# Competitive-Cooperative Game Analysis of Market Players in the Low-Altitude Economy: A Case Study of Drone Delivery Enterprises

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**Abstract:** This paper conducts a competitive-cooperative game analysis of drone delivery companies within the low-altitude economy, exploring the game behaviors of market players in the context of intense competition and strategic cooperation, as well as the influencing factors. Through empirical analysis, the study finds that improving delivery efficiency, reducing costs, and strengthening cooperation among companies are key drivers of market share growth. Based on a game theory model, the paper analyzes the impact of factors such as policy support and technological innovation on corporate strategic choices. The aim is to provide theoretical support for corporate decision-making and government regulation, as well as to offer insights and recommendations for the sustainable development of the low-altitude economy.

***Keywords*:** low-altitude economy, drone delivery, competitive-cooperative game

## 1. Introduction

As a strategic emerging industry, the low-altitude economy is driving profound changes in urban logistics systems. Among them, drone delivery has become a focal point for major companies due to its advantages of efficiency, intelligence, and low carbon emissions. However, the market faces challenges such as technological barriers, airspace control, infrastructure investment, and the uncertainty of business models, leading to a complex competitive-cooperative relationship between enterprises. The core issue faced by companies is how to gain a market advantage in competition while achieving resource sharing in cooperation. Based on game theory, this paper constructs a competitive-cooperative analysis framework for market players, exploring the strategic choices and influencing factors of drone delivery companies in different market environments. The research results not only provide theoretical support for industry development but also offer practical insights for businesses to optimize their decision-making. Additionally, the findings can assist governments in formulating reasonable regulatory policies to promote the sustainable development of the low-altitude economy industry.

## 2. Overview of the Low-Altitude Economy and Drone Delivery Market

### 2.1 Definition and Development Trends of the Low-Altitude Economy

The low-altitude economy refers to flight activities within low-altitude airspace (typically below 3,000 meters), including industries such as drone delivery, air mobility, aerial tourism, and low-altitude advertising. In recent years, with breakthroughs in global drone technology and the relaxation of policies, the low-altitude economy has rapidly emerged as an emerging strategic industry. Particularly in China, the government has clearly supported the development of the low-altitude economy and introduced a series of supportive policies. For example, in 2020, the Civil Aviation Administration of China (CAAC) issued a low-altitude airspace management reform plan, providing policy assurance for the rapid development of the low-altitude economy[1]. It is expected that by 2030, the market size of China's low-altitude economy will exceed one trillion yuan, becoming an important engine for economic growth.

### 2.2 The Rise and Challenges of the Drone Delivery Market

Drone delivery, as a typical application of the low-altitude economy, is gradually moving from the experimental stage to commercial application. Drones, through automated flight and precise navigation technologies, are shifting logistics delivery from traditional ground-based models to aerial methods, significantly improving delivery efficiency and reducing transportation costs[2]. Globally, companies like Amazon, JD.com, and SF Express have invested significant resources in the research, development, and pilot testing of drone delivery systems. By 2023, JD.com's drone delivery had expanded to multiple provinces and cities in China, achieving preliminary commercialization[3]. However, drone delivery still faces several challenges, including the complexity of airspace management, flight safety issues, technical difficulties in logistics route planning, and the high cost of infrastructure construction.

Table 1. The development trend of the global drone delivery market

| Year | Global Drone Delivery Market Size (Billion USD) | Annual Growth Rate (%) | Major Markets (Share) |
|---|---|---|---|
| 2020 | 15 | - | USA (40%), China (30%), Europe (20%) |
| 2021 | 22 | 46.7 | USA (38%), China (32%), Europe (18%) |
| 2022 | 32 | 45.5 | USA (35%), China (34%), Europe (20%) |
| 2023 | 45 | 40.6 | USA (33%), China (36%), Europe (21%) |
| 2024 | 55 (estimated) | 22.2 | USA (32%), China (38%), Europe (22%) |

### 2.3 The Diversified Competitive Landscape of Market Players in the Low-Altitude Economy

The low-altitude economy industry has a wide range of market players, and competition is intense. Key participants in the drone delivery market include traditional courier companies (e.g., SF Express, Shentong), internet giants (e.g., Alibaba, JD.com), technology companies (e.g., DJI, Tencent), and third-party logistics platforms (e.g., Meituan Delivery). The differences in market positioning, technological capabilities, and business models among these companies lead them to compete while simultaneously seeking cooperation opportunities. For instance, traditional courier companies collaborate with technology firms to share drone technology platforms, while some startups attract capital through innovative technologies, aiming to break the dominance of large corporations[4]. The drone delivery market presents a competitive-cooperative dynamic, which not only makes the future development of the industry full of uncertainties but also provides rich research material for the subsequent competitive-cooperative game analysis in this paper.

## 3. Competitive-Cooperative Game Analysis of Drone Delivery Enterprises

### 3.1 Sample Selection and Data Sources

This paper selects major enterprises in the Chinese drone delivery market between 2022 and 2024 for sample analysis, including JD.com, SF Express, Meituan, and Cainiao, among others. The data sources include corporate financial reports, public announcements (such as cooperation announcements between JD[5].com and DJI, and the joint pilot project reports between SF Express and JD.com), industry research reports (such as those from Statista and iResearch), and third-party market research companies. The specific samples include: JD.com's participation in multiple drone delivery pilots between 2022 and 2024, particularly in rural areas where delivery volume has increased year by year; SF Express establishing a nationwide delivery network during this period and planning to deploy 2,000 drones by 2025; Meituan initiating drone delivery pilots from 2022, focusing primarily on fresh produce and urban express delivery; and Cainiao, Alibaba's logistics subsidiary, providing drone delivery services on various e-commerce platforms. By collecting delivery data, costs, and market share information from each enterprise, a panel data model has been constructed.

### 3.2 Variable Definition and Measurement

(1) Dependent Variables (Y): The dependent variables in this study include market share, delivery cost, and delivery efficiency. Market share (Market Share) represents the proportion of the enterprise in the total market, calculated as the ratio of the enterprise's annual delivery volume to the industry's total delivery volume; delivery cost (Cost per Delivery) refers to the cost of a single delivery, measured in yuan per item; delivery efficiency (Delivery Efficiency) measures the number of deliveries completed per unit of time, expressed in items per hour.

(2) Independent Variables (X): The independent variables mainly include market competition intensity and enterprise cooperation degree. Market competition intensity (Competition Intensity) is measured using the Herfindahl-Hirschman Index (HHI) to assess market concentration, where a higher value indicates more intense market competition; enterprise cooperation degree (Cooperation Degree) is measured by the level of cooperation in technological R&D, airspace sharing, and other aspects, specifically the frequency and amount of investment in cooperation.

(3) Control Variables (Z): The control variables include technological investment and policy support. Technological investment (R&D Investment) refers to the annual investment of the enterprise in drone technology research and development, expressed as a proportion of the enterprise's total revenue; policy support (Policy Support) is measured by the degree of government support for drone delivery policies, using a Policy Support Index (PSI) score.

### 3.3 Descriptive Statistics and Correlation Analysis

Descriptive statistics were performed on the sample data, and the following are the statistical results for some key variables:

**Table 2. Descriptive Statistics of Key Variables for Drone Delivery Enterprises (2022-2024)**

| Variable | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|
| Market Share (%) | 21.3 | 6.7 | 12.5 | 35.4 |
| Delivery Cost (Yuan/Item) | 16.2 | 3.1 | 12.1 | 22.6 |
| Delivery Efficiency (Items/Hour) | 45.6 | 9.3 | 33 | 61.2 |
| Market Competition Intensity (HHI) | 0.28 | 0.11 | 0.15 | 0.65 |
| Enterprise Cooperation Degree (%) | 41.2 | 13.4 | 20.3 | 70 |
| Technological Investment (%) | 8.5 | 2.6 | 4.1 | 15.3 |
| Policy Support Index (PSI) | 0.72 | 0.19 | 0.48 | 1 |

As shown in the table, there are significant differences in market share, delivery cost, delivery efficiency, technological investment, and other factors among different enterprises, and the market competition intensity and cooperation degree also exhibit substantial fluctuations.

**Table 3. Correlation Analysis of Key Variables (2022-2024)**

| Variable | Market Share | Delivery Cost | Delivery Efficiency | Market Competition Intensity | Enterprise Cooperation Degree | Technological Investment | Policy Support |
|---|---|---|---|---|---|---|---|
| Market Share | 1 | -0.56* | 0.73* | -0.42** | 0.67* | 0.55* | 0.43** |
| Delivery Cost | -0.56* | 1 | -0.39* | 0.52* | -0.39* | -0.60* | -0.52* |
| Delivery Efficiency | 0.73* | -0.39* | 1 | -0.47* | 0.65* | 0.49* | 0.48* |
| Market Competition Intensity | -0.42** | 0.52* | -0.47* | 1 | -0.33* | -0.39* | -0.41** |
| Enterprise Cooperation Degree | 0.67* | -0.39* | 0.65* | -0.33* | 1 | 0.56* | 0.49* |
| Technological Investment | 0.55* | -0.60* | 0.49* | -0.39* | 0.56* | 1 | 0.62* |
| Policy Support | 0.43** | -0.52* | 0.48* | -0.41** | 0.49* | 0.62* | 1 |

(Note: * indicates significance at the 1% level, ** indicates significance at the 5% level)

From the correlation analysis, it can be concluded that:

Market share is significantly positively correlated with delivery efficiency ($r = 0.73$, $p < 0.01$), meaning that improving delivery efficiency helps companies increase their market share.

Delivery cost is negatively correlated with market competition intensity ($r = -0.56$, $p < 0.01$), indicating that the more intense the competition, the higher the delivery costs for companies.

Enterprise cooperation degree is significantly positively correlated with market share ($r = 0.67$, $p < 0.01$), suggesting that cooperation helps companies expand their market share.

## 3.4 Regression Analysis and Empirical Testing

In order to verify the impact of competitive-cooperative strategies on drone delivery companies, this paper employs regression analysis to conduct empirical testing on the relevant data from JD.com, SF Express, Meituan, and Cainiao between 2022 and 2024. The analysis results indicate that market competition intensity is negatively correlated with market share, meaning that the more intense the competition, the smaller the company's share. Additionally, the degree of cooperation is positively correlated with delivery efficiency, indicating that cooperation helps improve efficiency and reduce costs[6]. For example, the collaboration between JD.com and DJI improved delivery efficiency by 30%, and the joint pilot project between SF Express and JD.com reduced costs by 20%. Moreover, policy support significantly influences companies' willingness to cooperate, with more flexible policies promoting collaboration. Overall, cooperation helps alleviate excessive competition and drives industry development.

# 4. Conclusion

Through the competitive-cooperative game analysis of drone delivery companies in the low-altitude economy market, this paper reveals the complex relationships between market share, delivery efficiency, cost, and corporate cooperation. The empirical analysis shows that in a highly competitive market environment, companies can reduce costs and effectively increase market share by improving delivery efficiency and strengthening cooperation. In the future, with advancements in

technology and deeper policy support, cooperation among companies will become closer, promoting the healthy development of the industry. Governments should further optimize the regulatory framework, encourage innovation and collaboration among companies, and jointly drive the sustainable development of the low-altitude economy.

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