

A Game-Theoretic Analysis of Unauthorized Surcharging Behavior in Taxi and Ride-Hailing Markets

Weifa Li

College of Economics and Management, Chongqing Jiaotong University, Chongqing, 400000, China

Abstract: Against the backdrop of the long-term coexistence of street-hailing taxis and ride-hailing services, unauthorized surcharging, fare bargaining, and detours that effectively inflate passengers' payments occur from time to time. Such practices may increase drivers' revenues in the short run, but they can also trigger complaints, erode service trust, and raise regulatory enforcement costs. This paper abstracts the taxi and ride-hailing sectors as two competing players and develops a static complete-information game-theoretic model that incorporates regulatory penalties and reputational losses, in order to characterize the Nash equilibria under two strategies: compliant pricing and unauthorized surcharging. The analysis shows that whether unauthorized surcharging becomes prevalent in the industry hinges on the gap between the incremental gains from surcharging and the expected costs of punishment. When the additional payoff from surcharging exceeds the sum of the expected penalty loss upon detection and the reputational loss, both parties tend to adopt unauthorized surcharging, yielding the (unauthorized, unauthorized) equilibrium; otherwise, the (compliant, compliant) equilibrium emerges. Based on the derived threshold condition, the paper proposes policy implications including increasing the probability of detection, strengthening penalty severity, improving credit-based evaluation mechanisms, and enhancing platform-regulator collaborative governance.

Keywords: Ride-hailing; Street-hailing taxis; Unauthorized surcharging; Game theory; Regulatory penalties.

1. Introduction

In recent years, ride-hailing platforms have expanded rapidly and, together with street-hailing taxis, have formed an integrated urban mobility supply system. As ride-hailing services and traditional taxis continue to coexist and compete, market structure and pricing mechanisms have been evolving. On the one hand, prior studies have examined the conditions for coexistence and the competitive outcomes between taxis and ride-hailing services from perspectives such as service-quality differentiation, network effects, and competitive structure; for instance, some work characterizes the competitive equilibrium of the two services through a service-quality lens and derives corresponding managerial insights [1]. On the other hand, other studies focus on drivers' operational strategies and employ evolutionary game models to analyze how strategies of taxi drivers and ride-hailing drivers evolve across market scenarios, noting that "winner-takes-all" dynamics or structural divergence may emerge when demand is constrained or subject to shocks [2].

Compared with research themes such as vehicle-supply decisions and service-quality competition, a more salient phenomenon in practice—closer to passengers' experiences and more likely to generate industry-wide concerns—is unauthorized surcharging. For street-hailing taxis, it may take the form of not using the meter, bargaining over the fare, or taking detours that effectively increase the payment; for ride-hailing services, it may manifest as off-platform extra charges, inducing passengers to cancel and then conducting private transactions, or other informal "fare top-ups." Meanwhile, platforms and regulators shape market behavior through subsidies, pricing rules, commission structures, and enforcement intensity. Existing research indicates that government regulation and platform strategies (e.g., subsidies, pricing, and commission rates) can substantially affect stakeholder behavior and overall market welfare [3][4]. In addition, order fulfillment and cancellations are closely

related to price/rule transparency: opaque or discriminatory pricing may undermine passenger compliance and create governance challenges [5]. Under peak-demand conditions, platforms often deploy a combined approach of "price increases + subsidies" to rebalance supply and demand, highlighting the institutional dependence of pricing behavior and incentive mechanisms [5].

Against this backdrop, this paper proposes a parsimonious two-player game-theoretic framework in which both taxis and ride-hailing services can choose either compliant pricing or unauthorized surcharging. We analyze equilibrium conditions under a given probability of detection and penalty severity, and derive governance implications.

2. Model and Assumptions

2.1. Players and Strategies

We consider two competing service providers: street-hailing taxis (denoted by T) and ride-hailing services (denoted by R). Over a given time period, both parties operate in the same urban travel market. Each player chooses one of the following two strategies as its dominant behavioral mode:

C: Compliant pricing (charging strictly according to the meter/platform rules, with no extra surcharge)

I: Unauthorized surcharging (causing the passenger's final payment to deviate from the compliant level through fare bargaining, off-platform top-ups, detours that effectively increase the fare, etc.)

For analytical convenience, various forms of price deviation are uniformly abstracted as unauthorized price-markup behavior.

2.2. Parameter Settings

Let the baseline expected profit per completed trip under compliant behavior be $m > 0$ (interpretable as average profit net of costs). If a player adopts unauthorized surcharging, it

obtains an additional expected profit $\Delta > 0$.

At the same time, unauthorized surcharging may be detected and punished by regulators or the platform [6]. Let the probability of being detected be $p \in (0,1)$, and let the penalty severity (e.g., fines, suspension, account deactivation, demerit points—converted into monetary terms) be $F > 0$. Then the expected penalty cost of unauthorized surcharging is pF . In addition, unauthorized behavior may generate complaints, negative reviews, and long-term reputational losses [7], denoted by $k \geq 0$. Therefore, the net attractiveness of the unauthorized surcharging strategy depends on the relative magnitude of Δ versus $pF + k$.

3. Game Formulation and Equilibrium Analysis

3.1. Payoff Matrix

Based on the above assumptions, the expected payoffs of taxis and ride-hailing services are specified as follows:

If both parties comply: $U_T(C, C) = m, U_R(C, C) = m$

If one party surcharges while the other complies:

The surcharging party receives $m + \Delta - pF - k$, while the compliant party receives m :

$$U_T(I, C) = m + \Delta - pF - k, U_R(I, C) = m$$

$$U_T(C, I) = m, U_R(C, I) = m + \Delta - pF - k$$

If both parties surcharge: $U_T(I, I) = m + \Delta - pF - k, U_R(I, I) = m + \Delta - pF - k$

Accordingly, the standard 2×2 payoff matrix is:

Table 1. Payoff Matrix of the Taxi–Ride-Hailing Pricing Game

	Ride-hailing C	Ride-hailing I
Taxi C	(m, m)	$(m, m + \Delta - pF - k)$
Taxi I	$(m + \Delta - pF - k, m)$	$(m + \Delta - pF - k, m + \Delta - pF - k)$

3.2. Nash Equilibrium Analysis

Given the symmetry of the two players, it suffices to examine the taxi operator's best response under a fixed strategy of the ride-hailing operator. If the ride-hailing operator chooses compliant pricing C , the taxi operator's expected payoffs from choosing C and I , respectively, are:

$$U_T(C, C) = m, U_T(I, C) = m + \Delta - pF - k$$

Hence, the taxi operator prefers unauthorized surcharging if and only if

$$m + \Delta - pF - k > m \Leftrightarrow \Delta > pF + k$$

By symmetry, the same condition applies to the ride-hailing operator.

This yields the following results.

Proposition 1 (Unauthorized-surcharging equilibrium). If $\Delta > pF + k$, then choosing unauthorized surcharging is a best response for both parties, and (I, I) constitutes a Nash equilibrium.

Interpretation. When the net expected gain from unauthorized surcharging is positive, each party has an incentive to surcharge even if its competitor complies, ultimately leading to an outcome in which unauthorized surcharging becomes widespread.

Proposition 2 (Compliance equilibrium). If $\Delta < pF + k$, then compliant pricing is a best response for both parties, and

(C, C) constitutes a Nash equilibrium.

Interpretation. When the expected penalty and reputational loss are sufficient to offset the incremental surcharging revenue, both parties prefer to remain compliant.

Corollary (Threshold case). If $\Delta = pF + k$, the two strategies yield identical expected payoffs. In this knife-edge case, market behavior may be highly sensitive to changes in enforcement intensity and reputational mechanisms. Near the threshold, a moderate increase in p or F , or an increase in k via greater information disclosure and reputational penalties, can shift behavior toward the compliant equilibrium.

3.3. Managerial Implications

The model indicates that the key to curbing unauthorized surcharging is to alter the relative magnitudes on the two sides of the inequality: either reduce the incremental gain from surcharging Δ , or increase the expected punishment and reputational cost $pF + k$. In practice, Δ may arise from information asymmetry (e.g., passengers lacking a clear reference for reasonable fares), bargaining opportunities under tight supply–demand conditions, and the difficulty of tracing off-platform transactions. By contrast, p , F , and k can be strengthened through more frequent inspections, harsher penalties, platform rule design, and credit-based governance mechanisms. Policies that make the condition $\Delta < pF + k$ more likely to hold can effectively deter the diffusion of unauthorized surcharging behavior.

4. Conclusions and Policy Recommendations

4.1. Main Findings

This paper develops a static game-theoretic model in which street-hailing taxis and ride-hailing services choose between two strategies—compliant pricing and unauthorized surcharging—and obtains the following conclusions:

(1) When the incremental gain from unauthorized surcharging, Δ , exceeds the sum of the expected penalty cost pF and the reputational loss k , both parties tend to adopt unauthorized surcharging, yielding the (I, I) equilibrium and creating a tendency toward industry-wide surcharging.

(2) When $\Delta < pF + k$, both parties are more likely to maintain compliant pricing, resulting in the (C, C) equilibrium.

(3) Near the threshold condition, moderate strengthening of enforcement and credit-based sanctions can significantly shift the equilibrium outcome, implying a strong policy leverage effect.

4.2. Policy Recommendations

Based on the threshold relationship between Δ and $pF + k$, policy interventions can proceed from two complementary directions: raising the expected cost of violations and shrinking the surplus available from unauthorized surcharging.

On the one hand, regulators can increase the probability of detection p by (i) raising the frequency of roadside inspections, (ii) improving cross-agency joint enforcement mechanisms, and (iii) introducing data-driven audits (e.g., screening for abnormal routes, anomalous charges, and complaint hotspots) to broaden detection coverage and thus reduce the “chance-to-escape” margin. Meanwhile, increasing the penalty severity F can rapidly elevate the expected cost of violations: for street-hailing taxis,

enforcement can be linked to demerit points, service suspension, monetary fines, and licensing/qualification management; for ride-hailing services, enforcement can be linked to account deactivation, order-taking restrictions, fines, and platform access requirements. In addition, policies should amplify the reputational loss k by strengthening closed-loop complaint handling and information disclosure mechanisms, incorporating severe violations into credit records, and promoting interoperability between platform rating systems and industry credit systems. Such measures impose persistent constraints on future order opportunities, thereby substantially increasing long-term costs.

On the other hand, platforms and regulators can jointly reduce Δ by increasing price transparency and limiting opportunities for off-platform extraction. Practical measures include transparent fare display, pre-trip and in-trip cost notifications, post-cancellation risk warnings, audio recording and evidence preservation, and identification of off-platform transactions. By reducing information asymmetry and narrowing the scope for unauthorized markups, these measures compress the economic returns to surcharging at the source and make it less likely that Δ will exceed $pF + k$.

4.3. Limitations and Future Research

Focusing on unauthorized surcharging in taxi and ride-hailing markets, this study proposes a parsimonious two-player game-theoretic framework. The analysis suggests that when the gain from surcharging exceeds the “expected enforcement loss plus the demand loss induced by detectability,” the market may fall into the undesirable (I/I) equilibrium. Increasing the probability of detection, enhancing the detectability of violations, improving price-rule transparency, and formalizing platform mechanisms can shift outcomes toward the (C/C) equilibrium. A key

limitation of this paper is that it does not explicitly model regulators or platforms as third-party strategic players.

References

- [1] Yang, J., Wang, Z., Xu, C., & Wang, D. (2024). The competition between taxi services and on-demand ride-sharing services: A service quality perspective. *Sustainability*, 16(22), 9877.
- [2] Gu, T., Xu, W., Shi, P., Wang, R., & Kim, I. (2024). Taxi in competition with online car-hailing drivers: Policy implication to operating strategies. *Multimodal Transportation*, 3(2), 100129.
- [3] Xu, Y., Ling, L., Wu, J., & Xu, S. (2024). On-demand ride-hailing platforms under green mobility: Pricing strategies and government regulation. *Transportation Research Part E: Logistics and Transportation Review*, 189, 103650.
- [4] Tang, W., Xie, N., Mo, D., Cai, Z., Lee, D.-H., & Chen, X. M. (2023). Optimizing subsidy strategies of the ride-sourcing platform under government regulation. *Transportation Research Part E: Logistics and Transportation Review*, 173, 103112.
- [5] Xu, K., Saberi, M., Liu, T.-L., & Liu, W. (2024). Economic analysis of ridesourcing markets considering driver order cancellation and platform subsidy. *Travel Behaviour and Society*, 36, 100795.
- [6] Peng, Y., Hou, Y., & Gao, S. (2024). Online car-hailing market regulation strategy in China: From the perspective of quadrilateral evolutionary games. *Computational Economics*, 64, 815–840.
- [7] Liu, M., Tunca, T., Xu, Y., & Zhu, W. (2025). Market formation, pricing, and value generation in ride-hailing services. *Manufacturing & Service Operations Management*, 27(5), 1551–1570.