
Foreword

The publication of this *Handbook*, bringing together game theory and industrial organization, is an occasion worth celebrating. After all, industrial organization (IO) – the study of how firms in a given market behave – was game theory’s first systematic application to economics, and the success of that application had much to do with giving game-theoretic ideas the prominent place they now have in the economics profession more generally.

Before game theory remade industrial organization in the 1970s, most IO analyses focused on two extreme but simple kinds of markets: perfectly competitive and monopolistic. In a perfectly competitive market, there are many small sellers (all selling the same kind of good) and many small buyers (“small” here means that the quantities sold by a seller and bought by a buyer are tiny compared with the totals for the market). One might guess that large numbers of traders would make analysis complicated, but they actually simplify matters. If each seller is small relative to the market, its own behavior can’t affect other sellers appreciably. So when figuring out what it should do, it needn’t worry about how the others anticipate it might behave – their anticipations aren’t relevant. In other words, a seller doesn’t have to be strategic (symmetrically, neither does a buyer). And consequently an economic analyst has a relatively easy job predicting the seller’s behavior as the solution to a simple profit-maximization problem. Indeed, because the seller is selling the same sort of good as all its competitors, it will take the good’s market price as given (if it chooses a higher price, it will have no customers – since they can get a perfect substitute for less; and it will be overwhelmed by customers if it chooses a lower price). In other words, the seller has no market power.

In a monopolistic market, by contrast, there is just one seller (I shall continue to assume throughout that there are many small buyers). Thus, as with perfect competition, the seller doesn’t have to worry about what other sellers are thinking about it – this time because there are no other sellers. And so, again, the seller’s optimization exercise as well as the analyst’s prediction exercise are quite straightforward (although the seller now does have market power; its own behavior determines the market price).

However, the intermediate case, oligopoly – where there is more than one seller, but not so many that a single seller has no effect on competitors – is more difficult. Think of the American automobile industry as it used to be, consisting primarily of General Motors (GM), Ford, and Chrysler. When GM worked out which models to manufacture, how many units of each model to produce, and what prices to set, it had to take into account what it anticipated Ford and Chrysler would do, and their actions depended on their forecasts about GM. Clearly, grappling with these anticipatory interactions between firms is essential to understanding the automobile industry. Yet such interactions are potentially very complex. Specifically, when an oligopolistic firm A tries to predict what its rival, firm B, will do, it must anticipate what B anticipates A will do, and what B anticipates A anticipates B will do, and so on. That’s why Nash equilibrium (Nash, 1950) was such a breakthrough: it cuts through this potentially infinite sequence of mutual anticipations.

A situation like the automobile industry can be modeled as a game (more precisely, a “non-cooperative” game) in which the firms are players, a rule for how a player behaves constitutes its strategy, and players’ strategy choices jointly determine their payoffs. Nash proposed that a good prediction for how players will behave in such a game is that they will choose Nash equilibrium strategies: a configuration of strategies from which no individual player gains by deviating. If each player chooses a strategy to maximize its payoff given its anticipation of others’ strategies, then a Nash equilibrium is simply a fixed point of these optimizations. That is, in equilibrium, players’ anticipations about other players are correct and thus the infinite sequence of anticipations is circumvented.

Nash equilibrium was, without doubt, the central foundation on which the game-theoretic literature in industrial organization (and, later, other fields in economics) was erected (and it was for this contribution that John Nash shared the 1994 Nobel Memorial Prize in Economics). Nevertheless, Nash’s work had at least two important economic precursors.

First, Cournot (1838) and Bertrand (1883) analyzed particular instances of duopoly (an oligopoly in which there are just two firms in the industry) in a game-theoretic way, even though game theory wasn’t to be developed formally until the twentieth century. Indeed, both Cournot and Bertrand used what amounted to Nash equilibrium to make their predictions of how firms will behave. Still, remarkable though they are, Cournot’s and Bertrand’s highly stylized analyses lacked Nash’s great generality. Thus, the fact that they had far less influence than Nash (1950) is quite understandable.

The other notable pre-Nash development was monopolistic competition, whose literature was initiated by Chamberlin (1933) and Robinson (1933). Like an oligopoly, a monopolistically competitive market is intermediate between monopoly and perfect competition. And like an oligopolist, a monopolistically competitive firm has market power (normally because the good it sells is not a perfect substitute for other sellers’ goods). However, the firm is presumed to be too small to affect its rivals’ behavior, and so the strategic interactions of oligopoly are absent.

It may seem surprising that Nash’s work, rather than von Neumann and Morgenstern’s foundational volume, *Theory of Games and Economic Behavior*, published six years before Nash (1950), had the primary impact on the industrial organization literature. I suspect that von Neumann and Morgenstern (1944) failed to make much of a dent in economics because it is largely devoted to cooperative game theory, which studies games where players can enter into binding coalitions and which normally presumes that the coalition of all players (the grand coalition) forms. This sort of theory is, unfortunately, unsuited to most real-life markets, where typically the grand coalition does not form. Indeed, even if it does arise (the OPEC cartel in the oil market may have been a reasonable approximation of a grand coalition), IO theorists want to understand why this happens and how the coalition sustains itself; they do not usually take the grand coalition for granted, contrary to the presumption of cooperative game theory.

Another surprise is that once Nash’s paper appeared, another 20 years passed for game-theoretic work in any economic field – let alone in industrial organization – to take off; there was remarkably little game theory in economics in the 1950s and 1960s (one important exception was Schelling’s, 1960, use of game-theoretic ideas to illuminate international relations). Here again, I can only speculate on the reasons, but I conjecture that two important extensions of Nash – Harsanyi’s (1968) treatment of games of

incomplete information (in particular, his concept of Bayesian equilibrium) and Selten's (1965) treatment of intertemporal games (in particular, his concept of subgame perfect equilibrium) – needed to be understood and digested by economists before they could make good use of game theory in their work.

In any event, the big game-theoretic applications to IO in the 1970s generally involved multiple periods and/or incomplete information; there was a flood of papers on topics such as tacit collusion by oligopolists, market entry by new firms, and limit pricing and predation by incumbent firms, all of which drew heavily on innovations by Harsanyi (1968) and Selten (1965) (who both shared the 1994 Nobel with Nash).

By the early 1980s, game theory had been such a success in industrial organization that it started being used in political economy, international economics, finance, and other areas of economic theory. And at the close of that decade, there was scarcely a self-respecting economics department that didn't offer game theory as an important component of its curriculum.

Industrial organization and game theory together led a revolution in economics. I am truly delighted that there is now a *Handbook* devoted to this transformative partnership.

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Eric Maskin
Adams University Professor
Harvard University

