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Information asymmetry and reentry

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HIGHLIGHTS

- We model short-run consumers choosing in sequence to interact with a long-run player.
- When the long-run player's reputation is bad, consumers stop to interact.
- If stopping is informative for the long-run player, reentry can occur in equilibrium.
- The long-run player has to be able to credibly improve on consumers' expected payoff.

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ABSTRACT

We model a reputation game, in which a sequence of short-run players chooses if to interact with a long-run player. Although beliefs may be identical, choices may be different, as not-interacting can lead the long-run player to improve on effort.

1. Introduction

This paper analyzes an example of a repeated game in which players decide upon participation in an experience goods market. It is shown that although participation stops, it may start again at a later point in time.

The model presented here involves a series of short-run players, who each decide once in an exogenously given sequence whether or not to interact with a single long-run player. There is uncertainty about the long-run player's type, linking the model to incomplete information models like discussed in Harsanyi (1967). The short-run players might be able to acquire some information about the long-run player by observing signals, which are due to past interactions. This puts the model at hand in line with reputation models like the ones of Kreps and Wilson (1982) and Milgrom and Roberts (1982). Although their models include different stage games in fashion of the chain-store game in Selten (1978), the way in which reputation is formed is similar in the present paper.

A feature of equilibrium behavior in models, close to the one presented here, is that once a short-run player refuses to participate, all subsequent short-run players will do so as well.[1] This happens as the refute to interact prevents the accumulation of additional information about the long-run player. In turn, this leads to grim-trigger like behavior, although short-run players are myopic and therefore would not be able to coordinate on such a strategy as a strategic punishment. Moreover, it gives the long-run player an incentive to invest highly in achieving signals, which induce short-run players to participate, as punishment can be pretty severe.

Similar to Ely and Välimäki (2003) the information, which is relevant to short-run players in order to decide upon participation, is the type of long-run player they are facing. In contrast to their paper our model does not allow the preferable type to identify as such as we assume imperfectly observed actions. Therefore, our model is close to the one in Fudenberg and Levine (1992), which also uses a similar stage game. But while their paper focuses on the payoff bounds for the long-run player, this paper rather stresses on the

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[1] See for instance Ely and Välimäki (2003) or the examples in Fudenberg and Levine (1989).

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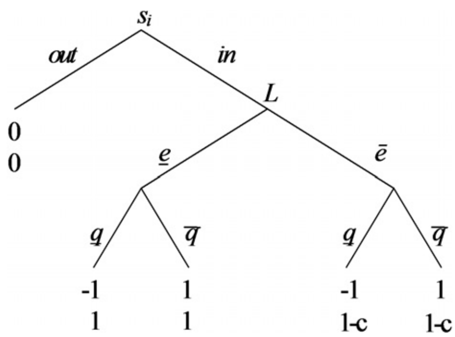

Fig. 1. Gametree for the stage game.

mechanic of information transmission and its implication for equilibrium behavior.[2]

The main argument illustrated in our paper is that even though the information transmission between short-run players may stop, non-participation might convey information for the long-run player. This may alter the long-run player's behavior and in turn lead short-run players to interact again, although they have the same belief about the long-run player's type as the short-run player, who chose not to participate.

Section 2 introduces a model for a game, in which reentry can happen in equilibrium. In Section 3, it is illustrated that if the number of feasible actions for the preferable type of long-run player is large enough, reentry can be part of an equilibrium. Section 4 concludes.

2. Model

Let us consider a 4 period model with a long-run player L and short-run players s_i for each period, with $i \in \{1 \dots 4\}$.[3] The long-run player is one of two types $\Omega = \{\underline{\omega}, \overline{\omega}\}$.

Starting with s_1 each short-run player and the long-run player play the following stage game.

Actions: first s_i chooses whether to participate or not, which is denoted by $a_i \in A = \{in, out\}$. If $a_i = in$, L chooses an unobservable effort level $e_i \in E = \{\underline{e}, \overline{e}\}$ and therefore incurs a cost $C(\underline{e}) = 0, C(\overline{e}) = c, c > 0$. Then, each short-run player receives a benefit $q_i \in Q = \{\underline{q}, \overline{q}\}$ with $\overline{q} = 1$ and $\underline{q} = -1$. The probabilities for realizing $\overline{q}$ are

$$\Pr(\overline{q}|\underline{e}, \underline{\omega}) = \Pr(\overline{q}|\overline{e}, \underline{\omega}) = \phi$$
$$\Pr(\overline{q}|\underline{e}, \overline{\omega}) = \underline{\theta}$$
$$\Pr(\overline{q}|\overline{e}, \overline{\omega}) = \overline{\theta}.$$

Furthermore, $1 > \overline{\theta} \geq \underline{\theta} > \frac{1}{2} > \phi > 0$.[4] The assumption $\overline{\theta} \geq \underline{\theta} > \frac{1}{2}$ makes it desirable to choose *in*, if L is $\overline{\omega}$ regardless of the chosen effort. On the other hand, $\frac{1}{2} > \phi$ makes it undesirable to interact with a long-run player of type $\underline{\omega}$. If $a_i = out, q_i = 0$ with certainty and the period ends. Fig. 1 shows the game tree for the stage game for a given type of long-run player.

Beliefs: short-run players do not know, which type of long-run player they are actually facing. There exists a commonly known prior $\mu_0 \in (0, 1)$ that the long-run player is the $\underline{\omega}$ type. Probability μ_i denotes player s_i's belief and $\forall i > 0$, μ_i is a Bayesian' update of μ_0, given the observed sequence $(q_{1,\dots,}q_{i-1})$. These signals are not observable for L.[5] Therefore, the long-run player only has an expectation about μ_i which is denoted by $\varrho_i = \mathbf{E}(\mu_i|\varrho_{i-1}, a_i, e_{i-1})$. The long-run player needs this expectation in order to assess the expected value of choosing either $\underline{e}$ or $\overline{e}$ at each decision node. Given ϱ_{i-1},[6] e_{i-1} leads to a distribution over q_i, which in turn can be used to derive an expected value for ϱ_i. Short-run player i's actual decision a_i allows for an update of this expectation.

Payoffs: the long-run player has a discount factor of δ. Stage game payoffs are assumed as follows:

$$\text{For player } s_i : u_i = \begin{cases} q_i, & \text{if } a_i = in \\ 0, & \text{otherwise} \end{cases}$$

$$\text{For player } L : \pi_i = \begin{cases} 1, & \text{if } a_i = in \text{ and } e_i = \underline{e} \\ 1 - c, & \text{if } a_i = in \text{ and } e_i = \overline{e} \\ 0, & \text{otherwise.} \end{cases}$$

At each of the long-run player's decision nodes a game has a continuation value $V_i(\varrho_i, e_i, \omega)$, which is the sum of discounted expected payoffs over all future periods, given the long-run player's type, the respective effort and expectation about the short-run players' beliefs.

With the assumption that all players maximize their expected utility at each decision node, we turn to the equilibrium behavior.

3. Equilibrium and reentry

In equilibrium short-run players and both types of the long-run player optimize:

$$a_i^* = \begin{cases} in, & \text{if } \psi_i \geq 0 \\ out, & \text{otherwise} \end{cases}$$
$$e_i^* := \arg\max V_i(\varrho_i, e_i, \omega) \tag{1}$$

ψ_i denotes the expected payoff for the short-run player i, when choosing $a_i = in$. Thus, simplifying (1) leads to the following conditions for all L types and all s_i:

$$\forall i : \arg\max V_i(\varrho_i, e_i, \underline{\omega}) = \underline{e} \tag{2}$$

and $\overline{\omega}$ chooses $\overline{e}$ if:

$$V_{i+1}(\varrho_{i+1}(\varrho_i, \overline{e}, \overline{\omega}), e_{i+1}^*(\varrho_i, \overline{e}, \overline{\omega}), \overline{\omega})$$
$$\geq V_{i+1}(\varrho_{i+1}(\varrho_i, \underline{e}, \overline{\omega}), e_{i+1}^*(\varrho_i, \underline{e}, \overline{\omega}), \overline{\omega}) \tag{3}$$

and $a_i = in$, if:

$$\mu_i\phi + (1 - \mu_i) \Pr(\overline{q}|e_i, \overline{\omega}) > \frac{1}{2} \tag{4}$$

Lemma. *In any equilibrium agents behave according to Eqs. (2), (3) and (4).*

It is straightforward to see that the strategies depicted in (2), (3) and (4) solve the respective agent's maximization problem for given beliefs. Further, as μ_i is a Bayesian' update of μ_0, beliefs are consistent with equilibrium behavior. No off-equilibrium beliefs can be specified as off-equilibrium behavior cannot be detected.

We derive equilibrium conditions the following way.

2 The main difference in modeling assumptions is that we assume the long-run player to infer the signals, which short-run players received in the past, from the short-run players' behavior, while Fudenberg and Levine (1992) assumes signals to be public information.

3 While the intuition behind the mechanic is similar for $i \in \{1 \dots \infty\}$, the formal arguments are much easier to illustrate in the finite case with 4 being the minimum number of periods for the mechanic to work.

4 Assuming all probabilities to be strictly less than 1 and greater than 0 does not allow any sequence of signal realizations to fully reveal the long-run player's type.

5 While the effect is easier to show under this strong assumption, it is sufficient to assume that L cannot perfectly observe the signals.

6 Note that as the short-run players' prior μ_0 is common knowledge, it holds that $\varrho_0 = \mu_0$.