Scientific Research Publishing

American Journal of Industrial and Business Management, 2026, 16(11), 1602-1609
https://www.scirp.org/journal/ajibm
ISSN Online: 2164-5175
ISSN Print: 2164-5167

Equilibrium in an Oligopolistic Market: The Microeconomic Basement of Game Theory

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How to cite this paper: Befio, P. E. (2026). Equilibrium in an Oligopolistic Market: The Microeconomic Basement of Game Theory. *American Journal of Industrial and Business Management, 16,* 1602-1609.
https://doi.org/10.4236/ajibm.2026.1611078

Received: October 16, 2026
Accepted: November 22, 2026
Published: November 25, 2026

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Abstract

Game Theory is the study of rational choice in interactive decision problems. It was first formally introduced into economics by John Von Neumann. The objective of this work is to find the microeconomic foundations of game theory using the principle of equilibrium in an oligopolistic market. In order to reach that, we used Cournot model (non-competition), which can lead to long-run equilibrium where firms earn positive profits if they can coordinate prices and Bertrand model (price competition with product homogeneity) that occurs in collaborative market or when firms face price leader. The result of this work allowed us to show that the game theory find obviously its basement in micro-economic principle, it is the tool that is mainly used in imperfect competition, especially in the oligopolistic market to analyze firms' behavior through the way they make their decision. It has proved to be a significant tool for both normative and descriptive research on collective action problems. The contribution of this work is to enlighten the theoretical relationship between micro-economics and game theory (Mankiw, 2020).

Keywords

Equilibrium, Micro Economy, Game Theory, Decision

1. Introduction

Game Theory is the study of rational choice in interactive decision problems. It has proved to be a significant tool for both normative and descriptive research on collective action problems. It was first formally introduced into economics by John Von Neumann. In its beginning, it was used for studying strategic aspects during the Cold War and it has later been successfully applied to several scientific fields such as biology. A central aspect that has emerged is that for collective and

individual interests to align, coordination is sometimes sufficient, but sometimes genuine cooperation is necessary.

A game is a formal representation of a situation in which a number of individuals interact in a set of strategic interdependence. By that, we mean that each individual's welfare depends not only on her own actions but also on the actions of the other individuals (Mass-Colell et al., 1995). A game is composed of players, rules, outcomes and payoffs. In economics, especially in microeconomics, the idea of a game is mostly found in an Oligopolistic market. In an oligopolistic market, a firm sets price or output based partly on strategic considerations regarding the behavior of its competitors. At the same time, competitors' decisions depend on the first firm's decision. Game theory is also applied in market analysis by predicting consumer behavior, competition and market dynamics; it's also applied in auctions and bidding, resource allocation and international relations.

Game theory has rich theoretical frameworks such as the role of rationality in strategic decision making and how it influences outcomes; the distinction between cooperative games (collaborations) and non-cooperative games (competition); game theoretic models of game theory itself: Nash equilibrium, iterated game theory and other extensions.

Therefore, in economics does game theory find its basement in microeconomics? To answer this question, we will try in this paper to find the microeconomic basis of game theory using the principle of equilibrium in an oligopolistic market. Two models will help us to achieve this: Cournot model (non-competition) and Bertrand model (price competition with product homogeneity).

2. Literature Review

2.1. Overview

In macroeconomic terms, equilibrium emerges as firms collectively seek a balance between efficiency and profit maximization (Arrow, 1970). For example, when a firm sets its price, others must either follow, respond, or exit the market—creating a stable state where each firm's profit is maximized while considering others' actions. This equilibrium reflects the interplay of incentives: firms may lower prices to gain market share, but this reduces their own profits, highlighting a tension between self-interest and collective welfare.

The Nash equilibrium, a cornerstone of game theory, explains how oligopolists adjust prices and output to align their strategies. For instance, if one firm sets a price below the market equilibrium, it may undercut competitors, reducing demand. This retaliation leads to a new equilibrium where prices rise, but the outcome depends on the initial conditions and rival behaviors. Unlike perfect competition, where prices adjust to marginal costs, oligopolies often exhibit non-zero-sum outcomes: firms benefit from coordination, even if it reduces individual profit.

Collusion, the formation of cartels or price-fixing agreements—represents a strategic equilibrium that can stabilize markets in certain contexts. Theoretically,

collusion reduces prices and increases output, but empirical evidence (e.g., the 2020 U.S. Department of Labor case of the Uber-Hertz agreement (Department of Labor, 2020)) shows that even well-intentioned collusion can lead to deadweight loss, as firms exit due to higher costs or reduced competition. However, in oligopolies, collusion often arises from trust or barriers to entry, making it a less efficient outcome compared to competitive markets.

Equilibrium in oligopolistic markets shapes macroeconomic outcomes. For example, the "competitive equilibrium" concept illustrates how firms optimize for profits while absorbing fixed costs, often leading to suboptimal resource allocation. However, the pursuit of equilibrium can result in inefficiencies: the "monopoly equilibrium," where a dominant firm captures all surplus, stifling innovation. Conversely, the "oligopoly equilibrium" may yield a stable but less efficient market structure, balancing competition with cooperation (Pindyck & Rubinfeld, 2010).

2.2. Cournot Model

Recall that in the Cournot model, each firm must decide how much to produce and the two firms make their decisions at the same time. When making its production decision, each firm takes its competitor into account. It knows that its competitor is also deciding how much to produce, and the market price will depend on the total output of both firms. The idea is that each firm treats the output level of its competitor as fixed when deciding how much to produce.

2.3. The Bertrand Model: Price Competition with Homogeneous Product

The Bertrand model was developed in 1883 by a French economist, Joseph Bertrand. Like the Cournot model, it applies to firms that produce the same homogeneous good and make their decisions at the same time. In this case, however, the firms choose prices instead of quantities. As we will see in the following, this change can dramatically affect the market outcome.

3. Methods and Materials

3.1. Cournot Model

Representation of the game

The game in the Cournot model like other games is described with the following components, the players, the rules and the outcome.

1) Players

In this game we have two players, Firm 1 and Firm 2.

2) Rules

Each firm produces a homogeneous product and knows the market demand curve. Also each firm takes its competitor's decision in account in order to make its own decision.

3) Firms strategy

Suppose our two Firms (duopolists) face the following market demand curve:

$$P = 30 - Q \quad (1)$$

With $Q = q_1 + q_2$

Suppose that both firms have fixed cost **C** and zero marginal cost:

$$MC1 = MC2 = 0$$

Using the marginal revenue of each Firm, we can find their respective strategy function (reaction curve).

Firm1's strategy function: $q_1 = 15 - \frac{1}{2}q_2$

Firm 2's strategy function: $q_2 = 15 - \frac{1}{2}q_1$

Table 1. Cournot model, formal form of the game.

	Firm 2	**Firm 2**
Firm 1	(15, 0)	(10, 50)
Firm 1	(0, 30)	(10, 10)

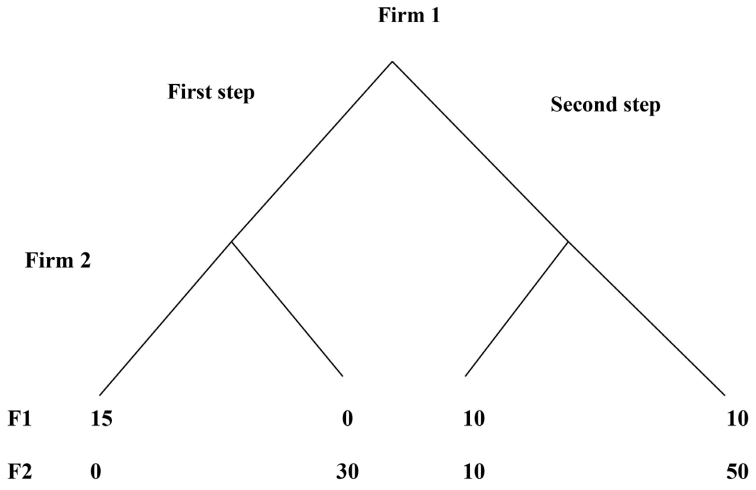


Figure 1. Extension game's form for Cournot model.

3.2. The Bertrand Model

To explain the Bertrand model of game, we follow the same pattern as the Cournot model (Narahari, 2012).

Representation

1) Players

We still have two players: Firm 1 and Firm 2

2) Rules

Each firm produces a homogeneous product. Both firms make their decision at the same time and fix their own prices, knowing the demand market curve.

3) Model characteristics

- **Assumptions**

- Firms can simultaneously produce at any level (no production restrictions);
- Productions are homogeneous;
- Firms have no market power;
- Firms aim to maximize their profit.

- **Keys features**

- First mover advantage (sequential model);
- Price discrimination;
- Saturation point.

- **Strategic behavior**

- Firms compete on quantity, not prices, leading to collusion;
- Price wars;
- Revenue maximization.

- **Limitations**

- Assumes zero competition, which is unrealistic;
- Ignores product differentiation;
- Does not account for non-price competition.

4) Model characteristics

- **Assumptions**

- Firms compete on price, with no product differentiation;
- Products are semi-specialized;
- Firms can produce at any quantity (no price constraints);

- **Keys features**

- First mover advantage (sequential model) ;
- Price wars;
- Zero-supply dynamics;
- Product differentiation.

- **Strategic behavior**

- Price competition;
- Pull strategy;
- Zero-profit pricing.

- **Limitations**

- Assumes constant costs, ignoring economies of scale;
- Ignores non-price effects;
- Product may be fine-tuned, making perfect differentiation impractical.

5) Strategy

Consider the above market demand curve:

$$P = 30 - Q$$

where $Q = q_1 + q_2$ is again total production of a homogeneous good. This time, however, we will assume that both firms have a marginal cost of \$3:

$$\text{MC1} = \text{MC2} = \$3$$

Using all these information,

$q_1 = 12 - \frac{1}{2} q_2$, **Firm 1 strategy**

$q_2 = 12 - \frac{1}{2}q_1$, **Firm 2 strategy**

We assume that in the standard Bertrand model firms select prices rather than quantities and according to the same marginal cost rule ($MC_1 = MC_2 = 3$ and the homogeneous product rule then the equilibrium price should be $p_1 = p_2 = 3$. Moreover, suppose the market demand is equal then the market demand for both firms is 13.5.

Table 2. Formal game's form for Bertrand model.

	Firm 2	**Firm 2**
Firm 1	(15, 0)	(9, 9)
Firm 1	(0, 30)	(13.5, 13.5)

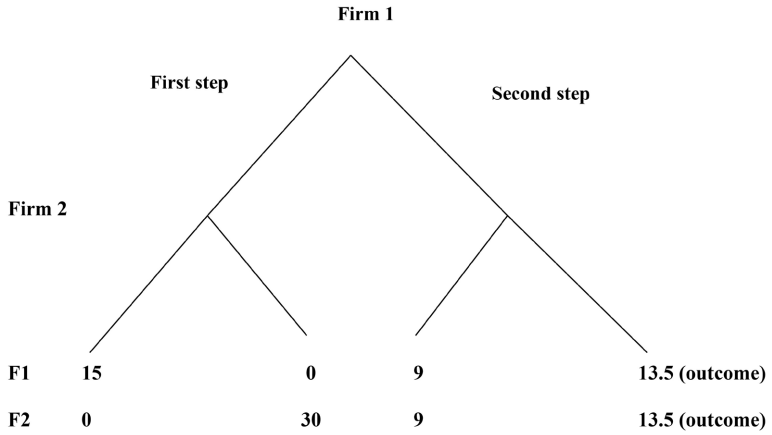


Figure 2. Extension form for Bertrand model.

3.3. Key Difference

Table 3. Comparison between Cournot model and Bertrand model.

Aspect	**Cournot model**	**Bertrand model**
Market structure	Fixed quantity	Flexible quantity
Price behavior	Constant prices (market mechanism)	Dynamic pricing based on Supply/demand (market clear)
Elasticity of demand	Typically inelastic (prices are less responsive)	Can be elastic (prices highly responsive)
Strategic use	Price coordination (collusion)	Competitive pricing (price wars, differentiation)
Long term dynamic	Predictable market equilibrium	Potential for market allocation or innovation

This part highlights the main differences between the Cournot and Bertrand models in terms of market structure, pricing behavior, demand elasticity, and strategic implications. Under the Cournot model, firms compete by setting fixed output

quantities, while prices are determined by market conditions. This approach generally results in relatively inelastic demand, as consumers are less responsive to price changes. It may also encourage price coordination among firms and lead to a more predictable market equilibrium in the long run. In contrast, the Bertrand model focuses on price competition, with firms adjusting their prices in response to supply and demand. This creates greater flexibility in pricing and allows demand to be more elastic, making consumers more sensitive to price differences. As a result, competition under the Bertrand model is more likely to involve price adjustments and differentiation, potentially leading to better market allocation and greater opportunities for innovation.

4. Results and Discussion

Recall that the Cournot equilibrium is an example of Nash-equilibrium; therefore, it is sometimes called Cournot Nash-equilibrium. In our case, this equilibrium is feasible when,

$q_1 = q_2 = 10$ (As shown in Table 1 and Figure 1).

In the case of price competition, the market is clear in terms of Cournot when both firms choose output simultaneously by the amount of $q_1 = q_2 = 9$. The market price is \$12, so that each firm makes a profit of \$81.

What is the Nash equilibrium in this case is when both firms set price equal to marginal cost:

$P_1 = P_2 = \$3$. Then industry output is 27 units, of which each firm produces 13.5 units. And because price equals marginal cost, both firms earn zero profit. This is Nash equilibrium because when we suppose Firm 1 raised its price, it would then lose all of its sales to Firm 2 and therefore be no better off. If, instead, it lowered its price, it would capture the entire market but would lose money on every unit it produced; again, it would be worse off. Therefore, Firm 1 (and likewise Firm 2) has no incentive to deviate: It is doing the best it can to maximize profit, given what its competitor is doing.

To better understand the Cournot model, suppose two firms that produce a homogeneous good and know the market demand curve. Considering the decision of Firm 1, suppose it thinks that Firm 2 will produce nothing. In that case, Firm 1's demand curve is the market demand curve, which means the demand curve for Firm 1, assuming Firm 2 produces zero. We have assumed that Firm 1's marginal cost MC1 is constant and its profit-maximizing output is 50 units, the point where MR1 (0) intersects MC1. So if Firm 2 produces zero, Firm 1 should produce 50. Suppose, instead, that Firm 1 thinks Firm 2 will produce 50 units. Then Firm 1's demand curve is the market demand curve shifted to the left by 50. Firm 1's profit-maximizing output is now 25 units, the point where MR1 (50) = MC1. Now, suppose Firm 1 thinks that Firm 2 will produce 75 units. Then Firm 1's demand curve is the market demand curve shifted to the left by 75. Firm 1's profit-maximizing output is now 12.5 units, the point where MR1 (75) = MC1. Finally, suppose Firm 1 thinks that Firm 2 will produce 100 units. Then Firm 1's demand and marginal revenue curves would intersect its marginal cost curve on

the vertical axis (if represented on a graph); if Firm 1 thinks that Firm 2 will produce 100 units or more, it should produce nothing. We can do the same thing for Firm 2 to assume how much it will produce according to different assumption.

Suppose now the Cournot demand curve $P = 30 - Q$, $MC = 0$

Then $q_1 + q_2 = 10$, $Q = 20$ and $P = 10$

The Bertrand model is the benchmark non-cooperative model, at that state, each firm apply price competition, and pull strategy and zero-profit pricing strategy in their market behavior.

The firm 1 strategy is $q_1 = 12 - \frac{1}{2}q_2$ and firm 2 strategy is $q_2 = 12 - \frac{1}{2}q_1$. The market is clear at the point where $q_1 = q_2 = 13.5$ (See Table 2 and Figure 2).

The Cournot and Bertand models both capture strategic interdependence in oligopolistic markets, but differ in structure and outcome. Cournot involves coordination and potential profit maximization through competitive pricing, while Betrand highlights price wars driven by rivalry. Understanding these models helps analyze firms' strategies, predict market reactions, and design competitive tactics. Each has practical relevance in industries ranging from telecommunications to automotive (Table 3).

5. Conclusion

We can conclude that game theory is a tool used to analyze a decision-make's behavior in an uncertain situation. It is used in many sciences; however it was introduced in economics by John Von Neumann. In this paper, we found that in economics, game theory is mainly used in imperfect competition, especially in the oligopolistic market, to analyze firms' behavior through the way they make their decision. We have used the Cournot model and Bertrand model to provide evidence in different market circumstances.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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