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Endogenous information acquisition in Bayesian games with strategic complementarities ☆

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Abstract

This paper studies covert (or hidden) information acquisition in common value Bayesian games of strategic complementarities. Using the supermodular stochastic order to arrange the structures of information increasingly in terms of preferences, we provide novel, easily interpretable and verifiable, though restrictive conditions under which the value of information is increasing and convex, and study the implications in terms of the equilibrium configuration. Increasing marginal returns to information leads to extreme behavior in that agents opt either for the highest or the lowest quality signal, so that the final analysis of this complex game simplifies greatly into that of a two-action game. This result can rationalize the complete information game as an endogenous outcome. Finally, we also establish that higher-quality information leads players to select more dispersed actions in the Bayesian game.

JEL classification: C44; C72; D83

Keywords: Information acquisition; Supermodular Bayesian games; Stochastic supermodular order; Costly rationality

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1. Introduction

The emergence of information economics, grounded on solid theoretical foundations, owes much to the theory of Bayesian games (Harsanyi, 1967, and Mertens and Zamir, 1985). The basic formulation of this class of games, adopted by most economic applications, posits an exogenously given structure of information. An unknown payoff-relevant parameter is part of the structure of the game and players receive some exogenous partial information (or message) that guides their decisions in the game. This message is usually costless and its reliability (quality) is fully out of the control of the players. Yet, in many of the natural economic settings, it would be more appropriate to postulate that players have the option of acquiring information on the unknown parameter, beyond what is readily available, provided they pay a corresponding cost.

We endogenize information acquisition in the class of common value Bayesian supermodular games of Van Zandt and Vives (2007), or VZ-V. These are games in which actions are strategic complements; for each player, own actions and the unknown are complements; and interim beliefs increase in messages. A typical example would be price-setting firms that compete in an industry with demand known up to a parameter whose prior distribution is common knowledge. We add an initial stage where players can purchase covert information as a noisy signal.

We show that, for the class of common value Bayesian supermodular games, the informativeness of the signal relies on its association with the state of the world, a feature nicely captured by the supermodular stochastic order. This result extends Athey and Levin (2001), who establish a positive value for information in monotone decision problems, to settings with strategic interactions (see Neyman, 1991, for a related analysis). To do so, we adapt some results from VZ-V to take care of the effects generated by extra information on rivals' behavior for one player. We also investigate how information affects agents' strategies in the action phase of the game. We find that more informative signals lead players to take more extreme actions. The intuition is easy to grasp: With signals of higher quality, players place more faith in the messages they receive and are, thus, encouraged to make more extreme decisions in the Bayesian game.[1]

The central part of the paper deals with the second order properties of the value of covert information as a fruitful approach to identify a subclass of models that can possess only extreme pure strategy Bayesian information equilibria. We propose a novel assumption of convexity of the information structure in the supermodular order. The interpretation of this notion of convexity is quite natural for the setting at hand: Higher quality raises the informativeness of the signal with increasing returns in signal quality. For this subclass, we show that for each player, all interior choices of signal quality are strictly dominated, so that only the extremal signal qualities can emerge at equilibrium. In this way, we reduce the complex existence issue for the full game to one involving a simple two-action (matrix) game. Although the level of generality does not allow us to settle in a systematic way the existence issue for this matrix game, this part should be easy to accomplish for a particular application, where the extremal information games are well structured and thus easier to compare in terms of payoffs.

The second order implications of information acquisition have been extensively investigated in the single-player case. A key general conclusion is that the value of information tends to be convex, mainly near zero: Radner and Stiglitz (1984) and Chade and Schlee (2002); see also Dimitrova and Schlee (2003). Our analysis represents an extension to a multi-agent setting, using the supermodular order to derive *conditions for global convexity of expected payoffs*. Intuitively,

[1] Roux and Sobel (2015) have independently derived a similar result to explain polarization of group decisions.