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Note

Dynamic communication with biased senders [☆]

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ABSTRACT

We study dynamic games in which senders with state-independent payoffs communicate to a single receiver. Senders' private information evolves according to an aperiodic and irreducible Markov chain. We prove an analog of a folk theorem—that any feasible and individually rational payoff can be approximated in a perfect Bayesian equilibrium if players are sufficiently patient. In particular, there are equilibria in which the receiver makes perfectly informed decisions in almost every period, even if no informative communication can be sustained in the stage game. We conclude that repeated interaction can overcome strategic limits of communication.

1. Introduction

Crawford and Sobel (1982) introduced cheap-talk games as a basis for the analysis of strategic transmission of unverifiable information. They considered a one-shot game between a sender who has private information and a receiver who takes an action. In equilibrium, informative communication can be sustained, but misalignment of players' interests limits the amount of information that can be transmitted. In particular, if players' preferences are misaligned, truthful communication of private information cannot be sustained; otherwise, the sender would bias reports to induce her preferred outcomes. The strategic considerations restrain communication and translate into inefficiency as both players could benefit from a better-informed action.

The strategic limits of communication highlighted in a one-shot game provide insights into many economic situations. A buyer relies more on the recommendation of a friend than that of a sales representative; an antitrust legislator takes arguments of firms opposing a newly proposed regulation with a grain of salt; a voter feels skeptical about the promises of a politician running for office. Nonetheless, in many settings in which interests are seemingly misaligned, informative communication is sustained: companies raise funds from investors, government agencies successfully split the state budget, conglomerates allocate resources among different divisions, and so on. In many of these cases, the informed parties have

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strong biases so that their payoffs are determined solely by the resulting decisions.[1] Importantly, all of these interactions happen repeatedly over time, with the parties trading off immediate opportunistic gains for the prospect of an ongoing relationship.

To investigate informative communication in these settings, we analyze a dynamic version of an information transmission game in which private information (states) evolve stochastically over time. We allow for many senders but focus on the case in which the senders' payoffs are state independent. In every period, each sender sends a message to the receiver, who then takes a publicly observable action. The "cheap-talk" nature of messages is preserved: no hard evidence can be presented, the sender cannot commit to a communication strategy, and the receiver never observes extraneous information to test the validity of the past messages. No contracts can be written between the players, so at any point in time it must be in players' interests to follow the equilibrium play.

We obtain an analog of a folk theorem—that any feasible and individually rational payoffs can be approximated in a perfect Bayesian equilibrium as the players become patient.[2] This payoff set, and hence the set of equilibrium payoffs, admits a simple characterization and includes all Pareto efficient payoffs that satisfy the receiver's individual rationality. Specifically, it includes the receiver's largest feasible "complete information" payoff. In equilibrium, the fraction of periods in which the receiver makes perfectly informed decisions can be arbitrarily close to one, even if no informative communication can be sustained in the stage game.

These results contrast with the conventional wisdom that state independence makes it harder to maintain informative communication. Indeed, in this case, each sender has an unambiguous ranking over actions and is willing to report truthfully only if indifferent among the messages she sends. However, what comes as a curse in a one-shot game turns into a blessing when the game is dynamic. If senders' payoffs depend only on actions and not on states, then the receiver fully observes and controls the payoffs. Our equilibrium construction actively uses this feature—it *targets* the senders' total payoffs and ensures they *do not depend* on the senders' messages. To achieve it, the equilibrium play alternates between communication and adjustment phases. In communication phases, the receiver makes informed decisions relying on the senders' messages. In adjustment phases, the receiver ignores all messages and plays according to a strategy that pulls the senders' payoffs towards the target. Specification of the phases and the transitions between them is tailored to guarantee that the senders' payoffs do not depend on their messages, and thus sustains truthtelling. By the law of large numbers, as players become more patient, the play occurs in the communication phase most of the time and any individually rational payoffs can be achieved by changing the strategy the receiver plays in there.

Related literature. The general idea that an ongoing relationship can overcome strategic limits of interaction is the cornerstone of the literature on repeated games as discussed in depth by Mailath and Samuelson (2006). Further, the idea of using players' payoffs as a determinant of equilibrium construction is reminiscent of Abreu et al. (1990)'s recursive technique of equilibrium payoff decomposition. In fact, if individual states are independently and identically distributed, our dynamic game can be viewed as an infinitely repeated game and Fudenberg et al. (1994)'s standard method can be used to provide an alternative proof of our folk theorem result. However, the standard method cannot be applied to general stochastic sender–receiver games.

At the same time, the idea of linking decisions motivated a strand of mechanism design literature. Jackson and Sonnenschein (2007) showed that Pareto efficient outcomes can be achieved by linking many identical copies of a collective choice problem with private values into a single mechanism. Frankel (2016) extended these ideas into a dynamic setting where the sender has persistent private information. He introduced discounted quota contracts similar to our equilibrium construction and showed their optimality in many environments. The mechanism design setting, however, differs from ours in that it endows the receiver with commitment power and monetary transfers.

Finally, the closest paper to ours is by Renault, Solan and Vieille (2013), who analyzed a dynamic information transmission game between a single sender and a receiver. They considered a more general payoff structure that, however, did not allow the sender's payoff to be state independent. In their setting, they showed that our analog of a folk theorem does not generally hold. In particular, the players' equilibrium payoffs do not necessarily approach the Pareto efficiency frontier as the players become patient.

Neither Renault et al. (2013)'s nor our proof can be directly extended to cover both the cases of state-dependent and of state-independent payoffs. On one hand, their construction is based on the idea of statistical tests that require the sender to match the message distribution with the state distribution. However, in our setting, because payoffs are state independent, statistical tests cannot be used effectively; faced with these tests, the sender would induce favorable actions earlier in time independently of the realized states, rendering her messages uninformative. On the other hand, our construction is based on the ability of the receiver to adjust the senders' continuation payoffs exactly to the target without knowing the state.[3]

[1] Chakraborty and Harbaugh (2010) provide many more examples of such strong biases.

[2] There is no standard formulation of a "folk theorem" in repeated games with incomplete information.

[3] In the equilibria we construct, after every history each sender is indifferent between sending any message, independently of the private histories observed by the other senders. Nevertheless, these equilibria are not "belief-free" in the sense of Ely et al. (2005) as the same property does not hold for the receiver.

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