

A Game-Theoretic Thought Experiment on Oligopoly Pricing Strategies

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Abstract. This paper employs game-theoretic methods and constructs a series of thought experiments to analyze how firms set prices in oligopolistic markets and what outcomes ultimately emerge. It first introduces classical models of oligopolistic competition, such as the Cournot, Bertrand, and Stackelberg models. However, since real-world firm behavior is influenced by information asymmetry, forecasting biases, and strategic interactions, traditional models fail to adequately capture actual market dynamics. Therefore, the paper designs several typical thought experiments—such as price war scenarios, tacit collusion scenarios, and signaling scenarios—to simulate firms' optimal response strategies under different information structures and decision sequences. The results of these experiments are analyzed using game-theoretic concepts like Nash equilibrium and sequential equilibrium. The study finds that when information is fully symmetric and the game is repeated, oligopolistic firms are more likely to achieve implicit collusion and thereby earn higher profits. In contrast, under conditions of information asymmetry or one-shot games, price competition becomes more intense, prompting firms to adopt aggressive low-price strategies to capture market share. Additionally, the paper discusses how firm reputation, retaliation capacity, and market entry barriers influence pricing strategies, arguing that these factors significantly affect equilibrium outcomes and thus alter overall market welfare. The paper contends that thought experiments, as a method combining theoretical modeling with logical reasoning, can address the limitations of traditional mathematical models in explaining dynamic strategic interactions, offering new insights into the strategic behavior of oligopolistic firms. Finally, it suggests that future research could integrate behavioral economics and empirical data to further test the validity of the pricing mechanisms proposed in these thought experiments in real-world settings, and explore how regulatory policies might reshape the game structure to deter tacit collusion and promote fair competition. This research contributes to enriching the application of game theory in industrial organization and offers valuable implications for government antitrust policy formulation and corporate competitive strategy development.

Keywords: Game theory, Oligopoly pricing, Thought experiment, Nash equilibrium, Strategic interaction.

1. Introduction

Under today's market economy system, an oligopolistic market represents a market structure intermediate between perfect competition and pure monopoly, commonly found in industries such as telecommunications, internet platforms, aviation, and petrochemicals. According to the "China Competition Policy Implementation Report" released by the State Administration for Market Regulation from 2019 to 2023, market concentration in sectors including internet platforms, mobile communications, and civil aviation has been continuously increasing. The combined market share of the top four firms typically exceeds 60%, clearly exhibiting characteristics of oligopolistic competition. In such a market environment, pricing decisions of a few dominant firms influence each other and also affect consumer welfare and market efficiency. Although traditional oligopoly theories include classic models such as the Cournot and Bertrand models, these models rely on relatively stringent assumptions and are inadequate in explaining complex real-world issues such as incomplete information, dynamic changes, and strategic interactions. Game theory serves as a mathematical tool for analyzing strategic interactions and plays a crucial role [1] in understanding the pricing behaviors of oligopolistic firms. Meanwhile, thought experiments—by constructing idealized decision-making scenarios—can logically illustrate how different game structures influence firms' strategic choices. This paper attempts to integrate game-theoretic tools with the method of thought experiments,

designing various typical game scenarios under specific conditions to analyze the optimal pricing strategies adopted by oligopolistic firms under different information structures, decision sequences, and market environments. By doing so, it offers new insights into real-world issues such as price competition, tacit collusion, and strategic entry, providing valuable references for government antitrust regulation and corporate competitive strategies.

2. Game Theory and the Theoretical Foundation of Oligopolistic Markets

2.1 Basic Concepts and Classification of Game Theory

Game theory is a mathematical framework that studies how rational decision-makers choose optimal actions in strategic interactions, primarily focusing on equilibria achieved when one's payoff depends not only on one's own choices but also on the choices of others. Based on the timing of decisions made by participants, games can be classified into static and dynamic games. Static games involve simultaneous decisions or sequential decisions where later players cannot observe earlier ones' actions, while dynamic games involve sequential decisions where later players can observe previous strategies. Games can also be categorized as either complete information or incomplete information games. In complete information games, all participants fully understand the game rules, payoff functions, and all possible strategies; in incomplete information games, some information remains private [2]. The Nash equilibrium is the most fundamental solution concept in game theory, representing a situation where each player chooses the strategy that maximizes their own payoff given the strategies chosen by others. In the context of oligopoly pricing, firms act rationally, taking into account potential reactions from competitors when setting prices or output levels—this is precisely what game theory analyzes and forms the foundation for understanding oligopolistic pricing behavior.

2.2 Characteristics and Competition Patterns of Oligopolistic Markets

The essence of an oligopolistic market lies in the presence of only a few firms, each of whose actions significantly affect the others, resulting in strong strategic interdependence. According to the "China Industrial Development Report" released by the Ministry of Industry and Information Technology from 2020 to 2023, in strategic emerging industries such as telecommunications equipment manufacturing, integrated circuit design, and new energy vehicles, the top five firms collectively hold more than 50% of the market share. This indicates intense competition among companies within these sectors, requiring firms to carefully consider how their rivals' actions impact them. In oligopolistic markets, competition typically takes three forms: price competition, output competition, and product differentiation. Among these, price competition is the most intense—sometimes even driving prices below marginal cost. Output competition involves influencing prices by adjusting production levels, while product differentiation enables firms to gain competitive advantages [3] through non-price factors such as quality, brand, and service. Due to high barriers to entry and long-term interactive relationships among firms, oligopolists simultaneously seek to capture market share through price competition while also pursuing tacit collusion to maintain higher prices and earn substantial profits. This coexistence of competition and cooperation makes oligopolistic pricing complex and dynamic, necessitating analysis through game theory.

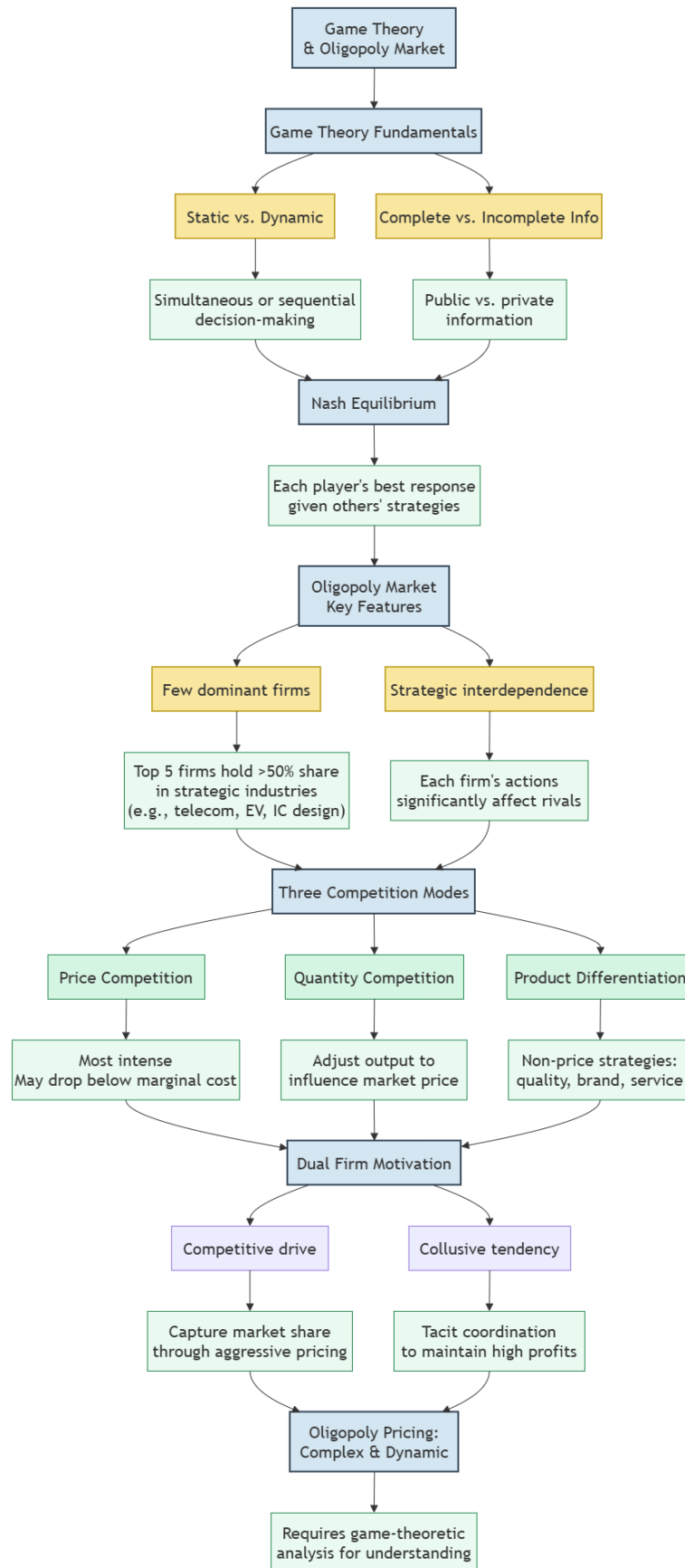


Figure 1. Framework of the Relationship between Oligopoly Market Characteristics and Competitive

2.3 Game-Theoretic Analysis Framework for Oligopoly Pricing Strategies

To study oligopoly pricing using game theory, a complete game model must be established, encompassing the set of players, strategy spaces, payoff functions, and information structures. In a typical oligopoly pricing game, the players are firms in the market; the strategy space consists of firms' choices regarding price or output levels; the payoff function is generally firm profit—total revenue minus total cost; and the information structure reflects each firm's knowledge about market demand, competitors' costs, and past actions. Depending on the decision variables, analytical approaches can be divided into price competition models and quantity competition models. The former assumes firms directly set prices while quantities are determined by the market, whereas the latter assumes firms choose quantities and prices are then determined by the market. Based on timing differences, games can also be categorized as simultaneous or sequential. In simultaneous games, firms make decisions at the same time or without knowledge of rivals' choices, while in sequential games, there is a clear order [4] of moves. Moreover, the repetition of the game affects pricing strategies: in one-shot games, firms typically aim to maximize short-term profits, whereas in infinitely repeated games, implicit cooperation becomes possible through trigger strategies that punish deviations from cooperative behavior. This analytical framework not only incorporates classical models such as Cournot, Bertrand, and Stackelberg but also provides a platform for incorporating factors like asymmetric information, bounded rationality, and reputation, serving as a theoretical tool for understanding the complexity of oligopolistic pricing.

3. Game Model Construction of Oligopoly Pricing Strategy

3.1 Quantity Competition Game under the Cournot Model

The Cournot model is the most classic output competition model in oligopoly theory. It assumes that two or more firms simultaneously decide their production levels, while market price is determined by the total output through the demand function. Each firm chooses its output level based on its competitors' outputs to maximize its own profit. In this static game, firms' strategies are output quantities rather than prices, and the equilibrium is a Nash equilibrium—each firm's output is an optimal response to the outputs of the other firms. Taking a duopoly market as an example, if the market demand function is linear and both firms have identical marginal costs, solving each firm's best-response function and finding their intersection yields the Cournot equilibrium output and the corresponding market price [5]. A key feature of the Cournot equilibrium is that the equilibrium output lies between monopoly and perfectly competitive levels, and the equilibrium price is above marginal cost but below the monopoly price. This indicates that oligopolistic competition achieves neither full market efficiency nor maximum monopoly profits. The model effectively explains issues such as OPEC's output decisions and capacity planning in the home appliance manufacturing industry, where firms must determine production scale in advance and cannot adjust it quickly in the short term, making output competition the dominant form of rivalry. However, the Cournot model assumes simultaneous decision-making and a single round of play, ignoring the effects of timing and repeated interactions on firms' strategies, leaving ample room for further research.

3.2 Price Competition Game under the Bertrand Model

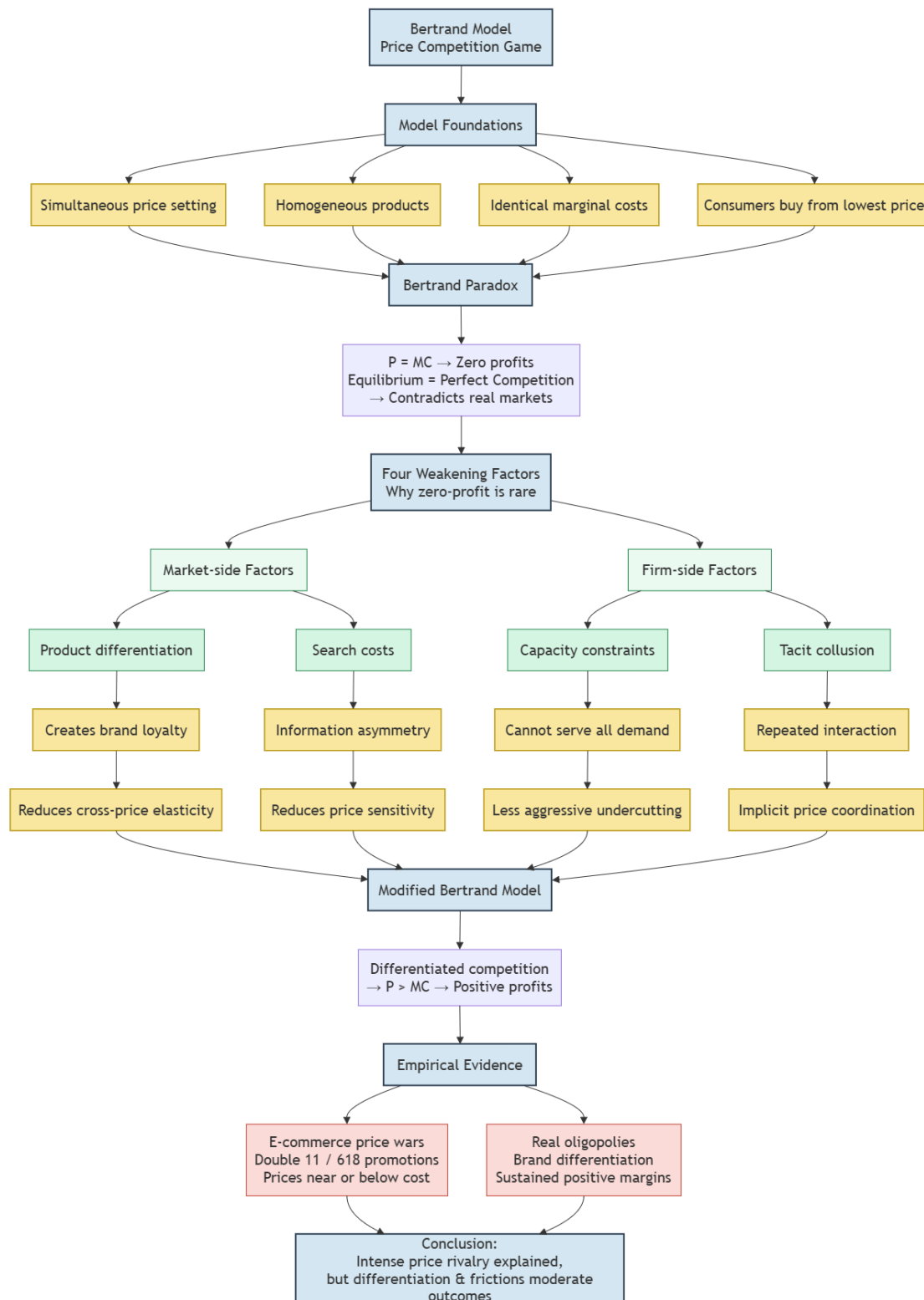


Figure 2. Bertrand Model Price Competition Game Mechanism

The Bertrand model primarily examines competition among oligopolistic firms based on price. In this model, firms simultaneously set prices for their products, and consumers choose which firm to buy from based on the lowest price. The firm with the lower price captures the entire market; if prices are equal, the market is shared equally. Under conditions of perfectly homogeneous products and identical marginal costs across firms, the Bertrand paradox shows that the unique Nash equilibrium occurs when both firms set their prices equal to marginal cost—resulting in a market outcome

identical to perfect competition, where firms earn no excess profits [6]. This paradox highlights the intensity of price competition: any firm charging above marginal cost will lose all its customers to competitors offering slightly lower prices, driving prices down until they reach marginal cost. In recent years, price wars on Chinese e-commerce platforms have served as an example of the Bertrand model. According to iResearch's "China E-Commerce Market Competition Report" (2021–2023), mainstream e-commerce platforms frequently offer price subsidies during promotional events such as Singles' Day, with some product prices approaching or even falling below cost. However, in reality, the zero-profit scenario described by the Bertrand paradox rarely occurs in oligopolistic markets. Factors such as product differentiation, capacity constraints, consumer search costs, and implicit collusion between firms reduce the intensity of price competition. When product differentiation is introduced, firms can still attract a certain number of loyal customers even if they charge above marginal cost. In this case, the Nash equilibrium price exceeds marginal cost, allowing both firms to earn positive profits—a result that better aligns with real-world market observations.

3.3 Leader-Follower Game under the Stackelberg Model

The Stackelberg model accounts for the asymmetry in decision-making timing, where a leading firm first determines its output or price, and then follower firms make their decisions based on the leader's choice—more accurately reflecting the real-world interaction between market leaders and followers. In the quantity competition version of the Stackelberg model, the leader exploits its first-mover advantage by choosing an output level that maximizes its own profit, anticipating how [7] the follower will respond to this output. Using backward induction, we first derive the follower's best-response function to any given output of the leader, then substitute this into the leader's profit function to solve for the Stackelberg equilibrium. Theoretically, the leader's equilibrium output exceeds that in the Cournot equilibrium, while the follower's output is lower than in the Cournot case; likewise, the leader's profit is higher than in the Cournot equilibrium, illustrating the value of being a first mover. In China's telecommunications equipment market and new energy vehicle sector, leading companies such as Huawei and BYD have influenced later entrants by pioneering new technologies or making large-scale capacity investments, demonstrating characteristics consistent with Stackelberg leadership. However, the advantages of being a first mover depend on certain conditions: the leader's commitment must be credible—once the output decision is made, it cannot be changed—and the follower must be able to accurately observe the leader's actions. Otherwise, the sequential game effectively becomes a simultaneous one, eliminating the leader's strategic advantage [8].

3.4 Repeated Games and Collusive Pricing Analysis

When oligopolistic firms engage in long-term repeated interactions, the equilibrium outcomes of one-shot games may be disrupted. Firms can potentially sustain prices above the non-cooperative game equilibrium through tacit collusion to achieve higher joint profits. Under the framework of infinitely repeated games, the Folk Theorem shows that if firms sufficiently value future payoffs—i.e., when the discount factor is high enough—collusive pricing can be maintained via trigger strategies. Specifically, firms agree to jointly set monopoly prices; if any firm deviates by undercutting the collusive price, the others respond permanently with punishment strategies such as price wars, ensuring that the deviator's long-term payoff falls below what it would have been under cooperation. This deterrence mechanism prevents short-term gains from deviation from outweighing the long-term losses due to punishment, thereby supporting the stability of the collusive equilibrium. In reality, phenomena such as price rigidity, price leadership, and industry norms in oligopolistic markets are largely manifestations of tacit collusion, where firms coordinate implicitly without explicit agreements by observing competitors' pricing behavior. According to antitrust cases disclosed by the Price Supervision and Anti-Monopoly Bureau of the National Development and Reform Commission between 2019 and 2022, industries such as pharmaceuticals and building materials have repeatedly seen firms colluding through industry association platforms to exchange price information and coordinate price increases, confirming the explanatory [9] power of repeated

game theory for real-world pricing behavior. However, maintaining collusion faces many challenges: conflicts over profit distribution caused by shifts in market demand, entry of new firms disrupting existing equilibria, and stricter antitrust enforcement raising the costs of violations—all of which undermine the effectiveness of trigger strategies. Therefore, when studying oligopolistic pricing, it is essential not only to recognize the role of repeated interactions in supporting collusion but also to analyze the market conditions and institutional environments required to sustain it, in order to better understand the interplay between competition and cooperation in oligopolistic markets.

4. Design and Analysis of a Thought Experiment on Oligopoly Pricing Strategies

4.1 Theoretical Basis and Design Principles of Thought Experiments

A thought experiment is a method of scientific inquiry that uses logical reasoning and hypothetical scenarios to test the validity and explanatory power of a theory without conducting any physical experiments. In studying oligopoly pricing, the design of thought experiments must meet several requirements: first, the experimental setting should be representative, capturing real-world issues faced by oligopolistic firms such as pricing, output, and strategic interactions [10]; second, the information available to participants, timing of actions, and payoff functions must be clearly defined to ensure the game model is self-consistent; third, the design should be flexible, allowing adjustments to certain parameters to reflect equilibrium outcomes under different market conditions. This paper employs game-theoretic methods for thought experiments, based on the assumptions of rationality and common knowledge, while also incorporating the effects of bounded rationality and information asymmetry on firm decision-making. By maintaining theoretical rigor while preserving explanatory relevance to reality, this approach provides methodological guidance for future research in specific industries such as aviation and telecommunications.

4.2 A Thought Experiment on Oligopoly Pricing in the Aviation Industry

The aviation industry is a classic oligopoly market, with global market share concentrated among a small number of major airlines. According to data from the International Air Transport Association, as of 2023, the world's top ten airlines accounted for over 60% of international route capacity [11]. This thought experiment assumes three airlines competing on pricing along an international route, with similar operating costs and service levels, and moderate price sensitivity in market demand. The process consists of two stages: in the first stage, all three airlines simultaneously set their fares, and consumers choose airlines based on price; in the second stage, firms can adjust prices in response to market feedback. Under conditions of perfect information, if one airline lowers its price to capture more market share, the other two will also reduce their prices to retain customers, triggering a price war that leads to the Bertrand paradox—where profits across all firms fall close to marginal cost. However, in reality, airlines typically do not behave this way due to repeated game [12] dynamics. If one airline cuts prices, others are likely to follow suit, creating a deterrent effect that encourages all parties to maintain higher prices. Additionally, high fixed costs, limited flight slot availability, and frequent flyer programs in the aviation industry act as natural barriers to entry, further reinforcing implicit collusion among oligopolistic firms and contributing to greater price stability and predictability.

4.3 An Experimental Study on Oligopoly Pricing in the Telecommunications Market

The Chinese telecommunications market is dominated by three major operators: China Mobile, China Unicom, and China Telecom. According to data released by the Ministry of Industry and Information Technology, these three companies collectively held over 99% of the mobile communications market share in 2022. This study develops a triopoly sequential game model in which the market leader first announces its pricing strategy, followed by two followers who

subsequently make their own pricing decisions. In this process, firms not only aim to maximize short-term profits but also consider the long-term impact of pricing on brand image and customer loyalty. In the first scenario, if the leader adopts an aggressive low-price strategy to attract more users, the followers face a dilemma: lowering prices would trigger an endless price war, while maintaining higher prices risks losing many price-sensitive [13] customers. However, when the market reaches maturity and switching costs for users are high, followers tend to adopt differentiated competition strategies—such as improving service quality and introducing personalized products and services—to retain customers rather than engaging in mere price competition. In the second scenario, the three operators form an implicit price alliance, periodically adjusting tariffs in coordination while keeping prices largely consistent. This behavior can be explained by the folk theorem, which states that in infinitely repeated games, cooperative equilibria can be sustained through appropriate discount factors; any deviation from the agreement results in permanent punishment. Due to strict government regulation and highly standardized technical specifications in the telecommunications industry, competition among these oligopolists remains relatively mild, leading to strong coordination in their pricing behaviors.

4.4 Game-theoretic Explanation of the Thought Experiment Results

The two industry cases above illustrate that oligopolistic pricing strategies can have multiple equilibria, rooted in general principles of game theory. According to the Nash equilibrium concept, the one-time Bertrand competition in the airline industry results in a unique Nash equilibrium where price equals marginal cost; however, this equilibrium is unstable [14] in repeated games. Once time and reputation effects are considered, subgame-perfect Nash equilibrium requires firms to make optimal responses in every period, allowing high-price collusion to be sustained through trigger strategies. The sequential game in the telecommunications industry also reflects the core idea of the Stackelberg model: the leader gains first-mover advantage by making credible commitments, and his pricing effectively becomes a constraint in the follower's optimization problem. Experiments show that market structure significantly influences equilibrium outcomes—when products are highly homogeneous and information is complete, price wars tend to be intense. In contrast, when brand differentiation, switching costs, or government regulation exist, coordinated pricing becomes more likely. Furthermore, incomplete information game theory helps explain how firms use prices to signal information about their costs or market demand to outsiders. A low price may indicate improved efficiency or serve as a predatory pricing threat, meaning price signals carry multiple interpretations and thus render pricing behavior inherently strategic [15].

4.5 Implications of Experimental Conclusions for Oligopoly Pricing Strategies

A systematic analysis of thought experiments offers valuable insights into pricing decisions in oligopolistic markets. First, firms should recognize that pricing strategies are dynamic and strategic. While short-term price wars may rapidly expand market share, they could reduce overall industry profitability in the long run. Rational oligopolists should prevent cutthroat competition by building a strong reputation and adopting transparent, open pricing standards. Second, market structure plays a decisive role in shaping pricing strategies. In markets with high entry barriers and minimal product differentiation, firms are more likely to engage in tacit collusion; governments must therefore use antitrust laws and information disclosure to prevent such behavior. Third, in sequential decision-making scenarios, first-movers enjoy a first-mover advantage, but this advantage must be credible. Firms can strengthen their position through capacity investments, signing long-term contracts, or establishing technical standards. Fourth, under conditions of incomplete information, signaling games reveal how pricing strategies convey information—price changes affect not only current demand but also competitors' and consumers' expectations [16] about the firm. From a policy perspective, governments should distinguish between legitimate price coordination and illegal collusion, design sound pricing policies to achieve both efficiency and fairness, and maximize social welfare within dynamic game frameworks.

5. Conclusion

This paper examines firms' pricing behavior in oligopolistic markets from a methodological perspective of thought experiments grounded in game theory, revealing that oligopoly pricing is not merely a simple markup over costs or a straightforward response to demand, but rather a complex outcome shaped by strategic interactions. Thought experiments applied to the aviation and telecommunications industries demonstrate that factors such as information structure, decision-making sequence, market entry barriers, and reputation significantly influence pricing strategies. These conditions may lead either to price wars driving industry profits to zero or to tacit collusion maintaining high prices through cooperative equilibria. Game theory—particularly repeated games and sequential games—plays a crucial role in explaining these phenomena, with concepts like trigger strategies, subgame perfect equilibrium, and signaling effectively accounting for various observed pricing behaviors in real-world markets.

The value of thought experiments lies in their ability to overcome the limitations of traditional mathematical models, which are confined to static analysis, by using logical reasoning to describe the process of strategic changes in dynamic games. This study offers useful insights for enriching research methodologies in industrial organization theory and also provides reference value for corporate competitive strategies and policy-making by government agencies. Future research could explore, from the perspective of behavioral economics, how bounded rationality, fairness preferences, and other factors influence oligopolistic pricing, while employing big data methods for empirical analysis to test the universality of conclusions derived from thought experiments. Moreover, within the context of the digital economy, platform-based oligopolies have developed new pricing characteristics—such as algorithmic collusion and dynamic pricing—that have become emerging research topics, posing new challenges for the application of game theory.

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