Economics Bulletin

Volume 31, Issue 3

The Power of an Outside Option that Generates a Focal Point: An Experimental Investigation

Quazi Shahriar
San Diego State University

Abstract

Existing experimental studies (Cooper, DeJong, Forsythe and Ross, 1993; Shahriar, 2009) have shown that an outside option, when offered to one of the two players who later participate in a battle-of-the-sexes game, makes the equilibrium that favors the same player focal. This focal point arises even when the option gives that player a payoff lower than both the subgame equilibria payoffs. The source of the focal point, therefore, is not obvious from the existing studies. It is also not clear whether an outside option offered in this fashion is always likely to generate the focal point or the results in the existing studies are due to the particular outside-option payoffs considered in these studies. The current paper hypothesizes and reports experimental evidence to show that the results in the previous studies are not due to the particular outside-option payoffs considered, and the type of outside option considered in these studies can always generate the focal point as it enables the player rejecting the option signal her intended strategy choice in the subgame.

Citation: Quazi Shahriar, (2011) "The Power of an Outside Option that Generates a Focal Point: An Experimental Investigation", *Economics Bulletin*, Vol. 31 no.3 pp. 2151-2158.
Submitted: Oct 31 2009. **Published:** July 21, 2011.

1. Introduction

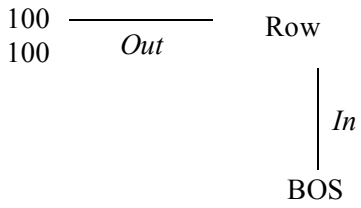
Previous experimental studies (Cooper, DeJong, Forsythe and Ross 1993 and Shahriar 2009) have shown that an outside option, when offered to one of the two players who later participate in a battle-of-the-sexes (BOS) game, makes the equilibrium that favors the same player focal. The focal point emerges even when the option gives that player a payoff lower than the payoffs in both the equilibria in the BOS subgame. As a result, the source of the focal point is not apparent to us from the above two studies. We are not sure whether an outside option offered in this manner is always likely to give rise to the focal point or the focal point observed in the above two studies somehow resulted from the particular outside-option payoffs the studies considered. We hypothesize that the focal point observed in the previous studies is not due to the particular outside-option payoffs considered, and the type of outside option considered in these studies can always generate the focal point; the rejection of the outside option enables the player who is offered the option to signal her intended subgame play via a forward induction type argument which leads to the focal point. The objective of the current paper is to test this hypothesis.

Consider the BOS game in Figure 1. It is a symmetric 2x2 coordination game in which two players (Row and Column) simultaneously and independently choose between two strategies – 1 and 2. The game has two pure-strategy Nash equilibria; (1,2) and (2,1).[1] In the mixed-strategy Nash equilibrium, both players choose strategy 1 with ¼ probability and obtain an expected payoff of 150 points. Now, consider the game BOS-100 in Figure 2. This is a two-stage game in which an outside option is offered to Row in the first stage. If she decides to take the outside option by choosing *Out*, then the game ends; both players receive 100 points. If, instead of choosing *Out*, Row chooses *In*, then the game proceeds to the second stage where the players play the BOS subgame. BOS-100 has two pure-strategy subgame perfect Nash equilibria (SPNE) – $\big((In,1),\ 2\big)$ and $\big((In,2),\ 1\big)$.

Figure 1: BOS.

		Column 1	Column 2
Row	1	0, 0	200, 600
	2	600, 200	0, 0

Figure 2: BOS-100.



Cooper *et al.* (1993) and Shahriar (2009) report results from experiments on BOS and BOS-100. Table I below shows the outcome frequencies in the last halves of the sessions in these two studies.[2] The coordination problem in BOS is evident in both the studies. Conditional on a subgame equilibrium being played, we cannot reject the hypothesis that the two equilibria are equally likely in BOS ($\chi^2 = 0.53$, $p = 0.47$ and $\chi^2 = 0.45$, $p = 0.50$ in Cooper *et al.* 1993 and Shahriar 2009, respectively).[3] In BOS-100, Row seldom takes the outside option. Conditional on the subgame being played, the relative frequency of Row's favorable outcome (2,1) is

[1] The elements in a strategy profile correspond to strategy choices by Row and Column, respectively.
[2] There were 165 observations in total in the last halves of the sessions on each game in both the studies.
[3] All the tests reported in this paper are two-tail Chi-square tests.

significantly higher in BOS-100 than in BOS ($\chi^2 = 64.29$, $p < 0.01$ and $\chi^2 = 8.35$, $p < 0.01$ in Cooper *et al.* 1993 and Shahriar 2009, respectively). This shows that the (2,1) outcome is a focal point in BOS-100.

Table I: Outcome Frequencies in BOS and BOS-100 in Cooper el. al (1993) and Shahriar (2009).

	Games	**Outcomes**			
		Outside Option	**(2, 1)**	**(1, 2)**	**Disequilibrium: (1,1) and (2,2)**
Cooper *et al.* (1993)	BOS	-	31 (19%)	37 (22%)	97 (59%)
	BOS-100	3	102 (63%)	5 (3%)	55 (34%)
Shahriar (2009)	BOS	-	37 (22%)	43 (26%)	85 (48%)
	BOS-100	9	59 (38%)	26 (17%)	71 (45%)

Note: Figures in the parentheses show the frequency distribution in each treatment among four outcomes – (1, 2), (2, 1), (1, 1) and (2, 2).

In BOS-100, it apparently appears to be the case that Row is unable to signal her preference between the two subgame equilibria by rejecting the outside option as it gives her a lower payoff than that in each of these equilibria, making the source of the focal point inconspicuous.[4] We, however, argue that Row is still able to signal her intended choice between the two subgame strategies by rejecting the outside option. When Row rejects the outside option, she gives up the sure payoff of 100 in exchange for a risky prospect. In the BOS subgame, Row faces a choice between two risky options – strategies 1 and 2; the risky option 2, however, is more attractive than the risky option 1. So, Row would reject the outside option only if she had planned to choose strategy 2 in the subgame, and her rejection of the outside option signals this intension to Column. Having received this signal, the best response of Column is to choose strategy 1. We hypothesize that Row's signaling by rejecting the outside option thus generates the (2,1) focal point in BOS-100.[5]

The goal of the current paper is to test for the above signaling hypothesis. To do this, the paper considers a game which is exactly similar to BOS-100 except that the outside option in this new game gives Column a payoff of 200. Since the new game is characterized by an asymmetrically offered outside option as in BOS-100 in which Row receives a sure payoff by

[4] See Kohlberg and Mertens (1986) and Van Damme (1989) for discussions on forward induction.

[5] Since Column's payoffs in both the subgame equilibria are higher than her outside-option payoff, one may suspect that Column's positive reciprocity towards Row leads to the focal point in BOS-100. We, however, think that this is implausible. Even though Column prefers both the subgame equilibria to the outside option, she will realize that Row's rejection of the outside option can be motivated solely by Row's own payoff maximization. In that case, Column would not reciprocate. This doubt is also reflected in predictions from models of reciprocity, such as Rabin (1993) and Dufwenberg and Kirchsteiger (2004), according to which not only (2,1) but also (1,2) is a reciprocity equilibrium in BOS-100.

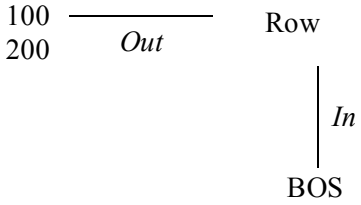
accepting the option but faces a risky prospect by rejecting it, the same signaling argument applies and we expect (2,1) to be focal in the new game as well.[6] The results from the experiment on the new game support our expectations. Consistent with our hypothesis, we find that the outside option still makes the (2,1) outcome focal. The paper thus contributes to the literature on focal points by confirming the focal-point generating power of an asymmetrically offered outside option in the BOS game.[7]

The rest of this paper is organized as follows. Section 2 describes the experimental design, Section 3 discusses the results from the experiment and Section 4 makes some concluding remarks.

2. Experimental Design

In order to test for our hypothesis mentioned in the previous section, we consider the M-BOS-100 game in Figure 3. In the first stage, Row decides between an outside option and playing the BOS subgame. If she takes the outside option by choosing *Out*, then the game ends; Row receives 100 points and Column receives 200 points. This game has the same two pure-strategy SPNE's as BOS-100 – $\big((In,1),\ 2\big)$ and $\big((In,2),\ 1\big)$.[8]

Figure 3: M-BOS-100.



Notice that the M-BOS-100 game shares the same asymmetric feature as BOS-100 – the outside option is offered only to Row in both games. So, if an asymmetrically offered outside option is able to generate a focal point due to the forward induction type signaling argument mentioned in the previous section, then the same focal point should arise in both games. So, we expect (2,1) to be focal in M-BOS-100.[9]

The experimental design used in this paper is adopted from Cooper *et al.* (1993) and Shahriar (2009). Three sessions are run for each of the three games (BOS, BOS-100 and M-BOS-100); each session recruited 12 subjects. Upon arrival at the lab, a subject was seated in front of a computer terminal and was given a copy of the instructions.[10] The instructions were

[6] Since the outside option gives Column a payoff equal to that in (2,1), the new game removes reciprocal motives, if any, for players to coordinate on (2,1) in the BOS subgame. Although we don't expect any reciprocal motive at play in BOS-100, the new game helps us verify whether it actually is or is not the case.

[7] For a survey on coordination games and focal points, see Camerer (2003).

[8] According to Rabin (1993) and Dufwenberg and Kirchsteiger (2004), these two equilibria are also reciprocity equilibrium as in BOS-100.

[9] Notice that Column receives the same payoff in the outside option as in the (2,1) outcome. M-BOS-100 thus leaves out the possibility of reciprocal motives, if any, for players to coordinate on (2,1).

[10] A copy of the instructions for M-BOS-100 is available at www-rohan.sdsu.edu/~qshahria/Instruction-M-BOS-100.pdf.

also read aloud. Each session consisted of 20 rounds of one of the three games and lasted for about an hour.

In each round of a session, one subject was matched with another subject. Thus, in each round there were 6 pairs. Within each of the 6 pairs in a round, one subject was assigned the role of Row and the other Column.[11] In a random manner, each subject played exactly twice with another subject (once as Row and once as Column). So, in each session, each subject participated in 20 rounds; playing as Row in 10 rounds and Column in the other 10 rounds.

At the end of each round in a session, a subject earned points according to the choices made. This point determined the probability of winning in a binary lottery with two outcomes – \$0 and \$3. To implement the lottery, at the end of each round, the computer generated random numbers between 0 and 1000 for each subject separately. If this number was less than or equal to the points a subject received in that round, then the subject earned \$3; she earned \$0 otherwise.[12] Through out the session each subject accumulated her earnings which were paid in cash at the end of the session. The average earnings were about \$20.

The experiment was run at the San Diego State University. 108 undergraduate students were recruited for the experiment. All the sessions were computerized using zTree (Fischbacher, 2007).

3. Results

The results from the experiment are summarized in Tables II and III. Table II reports separately the outcome frequencies in the two halves (the first and the last 10 rounds) of the sessions; the latter in italics. In a similar manner, Table III lists the frequencies of strategies played.

Similar to the previous studies, the current study finds prevalence of coordination problem in BOS (Table II). Conditional on a subgame equilibrium being played, we cannot reject the hypothesis that the two equilibria are equally likely in BOS ($\chi^2_{first} = 2.59$, $p = 0.11$ and $\chi^2_{last} = 0.10$, $p = 0.75$).[13,14] Conditional on the subgame being played, the relative frequency of (2,1) is higher in BOS-100 than in BOS and, similar to the findings in Shahriar (2009), this difference is significant in the second halves of the sessions ($\chi^2_{first} = 1.62$, $p = 0.20$ and $\chi^2_{last} = 13.96$, $p < 0.01$). This shows that the (2,1) outcome is a focal point in BOS-100.

In M-BOS-100, conditional on a subgame equilibrium being played, we can reject the hypothesis that the two subgame equilibria are equally likely ($\chi^2_{first} = 18.00$, $p < 0.01$ and $\chi^2_{last} = 40.00$, $p < 0.01$). A comparison of the results of M-BOS-100 and BOS will now reveal whether or not there is a focal point in M-BOS-100. We find that, conditional on the subgame being played, the relative frequency of the subgame equilibrium (2,1) is significantly higher in M-BOS-100 than in BOS ($\chi^2_{first} = 11.36$, $p < 0.01$ and $\chi^2_{last} = 18.39$, $p < 0.01$). These test results

[11] At the beginning of each round, subjects were privately informed of their assigned roles via the computer terminals in front of them.

[12] The points a subject received in a round divided by 1000 gave the probability of winning \$3. So, higher points gave higher probability of winning.

[13] Within the parenthesis, we report the test results for the first and the last halves of the sessions, respectively. In the remainder of the paper, whenever we report two results in this manner the results are to be interpreted this way.

[14] We would like to point out a potential drawback in our data analysis. Although the tests assume that observations are independent, the assumption may not be completely appropriate due to repeated interactions among the subjects.

show that, similar to what we saw in BOS-100, the outside option offered to Row makes the (2,1) outcome a focal point also in M-BOS-100.[15]

Table II: Frequencies of Outcomes in First and Last Halves of the Sessions (Last Halves in Italics).

Treatment	Outside Option	Outcomes in the Subgame			
		(2, 1)	(1, 2)	(1, 1)	(2, 2)
BOS	-	36 (20.0%)	51 (28.3%)	27 (15.0%)	66 (36.7%)
	-	*45 (25.0%)*	*48 (26.7%)*	*27 (15.0%)*	*60 (33.3%)*
BOS-100	21 (11.7%)	42 (26.4%)	39 (24.5%)	33 (20.8%)	45 (28.3%)
	27 (15.0%)	*69 (45.1%)*	*21 (13.7%)*	*9 (5.9%)*	*54 (35.3%)*
M-BOS-100	36 (20.0%)	54 (37.5%)	18 (12.5%)	27 (18.8%)	45 (31.3%)
	24 (13.3%)	*75 (48.1%)*	*15 (9.6%)*	*12 (7.7%)*	*54 (34.6%)*

Note: Percentages are given in parentheses; for outcomes in the subgame, the percentages show the distribution of the outcomes only within the subgame. The percentages for the outside option show the proportion of 180 observations in which the outside option was taken.

The focal point effect of the outside option can also be seen in terms of the frequencies with which players choose their strategies (Table III). Conditional on the subgame being played, Row chooses strategy 2 with higher proportions in both BOS-100 ($\chi^2_{first} = 0.07$, $p = 0.79$ and $\chi^2_{last} = 17.63$, $p < 0.01$) and M-BOS-100 ($\chi^2_{first} = 4.46$, $p = 0.03$ and $\chi^2_{last} = 22.32$, $p < 0.01$) compared to BOS. This is consistent with Row choosing according to her intension revealed by her rejection of the outside option. On the other hand, Column chooses strategy 1 with higher proportions in both BOS-100 ($\chi^2_{first} = 4.69$, $p = 0.03$ and $\chi^2_{last} = 3.60$, $p = 0.06$) and M-BOS-100 ($\chi^2_{first} = 13.78$, $p < 0.01$ and $\chi^2_{last} = 7.72$, $p < 0.01$) compared to BOS, which is consistent with Column best-responding to Row's intension and choices.

The results discussed above confirm the focal point effect of the outside option in M-BOS-100. The results provide support for our hypothesis that rejection of the outside option signals Row's intended play in the subgame via a forward induction type argument. Both players' choices in the subgame are consistent with the hypothesis – Row follows her intension by choosing strategy 2 and Column best-responds by choosing strategy 1 more frequently in BOS-100 and M-BOS-100 than in BOS.

[15] Since the same focal point arises in both BOS-100 and M-BOS-100, the results confirm that, consistent with what we expected, players' reciprocal motives do not play any role in generating the focal point in BOS-100.

Table III: Frequencies of Strategies Played in First and Last Halves of the Sessions (Last Halves in Italics).

Treatment	Outside Option	Row's Subgame Play		Column's Subgame Play	
		Str. 1	Str. 2	Str. 1	Str. 2
BOS	-	78 (43.3%)	102 (56.7%)	63 (35.0%)	117 (65.0%)
	-	*75 (41.7%)*	*105 (58.3%)*	*72 (40.0%)*	*108 (60.0%)*
BOS-100	21 (11.7%)	72 (45.3%)	87 (54.7%)	75 (47.2%)	84 (52.8%)
	27 (15.0%)	*30 (19.6%)*	*123 (80.4%)*	*78 (51.0%)*	*75 (49.0%)*
M-BOS-100	36 (20.0%)	45 (31.3%)	99 (68.7%)	81 (56.2%)	63 (43.8%)
	24 (13.3%)	*27 (17.3%)*	*129 (82.7%)*	*87 (55.8%)*	*69 (44.2%)*

4. Conclusion

The goal of this paper was to check for the actual focal-point generating power of an outside option which is asymmetrically offered before players participate in a BOS game. The experimental results in Cooper *et al.* (1993) and Shahriar (2009) have shown that, when an outside option is offered to one of the two players in a BOS game, the equilibrium in the BOS game that favors the same player emerges as a focal point even when the option gives that player a payoff lower than both the subgame equilibria payoffs. However, the source of the focal point and whether such an outside option alone is sufficient to generate the focal point were not clear from these earlier studies. The current paper hypothesizes that, even when the outside option gives the player who is offered the option a payoff lower than the payoffs in both the equilibria in the BOS subgame, the rejection of the option enables the player signal her intended strategy choice in the subgame; this signaling generates the focal point. The experimental results presented in the paper support this hypothesis and thus confirm the focal-point generating power of the asymmetrically offered outside option in a BOS game.

References

Camerer, C. F. (2003) *Behavioral Game Theory: Experiments in Strategic Interaction*, Roundtable Series in Behavioral Economics, Princeton University Press: Princeton.

Cooper, R., D. V. DeJong, R. Forsythe, and T. W. Ross. (1993) "Forward Induction in the Battle-of-the-Sexes Games" *The American Economic Review* **83**, 1303-1316.

Dufwenberg, M., and G. Kirchsteiger. (2004) "A Theory of Sequential Reciprocity" *Games and Economic Behavior* **47**, 268-298.

Fischbacher, U. (2007) "Z-Tree: Zurich Toolbox for Ready-made Economic Experiments" *Experimental Economics* **10**, 171-178.

Kohlberg, E., and J. F. Mertens. (1986) "On the Strategic Stability of Equilibria" *Econometrica* **54**, 1003-1037.

Rabin, M. (1993) "Incorporating Fairness into Game Theory and Economics" *American Economic Review* **83**, 1281-1302.

Shahriar, Q. (2009) "Forward Induction Works! An Experimental Study to Test the Robustness and the Power" San Diego State University Working Paper number 09-01.

Van Damme, E. (1989) "Stable Equilibria and Forward Induction" *Journal of Economic Theory* **48**, 476-496.