this case, $3.05 *will not* be added to the participant whose ideal point is the winner.

Upon completion of the tenth round, you will be paid, in cash, an amount equal to your cash earnings.

The distribution of ideal points for the five participants in each round will be as follows: This means that, for each round, one participant's ideal point is

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|-------------|----------------------|-------------------|-------------------|-----------------|---------|
              15                     30                  50                  70                95
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15, one participant's is 30, one participant's is 50, one participant's is 70 and one participant's is 95.

In each round, the winning point will be determined by the following process:

1. Each participant simultaneously chooses whether to nominate his/her ideal point, by writing YES (if you want to nominate your ideal point) or NO (otherwise) on a piece of paper. Any participant nominating his/her

ideal point will be charged \$3.00. The participant who nominates the winning point earns \$3.05. If no participant nominates his/her ideal point, the winning point will be determined by a random draw among the set of ideal points.

2. Once the set of nominated points is determined, the winning point will be determined by majority rule. Participants, however, will not actually choose the point for which they vote. Each participant's vote will be for the alternative that is closest to his/her ideal point. If more than one alternative is closest to a participant's ideal point, the vote is cast randomly between the closest points. The winning alternative is the one that receives the most votes. If more than one alternative ties for the highest number of votes, the winner is determined randomly among the points that tie for the highest vote total.

This process will be repeated for a total of 10 rounds.

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