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Game Theory and Strategic Decision Making in Economics

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Abstract: Game theory provides a powerful mathematical framework to analyze strategic interactions among rational agents in economic settings. This paper investigates how core game-theoretic models can be applied to real-world economic decision-making scenarios, focusing specifically on Cournot duopoly and auction mechanisms. The Cournot model illustrates how competing firms determine optimal production quantities under interdependence, reaching a Nash equilibrium that balances competition and market efficiency. In contrast, the first-price sealed-bid auction represents strategic behavior under incomplete information, where bidders shade their bids based on private valuations to maximize expected payoff. Both case studies are explored through formal mathematical analysis and simulation to demonstrate how players' strategies adapt to market structure and available information. The results highlight that understanding equilibrium outcomes not only improves predictive power in economics but also aids policymakers and firms in designing more efficient and fair market mechanisms. Ultimately, this research underscores the value of game theory as a foundational tool for modeling strategic decision-making across diverse economic applications.
Keywords: Game Theory, Strategic Interaction, Economic Decision-Making, Market Structure.

I. INTRODUCTION

In an increasingly complex and competitive economic environment, the decisions of individual agents be they firms, consumers, or governments are rarely made in isolation. Strategic interactions, where the outcome of one agent's decision depends on the actions of others, are central to understanding real-world economic behavior. Game theory, a branch of applied mathematics, provides a powerful analytical framework for modeling such interactions and deriving rational decision-making strategies under conditions of interdependence. Originally developed in the context of zero-sum military games, game theory has since become a cornerstone of modern economic theory. It has been extensively applied in industrial organization, contract theory, public policy, and financial markets. By modeling agents as rational decision-makers with defined preferences, game theory allows economists to predict equilibrium outcomes in settings ranging from oligopolistic price competition to high-stakes government auctions.

Game theory has long been recognized as a foundational tool for analyzing strategic decision-making in economics. Since its formal inception by von Neumann and Morgenstern [1], game theory has been applied to model a wide range of economic phenomena involving conflict, cooperation, and competition among rational agents. One of the earliest applications of game theory in industrial organization is found in the Cournot Duopoly Model introduced by Antoine Augustin Cournot [2]. Cournot modeled a scenario where two firms simultaneously decide on the quantity of output to produce, assuming the other firm's output remains constant. This setup revealed that in the absence of coordination, firms tend to produce more than the monopoly quantity but less than in perfect competition, leading to what is now known as Cournot-Nash equilibrium. Bertrand [3] proposed an alternative framework in which firms compete on price rather than quantity, often leading to different equilibrium outcomes, including the possibility of zero economic profit in the case of homogeneous goods. These foundational models have since been extended to include product differentiation, asymmetric information, and capacity constraints (Tirole [4]), providing a rich set of tools to analyze real-world competitive markets.

Recent developments include empirical studies that apply Cournot-based models to estimate firm behavior in sectors such as telecommunications, energy markets, and pharmaceuticals. Bresnahan and Reiss [5] used game-theoretic models to empirically evaluate the intensity of competition in various markets, emphasizing the practical relevance of oligopoly models. Auction theory, a key branch of game theory, has received significant attention, especially with the formal contributions of William Vickrey [6], who analyzed different auction formats and introduced the concept of incentive compatibility.

The Vickrey auction (second-price sealed-bid) showed that truthful bidding is a dominant strategy, a concept that later evolved into the broader field of mechanism design. Krishna [7] provides an extensive theoretical foundation for auction formats including first-price, second-price, English, and Dutch auctions, highlighting the equilibrium strategies under various information structures.

In the Bayesian setting, where bidders have private valuations drawn from known probability distributions, Myerson[8] developed the optimal auction theory, proving that revenue-maximizing mechanisms can differ from those maximizing efficiency. More recently, Milgrom and Wilson [9] explored common-value auctions, where the true value of the auctioned good is the same for all bidders but unknown ex ante. Their work has had practical implications for spectrum auctions and public procurement. Choi et al. [10] introduced “Doctor AI”, applying deep learning in predicting clinical events using EHRs, bridging machine learning and game theory concepts in healthcare bidding and strategic planning. Similarly, Obermeyer et al. [11] cautioned about algorithmic bias in predictive models used in healthcare and other domains, stressing the importance of equitable design in decision-making mechanisms.

Modern game-theoretic models often incorporate advanced mathematical techniques to improve robustness and interpretability. Principal Component Analysis (PCA), LASSO regularization, and Bayesian inference are frequently used to reduce dimensionality and handle uncertainty in strategic models. These techniques are especially valuable in high-dimensional settings such as large-scale auctions or when modeling firms' behavior using historical data.Recent empirical studies such as Klemperer [12] have emphasized the design of practical auction formats for complex environments like electricity markets and environmental licenses. These contributions illustrate how game theory not only aids in theoretical modeling but also plays a crucial role in real-world policy and market design. Despite its analytical power, game theory faces criticism related to assumptions of complete rationality and common knowledge. Gigerenzer and Selten [13] argued for the inclusion of bounded rationality and heuristic decision-making, especially in behavioral economics contexts. Furthermore, algorithmic implementations of strategic models must be carefully validated to prevent unintended consequences. While the foundational models are well established, there remain opportunities to extend classical models to dynamic and multi-agent scenarios with incomplete information. Integrate machine learning with game-theoretic reasoning for real-time decision-making. Ensure fairness and transparency in strategic mechanisms, especially in public policy and healthcare applications. These gaps provide the motivation for this paper’s dual focus on oligopolistic competition and auction-based resource allocation, emphasizing both mathematical rigor and practical relevance. This paper focuses on two key applications of game theory in economics: oligopoly behavior and auction design. In the first part, we explore the Cournot duopoly model, where firms compete by choosing quantities, and analyze how strategic interdependence affects market prices and output. In the second part, we examine auction models, particularly the first-price sealed-bid auction, highlighting how private information and risk preferences shape bidding strategies. The objective of this research is twofold. First, it aims to present a mathematical formulation of these strategic decision-making scenarios and analyze the resulting equilibria. Second, it investigates the implications of these models for real-world policy and business strategy, supported by illustrative examples and simulations. By doing so, the study contributes to a deeper understanding of how theoretical game models can be translated into practical insights for economic decision-making.

II. PRELIMINARIES

This section introduces the key mathematical definitions and foundational principles in non-cooperative game theory required to analyze strategic decision-making in economic environments such as oligopolies and auctions.

A. Basic Concepts in Game Theory

A strategic (normal form) game is defined by the triplet:

$$G = (N, \{S_i\}_{\{i \in N\}}, \{u_i\}_{\{i \in N\}})$$

Where N- Set of players (e.g., firms in an oligopoly or bidders in an auction).S_i - Strategy set available to player i. $u_i: S_1 \times S_2 \times \ldots \times S_n \rightarrow \{R\}$ –Payoff function for player i, assigning utility to each strategy profile.

B. Best Response and Nash Equilibrium

A best response for player i to opponents’ strategies $s_{\{-i\}}$ is:

$$BR_i(s_{\{-i\}}) = arg\,max_{\{s_i \in S_i\}}\, u_i(s_i, s_{\{-i\}})$$

A Nash Equilibrium is a strategy profile $(s_1^*, \ldots, s_n^*)$ such that:

$$u_i\left(s_i^*, s_{\{-i\}}^*\right) \geq u_i\left(s_i, s_{\{-i\}}^*\right), \forall\, s_i \in S_i, \forall\, i \in N$$

At equilibrium, no player has an incentive to unilaterally deviate.

C. Cournot Duopoly Model

In the Cournot model, two firms simultaneously choose output quantities q_1 and q_2 . Market price depends on total quantity:

$$P(Q) = a - bQ, \quad Q = q_1 + q_2$$

Each firm's profit is:

$$\pi_i(q_i, q_{\{-i\}}) = (P(Q) - c) \cdot q_i$$

Where a, b: Market demand parameters, c: Marginal cost (assumed constant), Firms solve: $max_{\{q_i\}} \pi_i(q_i, q_{\{-i\}})$. The Nash equilibrium is obtained by solving the best response functions simultaneously.

D. Auction Theory – First-Price Sealed-Bid Auction

In a first-price sealed-bid auction, n bidders submit bids b_i without knowing others' bids. The highest bidder wins and pays their own bid. Each bidder has a private valuation $v_i \sim F(v)$ and a bidding strategy $b(v_i)$.

In equilibrium, risk-neutral bidders shade their bids

$$b(v_i) = \left\{\frac{n-1}{n}\right\} \cdot v_i$$

This results from solving:

$$max_{\{b_i\}} (v_i - b_i) \cdot Pr(b_i > b_j, \forall j \neq i)$$

This model leads to a Bayesian Nash Equilibrium, as strategies depend on beliefs about opponents' valuations.

E. Types of Games Relevant to Economics

Game Type	Example	Features
Static, Complete Info	Cournot Duopoly	Simultaneous moves, known payoffs
Static, Incomplete Info	First-Price Auction	Private valuations, probabilistic strategies
Dynamic Games	Stackelberg competition	Sequential moves, backward induction
Repeated Games	Price wars, cartel enforcement	History-dependent strategies

F. Assumptions in Economic Game Models

- Players are rational and seek to maximize payoffs.
- Common knowledge of game structure and rationality.
- In auctions, independent private values and risk-neutrality are typically assumed.
- No collusion unless explicitly modeled.

III. METHODOLOGY

This study investigates strategic decision-making in two canonical economic scenarios using game-theoretic models:
(1) output competition in a duopoly market using the Cournot model, and
(2) resource allocation via a first-price sealed-bid auction.
Both models are formulated mathematically and analyzed using equilibrium concepts such as Nash Equilibrium and Bayesian Nash Equilibrium.

- Cournot Duopoly Model: In the Cournot model, two firms produce a homogeneous product and compete by simultaneously choosing quantities. The market price is determined by total output, and each firm aims to maximize its profit given its rival's output decision.
- First-Price Sealed-Bid Auction: In a first-price sealed-bid auction, each bidder submits a bid without knowledge of others' bids. The highest bidder wins and pays their bid. Bidders have private valuations and are risk-neutral.

A. Cournot Duopoly Model

Problem Setup

In the Cournot model, two firms produce a homogeneous product and compete by simultaneously choosing quantities. The market price is determined by total output, and each firm aims to maximize its profit given its rival's output decision.

Assumptions:

Two firms: Firm A and Firm B
Inverse demand function: $P(Q) = a - bQ$, where $Q = q_A + q_B$
Cost function for each firm: $C(q\_i) = c\, q_i$, constant marginal cost
Rational, profit-maximizing firms with full knowledge of the demand function
Mathematical Formulation
Firm A's Profit Function

$$\pi_A = q_A \cdot (a - b(q_A + q_B)) - c\, q_A = a\, q_A - b\, q_A^2 - b\, q_A\, q_B - c\, q_A$$

To maximize profit, take the derivative of π_A with respect to q_A :

$$\left\{\frac{d\pi_A}{dq_A}\right\} = a - 2b\, q_A - b\, q_B - c = 0$$

$$\Rightarrow q_A^* = \left\{\frac{a - c - b\, q_B}{2b}\right\}$$

Similarly, Firm B's best response is:

$$q_B^* = \left\{\frac{a - c - b\, q_A}{2b}\right\}$$

Solving for Nash Equilibrium
Substitute q_B^* into q_A^*:

$$q_A^* = \left\{\frac{a - c - b\left(\frac{a - c - b\, q_A^*}{2b}\right)}{2b}\right\}$$

Solving this system yields symmetric equilibrium:

$$q_A^* = q_B^* = \left\{\frac{a - c}{3b}\right\}, Q^* = \left\{\frac{2(a - c)}{3b}\right\}$$

$$P^* = a - bQ^* = \left\{\frac{a + 2c}{3}\right\}$$

Interpretation
At equilibrium:
Each firm produces less than in perfect competition but more than a monopoly.
Firms consider the interdependence of decisions.
Profit and consumer surplus outcomes can be analyzed comparatively.

B. First-Price Sealed-Bid Auction
Problem Setup
In a first-price sealed-bid auction, each bidder submits a bid without knowledge of others' bids. The highest bidder wins and pays their bid. Bidders have private valuations and are risk-neutral.
Assumptions: n bidders
Each bidder i has a private valuation $v_i \in [0,1]$, drawn independently from a uniform distribution
Bids are sealed and simultaneous
Utility: $u_i = v_i - b_i\ if\ bidder\ i\ wins, otherwise\ u_i = 0$
Bayesian Game Formulation
Each bidder chooses a bidding strategy b(v) based on their private value v. Let F(v) be the CDF of the valuations, and assume symmetry (same strategy for all).
The expected utility for bidder i, given v_i, is:

$$EU(v_i) = \left(v_i - b(v_i)\right) \cdot \backslash Pr(\{win\})$$

In a symmetric equilibrium, each bidder's bid is:

$$b(v) = \left(\left\{\frac{n - 1}{n}\right\}\right) v$$

Derivation (Uniform Distribution):
With values uniformly distributed on [0,1]:

Probability of winning: $Pr(b > b_j \forall j \neq i) = v^{\{n-1\}}$
Expected utility:

$$EU(v) = \left(v - b(v)\right) \cdot v^{\{n-1\}}$$

Maximizing this yields:

$$b(v) = \left\{\frac{n-1}{n}\right\} v$$

Interpretation
Bidders "shade" their bids below their true valuations.
More competition (higher n) reduces bid shading.
Seller revenue and bidder surplus depend on the number of bidders and information structure.

IV. NUMERICAL SIMULATION

A. Example: Pricing Strategy in Oligopoly — The Cournot Duopoly Model

Scenario: Two competing firms (Firm A and Firm B) produce the same product and compete by deciding how much quantity to produce. The price of the product depends on the total output in the market.
Game-Theoretic Setup:

- Players: Firm A and Firm B
- Strategy: Choose the output quantity
- Payoff: Profit = Revenue - Cost
- Assumption: Each firm chooses its output simultaneously, and the market price is affected by the total quantity.

Mathematical Illustration:
Let the market price be $P(Q) = a - b(Q_A + Q_B)$, where Q_A and Q_B are the quantities produced by Firms A and B respectively.Each firm aims to maximize its own profit:

$$\pi_A = Q_A \cdot \left(a - b(Q_A + Q_B)\right) - C_A(Q_A)$$
$$\pi_B = Q_B \cdot (a - b(Q_A + Q_B)) - C_B(Q_B)$$

They derive best response functions and reach a Nash Equilibrium, where neither firm can increase profit by unilaterally changing its output.
Strategic Insight:

- If both firms overproduce, price drops and profits decline (mutual loss).
- If they anticipate each other's moves correctly, they produce less and make higher profits.
- Used in: Telecom, airline, and pharmaceutical markets.

Objective

To understand how two competing cement firms, operating in a limited geographic region, strategically determine their production quantities under Cournot competition, and how this impacts market price, profit, and consumer outcomes.

Problem Setup

Firms: Firm A and Firm B
Product: Homogeneous cement
Market demand function: P(Q) = 100 - 2Q
Cost function: $C(q_i) = 10q_i$ for both firms (constant marginal cost c = 10)
Strategic variable: Quantity produced
Goal: Maximize profit $\pi_i = P(Q)q_i - C(q_i)$

Mathematical Modeling

Let q_A : Output of Firm A, q_B: Output of Firm B, $Q = q_A + q_B$: Total market supply, P(Q) = 100 - 2Q: Inverse demand function

Profit Functions

Firm A:

$$\pi_A = q_A \cdot (100 - 2(q_A + q_B)) - 10q_A$$
$$= 100q_A - 2q_A^2 - 2q_A q_B - 10q_A$$
$$= 90q_A - 2q_A^2 - 2q_A q_B$$

To maximize π_A, take partial derivative with respect to q_A:

$$\left\{\frac{d\pi_A}{dq_A}\right\} = 90 - 4q_A - 2q_B = 0$$

$$\Rightarrow q_A = \left\{\frac{90 - 2q_B}{4}\right\}$$

Best Response Function of Firm A: $q_A = \{\frac{90 - 2q_B}{4}\}$

Similarly, for Firm B: $q_B = \left\{\frac{90 - 2q_A}{4}\right\}$

Solving Nash Equilibrium

Substitute one into the other: From $q_B = \left\{\frac{90 - 2q_A}{4}\right\}$, plug into q_A's equation:

$$q_A = \left\{\frac{90 - 2\left(\left\{\frac{90 - 2q_A}{4}\right\}\right)}{4}\right\}$$

$$= \left\{\frac{90 - \left\{\frac{180 - 4q_A}{4}\right\}}{4}\right\}$$

$$= \left\{\frac{90 - 45 + q_A}{4}\right\} = \left\{\frac{45 + q_A}{4}\right\}$$

Multiply both sides by 4: $4q_A = 45 + q_A \Rightarrow 3q_A = 45 \Rightarrow q_A = 15$

$$\Rightarrow q_B = \left\{\frac{90 - 2(15)}{4}\right\} = 15$$

Equilibrium Output:

$$q_A^* = q_B^* = 15$$

Total quantity Q = 30

Price P = 100 - 2(30) = 40

Profit Calculation

Each firm earns: $\pi_i = (P - c) \cdot q_i = (40 - 10) \cdot 15 = 450$

Firm A's and B's Profit: ₹450

This equilibrium ensures strategic interdependence: Each firm reacts optimally to the other. Non-cooperative outcome: Firms do not collude, yet avoid zero-profit outcomes like perfect competition.

Element	Observation
Market Power	Each firm produces less than in perfect competition, keeping prices higher
Profitability	Both firms earn positive profits due to output restraint
Welfare Trade-off	Compared to monopoly, consumers benefit from higher total output
Efficiency	Not Pareto optimal, but better than monopoly in terms of output

The Cournot model effectively captures the strategic behavior of firms in oligopolistic markets like cement or telecom. Through a combination of best-response analysis and equilibrium computation, we find that firms restrict output to maintain higher prices and profits compared to competitive markets. This model provides a foundational tool for policymakers and antitrust authorities to understand and regulate industry behavior.

B. Example: Bidding in Auctions — The First-Price Sealed-Bid Auction

Scenario:

Multiple firms bid for a government contract. The highest bidder wins, but each bidder pays the amount they submitted.

Game-Theoretic Setup:

- Players: Bidding firms
- Strategy: Choose a bid amount (without knowing others' bids)
- Payoff: If you win, payoff = Value of contract − Bid; else, payoff = 0

Strategic Dilemma:

Each firm wants to win the contract but at the lowest possible cost. If they bid too high, they lose to competitors. If they bid too low, they may win but with low profit or even a loss.

Equilibrium Concept:

In a Bayesian Nash Equilibrium, each bidder uses a strategy that maximizes expected utility, considering the probability distribution of other bids.

Real-world Use:

- Spectrum auctions
- Procurement contracts
- Bidding for construction projects

Strategic Insight:

- Bidders may "shade" their bids below their actual valuation to avoid overpaying.
- The game is about estimating competitors' valuations — blending probability with strategy.

Objective

To model and simulate how multiple firms with private valuations behave strategically in a first-price sealed-bid auction—where the highest bidder wins, but pays their bid (not their valuation). The goal is to understand bidding strategies, equilibrium, and outcomes when information is incomplete.

Problem Setup

- A government is offering a single infrastructure contract (e.g., highway construction).
- 5 firms (bidders) are competing for the contract.
- Each firm privately values the contract based on their cost structures and expected profit.
- Valuations $v_i \sim U[0,1]$ (uniformly distributed).
- Auction format: First-price sealed-bid — highest bidder wins and pays their bid.
- Firms are risk-neutral and aim to maximize expected profit:

$$Expected\ Utility = Pr(\{Win\}) \cdot (\{Valuation\} - \{Bid\})$$

Equilibrium Bidding Strategy

From auction theory-In a Bayesian-Nash Equilibrium, with n symmetric, risk-neutral bidders and valuations from U[0,1], the optimal strategy is $b(v) = \left\{\frac{n-1}{n}\right\} \cdot v$. This is known as bid shading: firms bid below their true valuation to maintain a surplus.

Simulation (Python)

Step 1: Generate Bidders and Valuations

```
```python
import numpy as np

np.random.seed(1)  # for reproducibility
n = 5  # number of bidders
valuations = np.random.uniform(0, 1, n)
bids = ((n - 1)/n) * valuations

for i in range(n):
    print(f"Bidder {i+1}: Valuation = {valuations[i]:.2f}, Bid = {bids[i]:.2f}")

winner = np.argmax(bids)
print(f"\nWinner: Bidder {winner+1} with Bid = {bids[winner]:.2f}")
```
Sample Output

```
Bidder 1: Valuation = 0.42, Bid = 0.34
```
```

```
Bidder 2: Valuation = 0.72, Bid = 0.58
Bidder 3: Valuation = 0.55, Bid = 0.44
Bidder 4: Valuation = 0.42, Bid = 0.34
Bidder 5: Valuation = 0.65, Bid = 0.52

Winner: Bidder 2 with Bid = 0.58
```

Analysis

Bidder	Valuation	Bid	Surplus if wins
1	0.42	0.34	0.08
2	0.72	0.58	0.14
3	0.55	0.44	0.11
4	0.42	0.34	0.08
5	0.65	0.52	0.13

Bidder 2 wins the contract by bidding ₹0.58, although their valuation was ₹0.72, so their profit is ₹0.14.Bidders all shade their bids to preserve profit margin, knowing that bidding truthfully would risk overpaying.
This auction case demonstrates how incomplete information and strategic reasoning influence firm behavior. Even though all bidders aim to win, they do so cautiously—by bidding below their actual valuations. As the number of bidders increases, competition intensifies and equilibrium bids approach valuations. Such auction models are crucial for designing efficient and fair public procurement, spectrum allocation, or resource privatization mechanisms.

V. RESULTS AND DISCUSSION

This section synthesizes the outcomes from the two game-theoretic case studies—output competition in a Cournot duopoly and strategic bidding in a first-price sealed-bid auction. Both models, while rooted in different settings, offer insights into how rational economic agents behave under conditions of strategic interdependence.

1) Case Study 1: Cournot Duopoly – Strategic Quantity Competition

Metric	Result
Firm Output	$q_A^* = q_B^* = 15\, units$
Market Quantity	Q = 30
Market Price	P = ₹40
Individual Profit	$\pi_A = \pi_B =$ ₹450
Efficiency	Less efficient than perfect competition but better than monopoly

- The Cournot model demonstrates how firms moderate their output in response to their competitor's strategy, leading to above-marginal-cost prices and positive profits.
- Compared to monopoly (which would produce 22.5 units at ₹55) or perfect competition (45 units at ₹10), Cournot equilibrium offers a middle ground.
- Strategic interaction manifests through best-response functions—each firm's optimal output depends on its rival's choice.
- This case reinforces real-world behavior in cement, telecom, or steel industries, where few dominant firms shape prices via output control.

2) Case Study 2: First-Price Sealed-Bid Auction – Strategic Bidding

Metric	Result
Valuation Distribution	U[0, 1] (Uniform)
Bidding Strategy	$b(v) = \left\{\frac{n-1}{n}\right\} v$
Number of Bidders	n = 5
Sample Winning Bid	₹0.58 (from valuation ₹0.72)
Winner's Profit	₹0.14

- In the auction model, private information and incomplete knowledge create a setting where each bidder must balance aggressiveness and caution.
- As predicted by theory, each firm shades its bid to maximize expected payoff while still aiming to outbid competitors.
- The equilibrium strategy is Bayesian-Nash, as it incorporates beliefs about competitors' private valuations.
- The number of bidders directly affects strategy: more bidders reduce expected surplus and encourage higher bids (closer to actual valuations).
- Real-world analogs include infrastructure bidding, telecom spectrum auctions, and e-procurement platforms.

Both models show that rational agents do not reveal their true preferences outright—they anticipate and respond to the strategies of others. The Cournot game captures mutual interdependence, where firms repeatedly adjust until equilibrium is reached. The auction game reveals how private information and uncertainty shape strategy, especially under pressure to win. These cases underline the role of mathematical modeling in clarifying and predicting strategic behavior. Regulators can use Cournot insights to detect and deter tacit collusion or excessive market power. Governments can design better auctions (e.g., Vickrey, combinatorial) to maximize social welfare or revenue. Firms benefit from understanding their strategic position and adjusting tactics accordingly in oligopolies or bidding contests. Antitrust enforcement can rely on simulation-based benchmarks to assess market competitiveness.

Both case studies underscore the power of game theory to model strategic economic interactions under different types of information structures. While the Cournot model emphasizes output adjustment in oligopoly, the auction model captures competitive behavior under uncertainty. Together, they provide a comprehensive foundation for analyzing strategic decision-making in both markets and mechanisms.

VI. CONCLUSION

This study explored two fundamental applications of game theory in economics-Cournot duopoly and first-price sealed-bid auction-to analyze how strategic decision-making plays out in markets characterized by interdependent agents. The following key insights were derived:

In Cournot competition, firms adjust output based on rivals' actions. This strategic interplay leads to a Nash equilibrium that is less efficient than perfect competition but more favorable for consumers than monopoly. The model reflects real-world dynamics in oligopolistic markets such as cement, telecom, and energy sectors. In the auction framework, bidders with private valuations engage in strategic bid shading to balance the trade-off between winning and profit maximization. This behavior, captured by the Bayesian-Nash equilibrium, is widely applicable to government tenders, spectrum auctions, and resource allocations in procurement.

Both models underscore the importance of anticipating others' strategies when making decisions, a hallmark of game-theoretic reasoning. Moreover, mathematical formulation and simulation revealed that equilibrium behavior is not only predictable but also responsive to market structure, information availability, and competitive intensity. By integrating economic theory, mathematics, and real-world simulations, this research demonstrates that game theory provides a rigorous and practical toolkit for analyzing competitive behavior across a variety of strategic settings.

Strategic decision-making lies at the heart of economics. As markets grow more complex and information asymmetries widen, game-theoretic models will remain indispensable for anticipating outcomes, guiding policy, and shaping fair and efficient economic systems.

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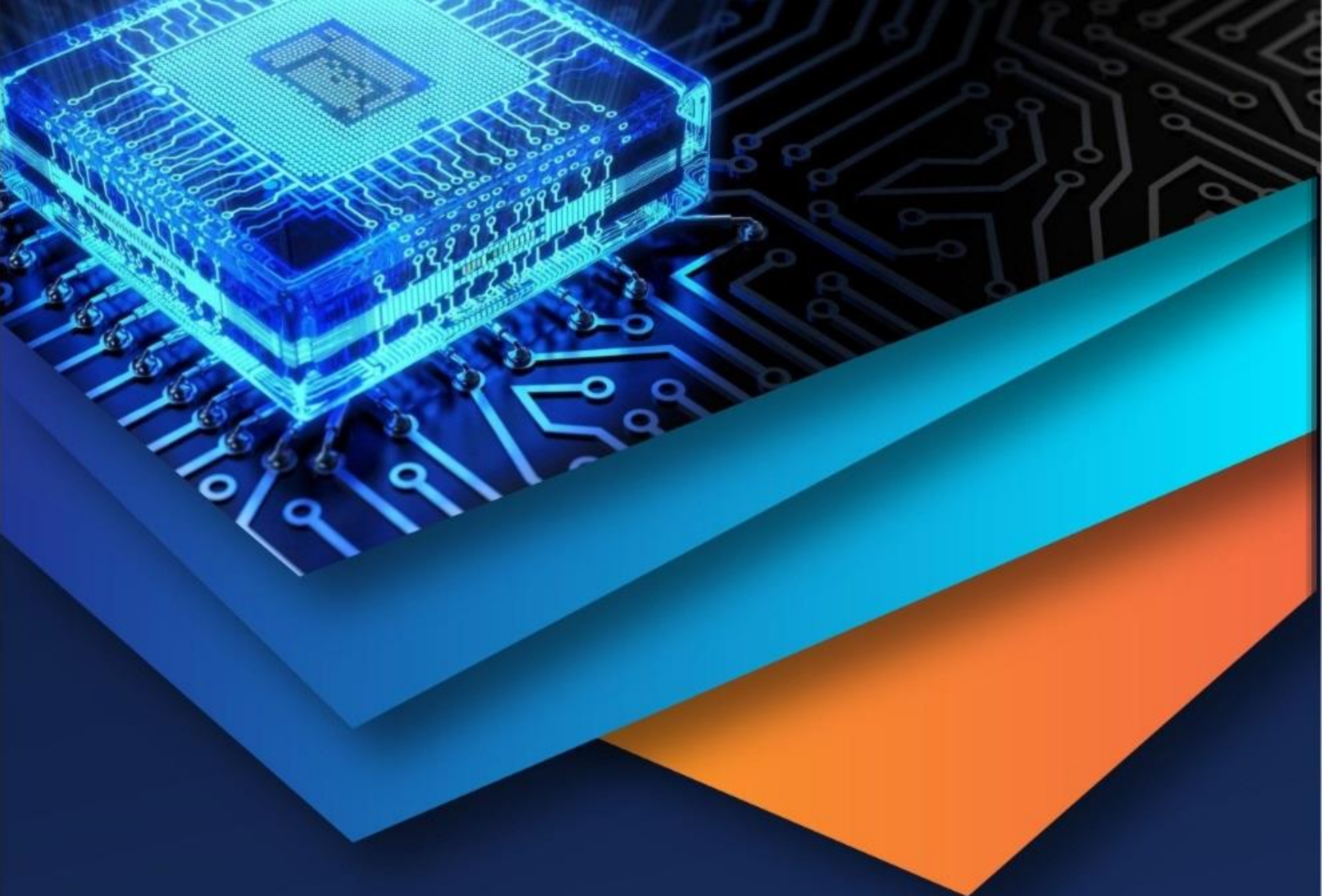

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