



Research on Pricing Strategy of Online Freight Platform Considering User Behavior

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Abstract. In recent years, with the development of network freight transportation platforms, the platforms have gradually shifted from a subsidized model to a high commission model, resulting in a general “order jumping” (direct transactions off the platform) by shippers and drivers in search of higher returns. This not only affects the sustainable operation of the platform, but also reduces the overall matching efficiency of the market and social welfare. This paper analyzes the equilibrium state of the platform under the commission pricing strategy by constructing a game model that takes into account the users' jumping order behavior, focusing on the impact of jumping cost and risk on users' behavior, platform pricing and social welfare. It is found that the platform's equilibrium commission percentage is positively related to users' jumping order efforts and risk costs, i.e., market imperfections instead enhance the platform's bargaining power, allowing it to convert transaction frictions into profits. Although the increase in the difficulty of jumping will inhibit some users' behavior, the increase in the platform's commission in turn incentivizes the motivation of jumping, creating the dilemma of “the more you prevent, the more you jump”. In addition, social welfare varies in a U-shape with the cost of jumping, suggesting that either too high or too low a cost is detrimental to the overall efficiency of the market.

Keywords: user jump-order behavior; online freight platform; pricing strategy

1 Introduction

Driven by both policy support and market demand, Chinese network freight industry has risen rapidly since 2020. As of July 2024, head enterprises such as Cargo Lala and Man Gang have formed a double oligopoly pattern, and market concentration has increased significantly. According to the Research Report on Employment and Income of Drivers on Digital Freight Platforms, nearly 80% of drivers mainly rely on platforms to take orders, and platform orders account for more than 62% of their total income, and platforms are increasingly consolidating their dominant position in the freight ecosystem. However, as the market matures, platforms are gradually eliminating subsidies and shifting to a profit model based on commission and membership fees, while excess capacity in the market has led to persistently low freight rates and squeezed drivers' profit margins. Cargo owners are also facing restrictions on the number of orders they

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H. Li et al. (eds.), *Proceedings of the 2026 5th International Conference on Big Data Economy and Digital Management (BDEDM 2026)*, Advances in Economics, Business and Management Research 383,

https://doi.org/10.2991/978-94-6239-640-1_26

can issue, and they need to pay to upgrade their membership if they exceed the limit. Against this backdrop, shippers and drivers choose to conduct transactions outside the platform to avoid platform fees. This behavior is usually referred to as "jumping orders". The act of "jumping orders" generally refers to the situation where at least two of the three parties "collude" to take advantage of the relevant information and services provided by a third party, and then "bypass" (without compensation) the third party to directly conduct transactions. Although this kind of behavior can improve user revenue in the short term, it exacerbates the loss of platform customers and order spillover, affecting the overall efficiency and stability of the market. Therefore, how to formulate a reasonable pricing strategy to balance the interests of platforms, drivers and shippers, inhibit jumping order and promote the sustainable development of platforms has become a practical issue that needs to be studied in depth.

Around the operation and pricing of network freight platforms, scholars have explored the issue from different perspectives: Zhang et al. (2020) constructed a multi-objective truck-cargo matching model to improve resource utilization; Gui Yunmiao et al. (2021) investigated the platform's information control strategy and pricing mechanism under different competitive environments; Guo Xiaolong et al. (2022) discussed the role of the level of effort of logistic services in pricing and social welfare, in terms of supply chain synergy; Wang Zhiqi et al. and social welfare; Wang et al. (2023) compare the equilibrium of unilateral and bilateral charging models in a dynamic game; and Koo et al. (2024) reveal the influence of system parameters on the effectiveness of vehicle-cargo matching by integrating multiple matching models. In terms of the research on order jumping behavior, existing literature is mostly found in the fields of real estate, retail and e-commerce. For example, Gu et al. (2020) empirically found based on the freelancer market that enhanced trust would increase the probability of skipping orders. Zhou et al. (2022) research indicates that factors such as higher frequency of bilateral user interaction, higher transaction prices, and service repetition all increase the possibility of platform leakage. Stephanie Nguyen et al. (2023) explored the motivations of users to conduct direct transactions outside the sharing economy platforms such as Airbnb and BlaBlaCar, and found that economic benefits, perceived risks, and perceived pleasure jointly influence users' intention to leave the platform. Hagiú et al. (2024) studied the widespread problem of platform leakage in online markets and analyzed six strategies to curb platform leakage: investing in transaction benefits, restricting communication, charging recommendation fees, using price equality terms, introducing seller competition in the market, and concealing sellers who attempt to induce platform leakage. Wang Yue et al. (2024) constructed a principal-agent model for the moral hazard of physical merchants in the O2O model - the behavior of skipping orders. The research shows that to solve the problem of skipping orders, O2O platforms need to design differentiated commission structures based on the characteristics of physical merchants on the basis of reducing the overall commission rate. Gomes et al. (2024) found that to prevent disintermediation, some platforms adopt price parity and reverse steering clauses to impose restrictions.

In general, existing studies still have the following limitations: first, the analysis of jumping behavior focuses on low-frequency or off-site transaction scenarios such as

real estate and e-commerce, and pays insufficient attention to high-frequency and of-line contact industries such as network freight transport; second, most of the existing freight transport platform pricing studies are centered on multi-platform competition, focusing on analyzing the cross-platform migration behavior of users, and seldom explore how the bilateral user behavior affects the user's willingness to leave the platform under the framework of a single platform. The second is that most of the existing freight platform pricing studies focus on multi-platform competition and analyze the cross-platform migration behavior of users, but there is less in-depth discussion on how the bilateral users' single-order jumping behavior reacts to the platform pricing strategy and its profit structure under a single platform framework. Therefore, this paper is based on the reality of jumping orders on network freight platforms, and constructs a tripartite game model covering platforms, shippers and drivers, aiming to reveal how the risk and cost of jumping orders affect platform pricing, user behavior and social welfare, to make up for the shortcomings of existing studies and provide theoretical basis for the platform to optimize the governance mechanism.

2 Problem Description and Model

2.1 Problem Description

In this section, we will study the pricing strategy of the network freight platform under the existence of bilateral users jumping orders behavior, with the network freight platform as the core, to construct the commission pricing game model, the commission pricing model refers to the completion of the transaction between bilateral users, the platform in accordance with a certain percentage of the two sides to extract the cost as a service fee. The specific model is shown in Figure 1.

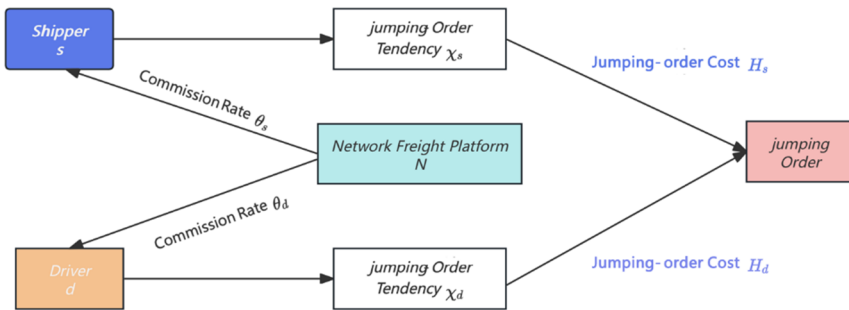


Fig. 1. Schematic diagram of the bilateral users jump order model

2.2 Model Assumptions and Parameter Descriptions

Suppose the marketplace consists of an online freight transportation platform (N) and a risk-neutral shippers (s) and drivers (d).

Suppose that the platform adopts a commission pricing, i.e., it charges a commission of $\theta_s, \theta_d \in (0,1)$ for each transaction concluded by the bilateral users in the model.

Assume that the bilateral users are not simply “jumping orders or not jumping orders”, but a continuous variable $\chi_s, \chi_d \in [0, 1]$, for the “tendency to jump orders”, which represents the degree of the bilateral users want to jump orders.

Assuming that the shipper and the driver transaction once the shipper needs to pay the cost of C_1 , the driver's transportation costs for $C_2 (C_1 > C_2 > 0)$, the shipper through the transaction of the value of the service can be obtained for the $V (V > C_1)$, the platform for the bilateral user to provide the transaction will be incurred costs $C_3 (C_3 > 0)$.

Assuming that the owner and driver off the platform for the transaction will produce risk, such as the owner of goods can not pay in time, damaged goods can not be compensated, etc., the owner and driver risk cost for R_s, R_d . Considering that the need for both parties to pay the cost of jumped orders, that is, “jumped orders cost”, the owner and driver jumped orders cost for H_s, H_d .

Assuming that one of the shippers and drivers chooses not to jump orders, and the other is forced to stay on the platform due to lack of cooperation. Only when both parties choose to jump orders at the same time, the behavior of jumping orders will occur. The platform, shipper and driver are for example π_N, π_s, π_d respectively

2.3 Model Formulation

This model is a Steinberg master-slave game model dominated by a network freight transportation platform, in which the network freight transportation platform as a leader makes decisions first, and the shippers and drivers as followers subsequently make decentralized decisions. The specific decision-making sequence is as follows: platform pricing stage: the network freight platform, aiming at profit maximization, takes the lead in determining the percentage of commission θ_s and θ_d for the shippers and drivers; the decision-making stage for both users: after observing the platform's pricing strategy, the shippers and drivers simultaneously and independently determine their own propensity to jump orders χ_s vs. χ_d and the two-sided user decision stage: shippers and drivers simultaneously and independently determine their own propensity to jump orders after observing the platform's pricing strategy.

Based on the actual situation, this paper sets the jumping cost as a convex function of the tendency to jump orders, reflecting the economics of increasing marginal search difficulty:

$$H_s = \frac{1}{2} k_s \chi_s^2 \tag{1}$$

$$H_d = \frac{1}{2} k_d \chi_d^2 \tag{2}$$

where k_s, k_d are jump order effort coefficients, constant greater than 0

Considering that order-jumping behavior is a matching process in bilateral markets, the probability of successful order-jumping is not a simple product of bilateral willingness, but is affected by market frictions and information asymmetry. In this paper, we draw on the search-matching theory in labor economics and adopt the classical Cobb-

Douglas type matching function to describe the joint probability of successful order jumping:

$$P(\chi_s, \chi_d) = (\chi_s * \chi_d)^{\frac{1}{2}} \tag{3}$$

Based on the above parameter setting and analysis, the profit functions of network freight platform, cargo owner and driver are derived:

$$\pi_s = (V - C_1(1 + \theta_s))(1 - P) + (V - R_s - C_1)P - \frac{1}{2}k_s\chi_s^2 \tag{4}$$

$$\pi_d = (C_1(1 - \theta_d) - C_2)(1 - P) + (C_1 - C_2 - R_d)P - \frac{1}{2}k_d\chi_d^2 \tag{5}$$

$$\pi_N = C_1(\theta_s + \theta_d)(1 - P) - C_3 \tag{6}$$

$$\pi_z = \pi_s + \pi_d + \pi_N \tag{7}$$

3 Solution and Analysis

3.1 Model Solution

The model is solved by backward induction. The owner of the goods to maximize their own profits as the goal, the χ_s equation (4) for the first-order partial derivatives. Similarly, the driver aims to maximize his own profit by taking a first-order partial derivative of χ_d in equation (5), which yields.

$$\frac{\partial \pi_s}{\partial \chi_s} = \frac{1}{2}\chi_s^{-1/2}\chi_d^{1/2}(C_1\theta_s - R_s) - k_s\chi_s \tag{8}$$

$$\frac{\partial \pi_d}{\partial \chi_d} = \frac{1}{2}\chi_s^{1/2}\chi_d^{-1/2}(C_1\theta_d - R_d) - k_d\chi_d \tag{9}$$

Let the first-order partial derivative expressions $\frac{\partial \pi_s}{\partial \chi_s}=0$ and $\frac{\partial \pi_d}{\partial \chi_d}=0$, and the optimal tendency expression for drivers and consignors to jump orders can be obtained as follows:

$$\chi_s = \sqrt[4]{\frac{(C_1\theta_s - R_s)^3(C_1\theta_d - R_d)}{16k_s^3k_d}} \tag{10}$$

$$\chi_d = \sqrt[4]{\frac{(C_1\theta_d - R_d)^3(C_1\theta_s - R_s)}{16k_d^3k_s}} \tag{11}$$

The above optimal jump order tendency is brought into the formula (6) network freight platform profit function to seek the first-order derivatives about θ_s, θ_d and make it equal to 0 joint solution can be obtained about the optimal value of the decision variables θ_s, θ_d , the optimal value of the optimal value is:

$$\theta_s^* = \frac{4\sqrt{k_s k_d} + 3R_s - R_d}{4C_1} \tag{12}$$

$$\theta_d^* = \frac{4\sqrt{k_s k_d} + 3R_d - R_s}{4C_1} \tag{13}$$

Substituting the θ_s^* , θ_d^* , and substituting the optimal propensity of drivers and shippers to jump orders as found above can be obtained:

$$\chi_s^* = \frac{4\sqrt{k_s k_d} - (R_s + R_d)}{8k_s^{\frac{3}{4}} k_d^{\frac{1}{4}}} \tag{14}$$

$$\chi_d^* = \frac{4\sqrt{k_s k_d} - (R_s + R_d)}{8k_d^{\frac{3}{4}} k_s^{\frac{1}{4}}} \tag{15}$$

Bringing the solution sought above into the relevant profit function, the optimal profit for each party is obtained as follows:

$$\pi_s^* = V - C_1 - \sqrt{k_s k_d} - \frac{3R_s - R_d}{4} + \frac{3(4\sqrt{k_s k_d} - (R_s + R_d))^2}{128\sqrt{k_s k_d}} \tag{16}$$

$$\pi_d^* = C_1 - C_2 - \sqrt{k_s k_d} - \frac{3R_d - R_s}{4} + \frac{3(4\sqrt{k_s k_d} - (R_s + R_d))^2}{128\sqrt{k_s k_d}} \tag{17}$$

$$\pi_N^* = \sqrt{k_s k_d} + \frac{R_s + R_d}{2} + \frac{(R_s + R_d)^2}{16\sqrt{k_s k_d}} - C_3 \tag{18}$$

$$\pi_z^* = V - C_2 - C_3 - \sqrt{k_s k_d} + \frac{3(4\sqrt{k_s k_d} + R_s + R_d)^2}{64\sqrt{k_s k_d}} + \frac{(R_s + R_d)^2}{16\sqrt{k_s k_d}} \tag{19}$$

3.2 Equilibrium Analysis

Based on the commission pricing model, this study constructs a tripartite game model of network freight transportation platform, cargo owner and driver, and analyzes the formation mechanism of market equilibrium when there is a single-order jumping behavior of bilateral users. By analyzing the equilibrium solution of the model, the following four core conclusions are obtained:

Structural characteristics of platform commission pricing: The optimal commission ratio of the platform is affected by the joint influence of the risk cost of jumping orders (R_s , R_d) and the coefficient of effort of jumping orders (k_s , k_d), which presents the following structural characteristics. When the risk cost of a side user's order jumping increases, its dependence on the platform increases, and the platform takes the opportunity to increase the commission percentage for this user (e.g., if R_s rises, θ_s^* rises, As shown in Figure 2). When the risk cost of users on the opposite side increases, the platform can cross-subsidize by lowering the commission on the side to maintain the user scale and network effect (e.g., if R_s and R_d go up, then θ_s^* and θ_d^* will go down). k_s and k_d are higher, the more difficult it is to match the user's hopping orders, the stronger the platform pricing ability is, and the equilibrium commission ratio rises, reflecting the "cascading pricing" principle. The higher k_s and k_d the more difficult it is to match users' jumps, the stronger the pricing power of the platform is, the higher

the equilibrium discount ratio is, and the “cascading pricing effect”, i.e., the higher effort cost of one side pushes up the discount of the other side.

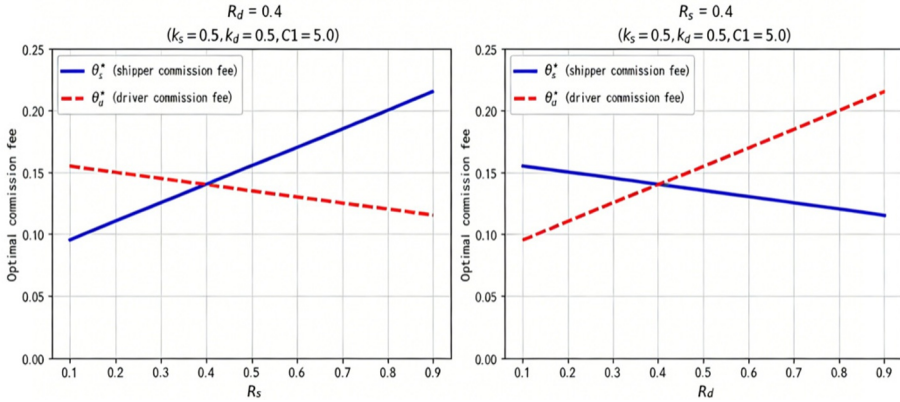


Fig. 2. The impact of the risk cost of jumping orders on the optimal commission fee

Reverse Incentive Mechanism of Users' jumping Behavior : In the equilibrium state, the optimal tendency of users to jump orders (χ_s^*, χ_d^*) is negatively correlated with the risk cost of jumping orders (R_s, R_d), but the relationship with the coefficient of effort of jumping orders reveals a kind of “paradox of backward incentive”. Although increasing the cost of jumping effort can inhibit some users from jumping, platforms increase the commission to capture higher profits, but amplify the potential benefits of successful jumping, incentivizing users to maintain a strong motivation to jump in a high-friction environment, forming a vicious cycle of “the more prevention, the more you want to jump(As shown in the red area of Figure 3, there is a difference between the expected tendency to jump orders and the actual tendency to jump orders)”, indicating that it is difficult to inhibit users from jumping by relying solely on price instruments. This indicates that it is difficult to inhibit users from jumping orders simply by relying on price.



Fig. 3. Schematic Diagram of the Paradox of the tendency to skip orders

Inherent contradiction in the distribution of benefits between platforms and users: The optimal profit of platforms (π_N^*) is positively correlated with the risk cost of jumping (R_s, R_d) and the effort coefficient (k_s, k_d), which indicates that the profit mode of platforms is highly dependent on the inefficiency of the market: the higher the friction of the transaction and the more asymmetric the information, the higher the “institutional rent” that platforms obtain. the higher the “institutional rent” the platform obtains. It also implies that the platform profitability base will be threatened if the market transparency increases or users establish stable cooperation.

User profit (π_s^*, π_d^*), on the other hand, declines with the rise of the risk cost of jumping orders (R_s, R_d), and when there is a risk in the market or information asymmetry, the platform extracts the bilateral user surplus by raising the commission, and the ability of users to play the game declines significantly. Of particular concern is that there is a “cascade” effect between users, i.e., when a party is locked in by the platform due to the increased difficulty of single-jumping, the platform will also increase the pricing of the other party, which makes it difficult for efficient single-jumping users to circumvent the platform's profit extraction.

The total social welfare shows U-shaped evolution and rent value dissipation dilemma: The total social welfare shows a U-shaped change with the effort coefficient of single-jumping: when the cost of single-jumping is very low, the users use the platform to match and then directly trade, and the social efficiency is close to Pareto-optimal; as the cost rises, the platform raises the profit extraction, and the users still invest a large amount of resources in seeking to single-jump in order to avoid the profit extraction, which results in a significant dissipation of the rent value; when the cost is very high, the users give up and the transaction is completed within the platform. When the cost is extremely high, users give up jumping orders and the transaction is completed within the platform, eliminating the dissipation of rental value and increasing welfare. In reality, the cost of jumping orders is often in the middle range, causing the market to fall into the multi-game dilemma of “high platform commission-users' strong jumping orders-social efficiency loss” for a long time.

4 Summary

This study conducts an in-depth analysis of the “jumping order predicament” faced by online freight platforms under the pure commission model, revealing the negative reinforcement mechanism existing between the platform's pricing strategy and users' jumping order behavior. Research has found that the profits of platforms are highly dependent on the “institutional rent” formed by market friction and information asymmetry. Although the increase in the cost of users' efforts to jump orders can temporarily curb jumping orders, it will lead to an increase in the platform's commission, which in turn encourages users to still seek jumping orders despite high costs. This has led to the total social welfare falling into a U-shaped trough of “high platform commission - users' strong order skipping - efficiency loss” in the medium cost range. This highlights that relying solely on price control and matching obstruction cannot fundamentally solve

the problem; instead, it may intensify the opposition of interests and efficiency dissipation. Therefore, the platform should proactively promote a shift in its profit model from "transaction rental" to "service empowerment". This can be achieved by building a reliable performance guarantee system, providing differentiated value-added services (such as finance, insurance, and compliance support), implementing dynamic pricing based on credit and loyalty, and continuously reducing the overall transaction costs within the platform through technology. Enable users to truly perceive that the value retained on the platform far exceeds the risks and benefits of jumping orders. Only by shifting the focus of competition from "preventing order skipping" to "creating irreplaceable service stickiness" can platforms effectively resolve conflicts of interest, break out of the game trap, and ultimately achieve a coordinated improvement in the overall efficiency of the platform, users and society.

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