E C O N O M I C S   B U L L E T I N

Are there timing effects in coordination game experiments?

Tao Li
Shanghai University of Finance and Economics

Abstract

The timing effects (timing without observability) identified by Weber, Camerer, and Knez (2004) in coordination game experiments are caused by their fixed-matching protocol. When we use a random-matching protocol the alleged timing effects completely vanish.

This paper has benefited from discussions with Steffen Huck, David Laibson, Al Roth, Roberto Weber, and participants in the 2006 Economic Science Association meeting. Financial support from Shanghai Pujiang Project is gratefully acknowledged.
Citation: Li, Tao, (2007) "Are there timing effects in coordination game experiments?." *Economics Bulletin*, Vol. 3, No. 13 pp. 1-9
Submitted: March 6, 2007. **Accepted:** April 10, 2007.
URL: http://economicsbulletin.vanderbilt.edu/2007/volume3/EB-07C90001A.pdf

1 Introduction

Can timing play a significant role in coordination games, even without affecting the information late movers have? According to von Newmann and Morgenstern (1947, p51), timing without observability never matters since it is equivalent to simultaneous move. According to Camerer (2003) and Weber, Camerer, and Knez (2004), there seems to exist a timing effect in coordination game experiments which overturns von Newmann and Morgenstern's presumption. Our paper contributes to this research question by showing that the timing effects Weber, Camerer, and Knez (2004) identified are caused by their fixed-matching protocol. When we use a random-matching protocol the alleged timing effects completely vanish.

Weber, Camerer, and Knez (2004) use a variant of the following Stag Hunt game (Table 1). In their treatment, it was common knowledge that Row players went first, but also that Column players did not know what Row did. Simply knowing the order of the play led pairs to move to Row's preferred equilibrium (Q, Q). So timing without observability can help solve this coordination problem.[1]

	Q	P
Q	$.9, .9$	$0, .6$
P	$.6, 0$	$.3, .3$

Table 1: Stag Hunt Game

However, the identified timing effects in Weber, Camerer, and Knez (2004) could be caused by their experimental protocols. Since they adopt a fixed-matching protocol with full feedback on previous outcomes, the early mover's previous-round actions are essentially revealed to the later movers. As the matching is fixed and the first mover in each round is always the same person, a previous-round Q choice from the first mover is a strong costly signal that she would choose Q again.

We successfully replicate their results using the same fixed-matching protocol with feedback. When we use random matching in which the first mover is not necessarily the same person for consecutive rounds, the alleged timing effects completely vanish. We also observe no timing effect in the experi-

[1]Another pure-strategy Nash equilibrium is (P, P).

ments using a simpler version of their game. Overall our results shed doubt on the existence of timing effects in coordination games.

Section 2 reports our experimental results. Section 3 discusses the literatures and implications.

2 Stag Hunt Experiments

Subsection 2.1 describes our replication of Weber, Camerer, and Knez (2004) with the fixed-matching protocol and reports the treatment experiments with random matching protocols. Subsection 2.2 reports corroborating results for simpler experiments.

2.1 Weak Link Game

Weber, Camerer, and Knez (2004) use a generalized 3-person Stag Hunt game called "weak link." The players are choosing an effort level between 1 and 7. The payoff is determined by own effort and own group's minimum effort. The detailed payoff is in the following table.

	7	6	5	4	3	2	1
7	1.3	1.1	0.9	0.7	0.5	0.3	0.1
6	-	1.2	1.0	0.8	0.6	0.4	0.2
5	-	-	1.1	0.9	0.7	0.5	0.3
4	-	-	-	1.0	0.8	0.6	0.4
3	-	-	-	-	0.9	0.7	0.5
2	-	-	-	-	-	0.8	0.6
1	-	-	-	-	-	-	0.7

Table 2: Weak Link (The rows correspond to your choice. The columns correspond to the minimum choice in your group.)

The weak link is a stag hunt game because all diagonal outcomes are pure-strategy Nash equilibria, which are ranked according to its associated payoff. Any equilibrium with higher payoff always comes with higher risk. Equilibrium selection in this game is a subtle problem.

We focus upon the following two experiments they conducted: 1) Simultaneous-move protocol, in which all three players choose simultaneously; and 2) Sequential-move protocol, in which three players move one by one, with early choices unobservable. Their experimental outcomes confirmed their prediction based upon virtual observability that subjects in the sequential treatment tend to coordinate on higher-effort equilibrium. The average choice in the sequential treatment is about one level higher.

Our replications were carried out in November of 2005. We conducted experiments with undergraduates at Shanghai University of Finance and Economics recruited from classes of various topics (including economics, business, information technology, English, and many others). Students normally have quite limited knowledge of modern economics. We do not allow students recruited from the same class to dominate any one session. Most participants get a payoff between \$1 and \$2 (1 US dollar = 8 yuan). The average length of each session (including instructions) was about half an hour. The local wage for a college student is at best \$1 per hour.

In each session 24 subjects sat in a networked computer lab specially designed for running economic experiments. They were subdivided into 3-person groups and played 10 rounds together. The group was fixed and there was feedback after each round. In each group the first (and respectively second and third) mover was always the same person. Subjects in each session played 10 rounds. This is longer than Weber, Camerer, and Knez (2004).

The replications was quite successful. The top two curves in Figure 1 is very close to corresponding curves in Figure 3 and 4 of Weber, Camerer, and Knez (2004). The average choice in the sequential treatment is also about one level higher.

We then conducted an additional treatment (timing without observability) using a random-matching procedure in May, 2006. We used only 9 subjects (divided into 3 groups) and also allowed feedback after each round. The result is reported in the bottom curve of Figure 1. Even for such a small population, which tends to facilitate coordination, the average choice for the first round is only 3.3, and it keeps dropping until in the last three rounds it is only about 1.2. The group minimum is above 1 for only two times (2 out of 30, roughly 7%).

Note that in Weber, Camerer, and Knez (2004), with feedback, the previous-round choice for each player is public information when they choose. The first mover in each round is always the same person. Then the first mover can choose high effort in the first round to signal her strong intention to lead the group in the following rounds. She might lose from her choice in the first round, which makes her signal costly and credible in a repeated game. The

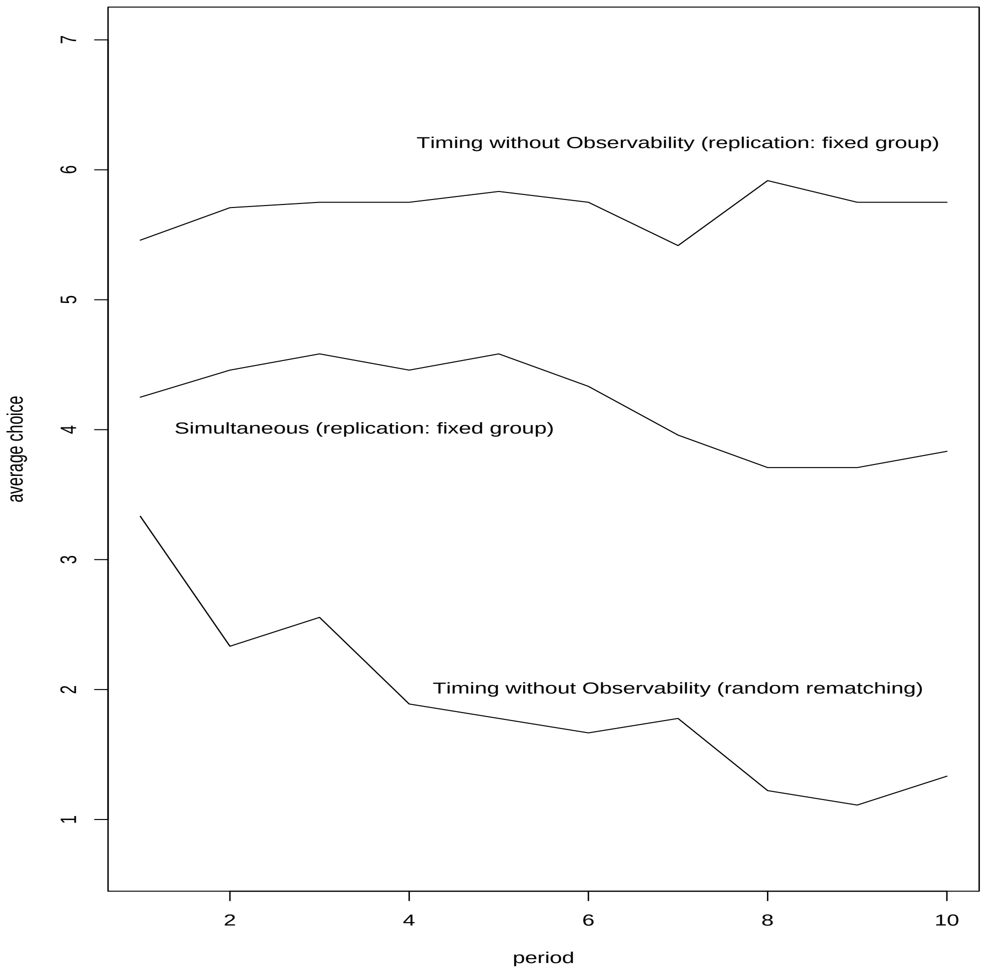

Figure 1: Weak Link Experiments

same logic applies to the second round and etc. It is not surprising that the first mover can lead the entire group to high-effort equilibria. But this is entirely a signalling effect in a repeated game, and not due to timing per se.

We conducted an additional experiment (not reported here) using a fixed-matching procedure in which we label players as first, second, and last mover. The real choices are made simultaneously. The label remains unchanged for the entire experiment. Again, subjects tend to coordinate on higher-effort equilibria, and the magnitude of treatment effect is the same as in Weber, Camerer, and Knez (2004).

2.2 2×2 Stag Hunt

For the game described in Table 1, which is a simper version of the weak link game, we run two similar experiments (simultaneous-move protocol Stag-SIM and sequential-move protocol Stag-SEQ). We observe no timing effects here either.

The experiments were carried out in May of 2006. The procedure is similar to what was described above except that we now have 42 subjects. In each session 8-12 subjects played 10 rounds together. There was random rematching and feedback after each round. The results are summarized in the following Table 3.

	P Play	Q Play	Total
Stag-SEQ I	73	7	80
	91%	9%	100%
Stag-SEQ II	85	35	120
	71%	29%	100%
Stag-SIM I	59	41	100
	59%	41%	100%
Stag-SIM II	111	9	120
	92%	8%	100%

Table 3: 2×2 Stag Hunt

There is some variation across sessions. But it is quite obvious that (Q, Q) failed to strongly emerge in both Stag-SEQ experiments. Overall Stag-SEQ is rather like Stag-SIM. A one-sided χ^2 test, ignoring the independence requirements by pooling data from the same treatment sessions, fails to reject the null hypothesis that the proportion of P play in Stag-SIM is the same as the same proportion in Stag-SEQ. The p value is 0.38.

3 Conclusion

Cooper et al. (1993) and Rapoport (1997) were the first to address the timing effects in asymmetric coordination games (battle of the sexes). Weber, Camerer, and Knez (2004) argue that symmetric stag hunt game is better than asymmetric coordination games for identifying timing effects since in asymmetric games moving first also makes first mover's preferred equilibrium outcome more "focal." Their procedure yields relatively less ambiguous results.

Building upon Amershi, Sadanand, and Sadanand (1985, 1992), Weber, Camerer, and Knez (2004) summarized the explanation for such timing effects as "virtual observability" (VO). The later mover would choose as if she could observe the early mover's choice. The early mover would then take advantage of this tacit follower behavior by choosing her preferred equilibrium action.

In recent years, more and more researchers acknowledged the findings of Weber, Camerer, and Knez (2004) and their VO explanation (Muller and Sadanand 2003, Poulsen and Tan 2004). This argument is appealing since it fits our intuition that a first mover often has an advantage. However, our paper shows that the evidence is not yet strong.

For practical implications of our results, consider a team production problem (a weak link game). In order for the group members to uniformly exert high effort, it is usually not enough to have a leader who makes a hidden first move, as was implicitly implied in Weber, Camerer, and Knez (2004). Such a leader is effective only in a repeated scenario with fixed group membership, where history is public information. Her previous-round action can then serve as a model to encourage other players.

4 Appendix

The following is an English translation of the original Chinese instruction for the stag hunt game experiment in which the early mover's choice is unobservable (Stag-SEQ treatment). Instructions for the other treatments are available upon request from the author.

Thank you for attending scientific experiments in economics. Every participant will get 5 yuan show-up fee. During the experiment you have the chance to earn additional money according to the rule. At the end of the experiment the staff will put all your money into an envelop and hand it to you when you leave the room one by one. Please keep quiet from now on. If you have questions please raise your hand.

We have 12 people in this room. We will conduct 10 rounds of identical experiments.

At the beginning of the 1st round, the computer will automatically divide 12 people into 6 groups, with 2 people in each group. The grouping is random and anonymous (you will never know who ever played with you).

At the beginning of the following 9 rounds of experiments, the computer will re-do the random and anonymous grouping. So it is highly unlikely that you are grouped with the same person in each round.

In each round of the experiment, we ask you and your partner in the same group to choose Left or Right respectively. One person is to choose first. When the second person chooses, he or she does not know the previous choice. The early mover is randomly picked by the computer in each round. When both persons have completed the above choices, you will be informed of the results of the experiment, which include the final choice of your partner and the money you earn in this round.

The money you earn in each round is determined by the following two factors:

- *your own choice*
- *your partner's choice*

The details are shown below (monetary unit: yuan)

your choice	your partner's choice	your income	your partner's income
Left	Left	0.9	0.9
Left	Right	0	0.6
Right	Left	0.6	0
Right	Right	0.3	0.3

Table 4: Detailed Income

Your have 3 minutes to go over the instructions before we start the experiment.

References

[1] Amershi, A., Sadanand, A., and Sadanand, V. 1985. "Manipulated Nash Equilibria III: Applications and a Preliminary Experiment." UBC Working Paper #1222b.

[2] Amershi, A.H., Sadanand, A., and Sadanand, V. 1992. "Player Importance and Forward Induction." *Economics Letters*. $38 : 291C297$.

[3] Camerer, C. 2003. *Behavioral Game Theory*, Princeton University Press.

[4] Cooper, R., Douglas V. DeJong, Robert Forsythe, and Thomas W. Ross. 1993. "Forward Induction in the Battle-of-the-Sexes Games." *American Economic Review* $83 : 5, 1303 - 16$

[5] Muller, A., and Sadanand, A., 2003. "Order of play, forward induction and presentation effects in two-person games." *Experimental Economics* $6 : 5C25$.

[6] Von Neumann, J., and Morgenstern, O., 1947, *The Theory of Games and Economic Behavior* (2nd ed.) Princeton NJ: Princeton University Press

[7] Poulsen, A., and Tan, J., "Can Information Backfire? - Experimental Evidence from the Ultimatum Game." *Working Papers from Aarhus School of Business, Department of Economics*

[8] Rapoport, A. 1997. "Order of Play in Stratetically Equivalent Games in Extensive Form," *International Journal of Game Theory* $26 : 113 - 36$.

[9] Schelling, T. 1960. *The Strategy of Conflict*, Cambridge, MA: Harvard University Press.

[10] Weber, R., Camerer, C., and Knez, M. (2004): "Timing and Virtual Observability in Ultimatum Bargaining and "Weak Link" Coordination Games", *Experimental Economics*, 7 (1), p. 25-49.