

AN EARLY PAPER ON THE REFINEMENT OF NASH EQUILIBRIUM

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Preface. In September 1994, I found in my attic an old student paper that I had written twenty years before, which I had thought to be lost forever. As I reread it, however, I saw it as a document of some historical interest, because it was written at a time of transition in game theory. In 1974, fundamental new research directions in noncooperative game theory were just beginning to emerge from the intellectual seeds that John F. Nash Jr. planted in the early 1950s.

Von Neumann's [15] first paper on game theory argued that, if we assume that each player can plan all of his or her moves before the game begins, then any multistage extensive game can be equivalently described by a one-stage normal-form game in which all players choose their plans simultaneously and independently. That is, normal-form games should be sufficient to describe all strategic interactions.

Thus, when Nash [10] formulated the equilibrium as the general solution concept for normal-form games, he could extend this argument for the sufficiency of the normal form to its ultimate logical conclusion: that the Nash equilibrium should be the general solution concept for all game-theoretic analysis. An immediate application of this principle was to call into question much of the literature of cooperative game theory. Cooperative-game theorists try to predict the effect of bargaining and coalition-formation among the players of a game. But the process of bargaining and coalition formation must consist of a series of moves by the individual players, and so the bargaining process can be modelled by some extensive-form game, which, in turn, can be reduced to a normal-form game; and the Nash equilibria of this bargaining game are the solutions that we should study. Thus, Nash taught that cooperative game theory should be reconstructed on the basis of noncooperative analysis, by studying the bargaining and coalition-formation process itself as a noncooperative game. This idea is now known as the *Nash program*. From this perspective, Nash [11] revisited his earlier bargaining theory, and he showed how the analysis could be extended and deepened by viewing the bargaining process as a noncooperative game.

Thereafter, however, the Nash program was curiously neglected for some years, in spite of its compelling logic. The first and most obvious difficulty is that nobody really had any game model that was both simple enough to describe mathematically and yet realistic enough to be accepted as an accurate description of bargaining among many players. But this lack of compelling models concealed

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