# Chapter 14
# Game Theory

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## ABSTRACT

*Economists, political scientists, and military analysts widely apply game theory techniques to analyze strategic decision making of players. The model is often adopted to analyze oligopolistic firms' actions, legal, and political negotiations, dating and mating strategies by couples, and competitive bidding in auctions. As a facet of neuroeconomics, game theory can highly complement the comprehension of human decision making processes. Although the model has been somewhat difficult for many readers, this chapter presents game theory with a high level of precision for easy understanding. The discourse presented in this chapter covers the different types of games, the approaches applied to predict games' outcomes, and general analysis of strategic choices. In its final section, the chapter underscores key aspects of auction and competitive bidding.*

## INTRODUCTION

Game theory has long been difficult to understand, probably because the model has always been presented in rather complex ways. This chapter presents the subject in its simplest form using practical examples and clear analyses of the theory of games with the hope that any ordinary person should be able to read, comprehend, and apply it to analyze situations involving conflicts or cooperation. This chapter covers the different types of games in game theory (static or dynamic, zero-sum or non-zero sum, cooperative or non-cooperative, etc.), the approaches used to predict outcomes of games, and it presents with examples how to analyze different types of games. In its final section, the chapter provides a comprehensive discussion of auction and competitive bidding.

## BACKGROUND

The set of tools applied to analyze conflict and cooperation among players (such as firms or individuals) who decide strategically is called game theory. Game theory techniques are often applied to evaluate situations where individuals or organizations have conflicting objectives. Developed in the 1940s by

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mathematician John von Neumann and economist Oskar Morgenstern, game theory formally describes games and predicts their outcomes conditional on the rules of the games, the information that players have and other factors. Each player adopts a plan (strategy) to compete with others (von Neumann & Morgenstern, 1944).

Any situation in which individuals must make strategic choices and in which the final outcome will depend on what each person chooses to do can be viewed as a *game.* All games have three basic elements: (1) players (2) strategies and (3) payoffs. Games may be *cooperative,* in which players can make binding agreements, or *non-cooperative,* where such agreements are not possible (Koutsoyiannis, 1979).

Economists use game theory when a player's optimal strategy depends on the actions of others, often described as ***strategic interdependence***. For example, telephone providers in most countries carefully monitor each other's behavior; since relatively few firms compete in such markets, each firm can influence the price, and hence the payoffs of rival firms. The need to consider the behavior of rival firms makes each firm's profit maximization decision more difficult than that of a monopoly or a competitive firm. A monopolist has no rivals, and perfect competitive firms ignore the behavior of individual rivals (Perloff, 2008). Game theory is therefore used to study oligopolistic behavior but not competitive or monopolistic behaviors.

Oligopoly markets are categorized depending on the characteristics of the market, such as the type of actions firms take, how the firms set quantity or prices, and whether firms act simultaneously or sequentially. The three poplar models of oligopoly are the Cournot model, the Stackelberg model, and the Bertrand model (Breitmoser, 2010).

In the Cournot model, firms simultaneously choose quantities without colluding. The firms have imperfect information about their rivals, so each chooses its output level before knowing what the other firm will choose. The quantity that one firm produces directly affects the profits of the other firm since the market prices depend on total (market) output. In choosing its strategy to maximize profits, each firm considers what it believes about the output the rival will sell.

In the Stackelberg model, a leader firm chooses its quantity and the follower firms independently choose their quantities. This type of situation where one firm acts before the other normally arises if one firm enters a market before another. The leader firm believes that once it sets its output, the rival (follower) must use its possible best response outputs to select its output. The leader therefore predicts what the follower will do before the follower acts.

Instead of setting quantities, in the Bertrand model, firms set prices and allow consumers to decide on the quantity to buy. The Bertrand model is similar to the Cournot model except that the strategic variable is price rather than quantity. The firms choose prices simultaneously and independently leading to a market equilibrium that is different form the Cournot or Stackelberg equilibra (Cumbul, 2012).

Game theory attempts to solve two problems: 1) *how to describe a game; 2) how to predict the game's outcome.* A game is described in terms of the players; its rules; the outcome (for example, who wins an auction); the payoffs to players corresponding to each possible outcome; and the information that players have about their rivals' moves. The rules of a game determine the timing of players' moves and the actions that players can choose at each move. A payoff function determines any player's payoff given the combination of actions by all players (Nicholson & Snyder, 2008).

Economists typically assume that players have common knowledge about the rules of the game, the payoff functions and other players' knowledge about these issues. In many games players have complete information about how payoffs depend on the strategies of all players. In some games, players have perfect information about players' previous moves.