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An experimental study of commitment in Stackelberg games with observation costs

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Abstract

We report on experiments examining the value of commitment in Stackelberg games where the follower chooses whether to pay some cost to perfectly observe the leader's action. Várdy [Games Econ. Behav. (2004)] shows that in the unique pure-strategy subgame perfect equilibrium of this game, the value of commitment is lost completely; however, there exists a mixed-strategy subgame perfect equilibrium where the value of commitment is fully preserved. In the data, the value of commitment is largely preserved when the cost of looking is small, while it is lost when the cost is large. Nevertheless, for small observation costs, equilibrium behavior is clearly rejected. Instead, subjects persistently play non-equilibrium strategies in which the probability of the follower choosing to observe the leader's action is a decreasing function of the observation cost.

JEL classification: C72; C91; D82; D83; D84

Keywords: Stackelberg duopoly; Experiments; Observation costs; Commitment; Costly leader games

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1. Introduction

One key insight of game theory is the value of commitment. A standard way of illustrating the value of commitment is by showing that in markets where firms compete in quantities, a firm can gain a strategic advantage if it can commit to its production quantity ahead of its rival. The reasoning is straightforward: Having observed the first-mover's commitment to produce a large quantity, the best response of the rival firm is to cut its own production. This leads to a situation where the first-mover, or 'leader', gains market share and profit at the expense of the second-mover, or 'follower.' Suppose, however, that to observe the leader's choice, the follower must undertake some investigative activity—perhaps at very low cost. Absent undertaking this activity, he remains in the dark about the leader's action. How does this option affect the strategic choices in the Stackelberg game? And how does it affect the leader's value of commitment?[1]

To fix ideas, consider the normal form game, g:

$L \backslash F$	s	c
S	(500, 200)	(300, 100)
C	(600, 300)	(400, 400)

In this game, two firms, designated L(eader) and F(ollower), are competing with one another. Here, the choices of the leader, S and C, correspond to the Stackelberg and Cournot outputs, respectively. Likewise for the choices of the follower. If firms choose their actions simultaneously, the game is dominance solvable and yields the unique rationalizable outcome (C, c). In contrast, if L moves first followed by F and L's choice is fully observable, then the unique subgame perfect equilibrium of the game is (S, s). Thus, the power of commitment yields L an additional 100 points at the expense of 200 points lost on the part of F.

Next, consider a variation of this game that Várdy (2004) refers to as the 'costly leader game.' In this game L chooses first. Then F decides whether to spend an amount $\varepsilon > 0$ to perfectly observe L's choice. If he does not spend ε, player F obtains no information about L's choice. Following this, F chooses s or c and payoffs are realized. The extensive form of the costly leader game is depicted in Fig. 1.

If one restricts attention to pure-strategy subgame perfect equilibria of the costly leader game, F never pays to observe L's choice and the outcome of the game is (C, c). In other words, the value of being a first-mover is completely undermined even for arbitrarily small costs of observing L's choice. The intuition is that, since F fully anticipates L's choice in a pure-strategy equilibrium, there is no point in spending anything merely to confirm these beliefs. Of course, L anticipates this behavior on F's part and thus cannot hope to

[1] In this paper, we use the terms 'value of commitment' and 'first-mover advantage' interchangeably. Both terms refer to the extra payoff the leader gets from moving first, as compared to his payoff when the players move simultaneously.