

Nash equilibrium when players account for the complexity of their forecasts

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Abstract

Nash equilibrium is often interpreted as a steady state in which each player holds the correct expectations about the other players' behavior and acts rationally. This paper investigates the robustness of this interpretation when there are small costs associated with complicated forecasts. The model consists of a two-person strategic game in which each player chooses a finite machine to implement a strategy in an infinitely repeated 2×2 game with discounting. I analyze the model using a solution concept called Nash Equilibrium with Stable Forecasts (ESF). My main results concern the structure of equilibrium machine pairs. They provide necessary and sufficient conditions on the form of equilibrium strategies and plays. In contrast to the "folk theorem," these structural properties place severe restrictions on the set of equilibrium paths and payoffs. For example, only sequences of the one-shot Nash equilibrium can be generated by any ESF of the repeated game of chicken.

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1. Introduction

Introducing the notion of Nash equilibrium in their text book, Osborne and Rubinstein (1994, p. 14) write: "*The most commonly used solution concept in game theory is that of Nash equilibrium. This notion captures a steady state of the play of a strategic game in which each player holds the correct expectation about the other players' behavior and acts rationally.*"

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The above citation describes one of the most commonly accepted interpretations of Nash equilibrium. It says that the equilibrium strategy of a player represents not only the action plan this player actually takes, but also this player's plan of action as envisioned by the other players. According to this interpretation, players' strategies in a Nash equilibrium must meet *two* requirements:

- (1) they must be best responses to each other, and
- (2) they must also represent what the other players expect each player to do.

Thus, if for some reason player i 's actual strategy does not coincide with player j 's expectations, then we are not at a Nash equilibrium.

This paper investigates the robustness of the above interpretation of Nash equilibrium, when there are small costs associated with complex forecasts. The paper addresses the following question: What is the set of strategy profiles that retain the two properties described above, when players try to use the simplest forecasts? I argue that this set can be surprisingly small.

In order to address the question posed above I perform the following exercise for two-person games. I look at the Nash equilibria of a game and then ask, if complicated forecasts are costly, will each player continue to maintain an accurate forecast of his opponent? Suppose one of the players can find a best response to his opponent, which is rationalized by a simpler (but possibly inaccurate) forecast. Then the original pair of strategies cannot be considered a Nash equilibrium that is consistent with our interpretation of this solution concept.

To help motivate the question this paper addresses, consider the following example. An army is engaged in (the strategic form of) the infinitely repeated game of chicken. The stage game payoffs are given in Fig. 1.

You are an intelligence officer in charge of analyzing the opponent and reporting your forecast of his strategy to the Chief of Staff (COS). Given your forecast, the COS will choose a best response. The COS's are replaced every period, and every new COS requests an intelligence report on the opponent. The intelligence report you prepare must pass through a long chain of hierarchy before arriving at the COS's desk. That is, you pass your report to the officer in charge of you, who edits it and then sends it to the officer in charge of him who edits your officer's report and so forth. Along this chain of command there are many opportunities for your report to be distorted so that the final version of it (which the COS receives) may be very different from your original report.

Suppose you come to the conclusion that the opponent is using a "grim trigger-strategy": He starts by cooperating and continues to do so as long as you cooperate as well; if you defect at any period, he will forever defect. You conclude that the best response is to cooperate in every period. However, you worry that a report describing the threat might get distorted along the chain of command (for example, someone may decide to

	C	D
C	(3, 3)	(1, 4)
D	(4, 1)	(0, 0)

Fig. 1. The game of chicken.

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