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Research Article

Evolutionary Game between Government and Ride-Hailing Platform: Evidence from China

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The ride-hailing industry is a new business form that combines traditional taxi services with Internet technology and a sharing economy. However, after its emergence, countries have focused on finding ways to regulate this industry. The regulation of ride-hailing has gone through three stages: from denial of negation to laissez-faire and prudential supervision. This study focuses on the market regulation of the ride-hailing industry, discusses whether ride-hailing platforms require strict regulation under the current Internet setting, and provides evidence for this problem from the perspective of evolutionary game theory between the behavior of the government and the platforms. This study argues that both ride-hailing platforms and the government are evolutionary game players with bounded rationality, constantly adjusting their strategies through confrontation, dependence, and restriction. Therefore, this study constructs a two-dimensional game model between the government and ride-hailing platforms and analyzes the stability strategies of the two participants in different scenarios, to clarify the game behavior and the game return matrix. Assuming that loose government regulation and the standard operation of the ride-hailing platforms are the optimal Pareto equilibrium of the game system, the study concludes that this optimal equilibrium cannot be achieved under the current conditions. Through parameter analysis and sample simulation calculations, the system can be directed toward this equilibrium by reducing government supervision cost and increasing government punishment. This provides a theoretical basis for the government to regulate the ride-hailing industry from the perspective of quantitative analysis. Related implications are finally proposed, which can help the decision-makers better understand the regulation countermeasures of the government and ride-hailing platforms.

1. Introduction

The maturity of mobile Internet technology and the popularity of smart phones have provided powerful technical support for the development of the sharing economy. As a new economic development mode, the sharing economy has a profound impact on the development of all life spheres [1, 2]. In recent years, as a representative of the integration of transportation and sharing economy, the ride-hailing industry has been developing rapidly. This industry utilizes network technology to integrate ideal resources and fulfill accurate supply and demand matching; it also provides a new travel mode for urban residents. Ride-hailing has become one of the main modes of daily travel for urban residents [3]. According to the 41st Statistical Report on the Development of China's Internet, released by the China Internet Network Information Center (CNNIC), in December 2017, the total number of China's Internet users had reached 435 million, and the current growth rate is 19.2% in 2017. There are more than 20 million active orders per day on ride-hailing platforms, more than 20,000 passenger requests per minute during peak periods, and more than 9 billion daily requests for path planning. Shared mobility has become the most active business mode of sharing economy [4, 5], especially in China.

Although ride-hailing is technologically beneficial, it has also generated a fair amount of controversy, resulting in a regulatory dilemma. Furthermore, it has experienced strong resistance from traditional cruise-taxi operators [6].The combination of ride-sharing and profit-oriented attributes distinguishes the ride-hailing industry from both traditional cruise taxis and "carpooling" services [7]. In the early stages of development, ride-hailing was globally recognized as an illegal operation by the traditional regulatory mechanism;

although deregulation allows for its operation, the regulatory paths are different. In general, there are four typical ways of regulating ride-hailing: (1) Singapore has established a register records system to manage ride-hailing, without setting an entry threshold; (2) California, USA, distinguished the existing passenger service mode, creating a regulatory middle ground (Transportation Network Company), and implemented cooperative supervision between the government and ride-hailing platforms; (3) London, UK, classified ride-hailing services under the private hire vehicles regulation system and set up a lower entry threshold; (4) France recognized it as a traditional taxi operation, strictly regulating and banning Uber. As in other countries, China's regulation of ride-hailing has gone through three stages, from laissez-faire to strict regulation and prudent regulation [8]. On November 1, 2016, the Tentative Measures for the Administration of Ride-Hailing Service was implemented, which recognized the legal status of ride-hailing services. However, it is not clearly stipulated whether the ride-hailing industry must be strictly regulated or not; this was to be determined by the local government, since it establishes detailed rules to regulate the development of the local market. Countries worldwide are still debating whether the ride-hailing business should be strictly controlled. Cannon and Summers [9] investigated the institutional obstacles to the sharing economy business model, revealing that regulation will always be the main obstacle to the future growth of sharing economy enterprises. According to Posen [10], regulators must implement experimental regulations on ride-sharing operators, who are different from traditional taxis (e.g., Uber), and adjust them according to the regulatory effect feedback.

From the perspective of China's ride-hailing business development, several ride-hailing platforms have emerged in China since 2012. The emerging ride-hailing travel format has relied on offering lower prices and providing high subsidies to their customers and drivers to gain market share as quickly as possible, under a no-regulation condition. In 2014, the ride-hailing industry underwent an outbreak period, during which the user scale expanded rapidly and the growth rate exceeded 500% in China. Ride-hailing travel has become an indispensable component of China's resident travel market. However, the lack of effective industry regulation has resulted in vicious competition in the market, seriously disturbing the order of the travel market; moreover, the huge scale of the industry has caused urban congestion and air pollution. Furthermore, the "pioneering" development mode that emphasizes quantity over quality has led to a passenger safety crisis. Hence, a series of negative externalities must be eliminated by government regulation. In 2016, the seven authorities, including the Ministry of Transport, jointly promulgated the Tentative Measures for the Administration of Ride-Hailing Services to regulate the market, controlled the number of Internet-based taxis by restricting drivers' household registration, vehicle license plate and specifications, and charging standards for ride-hailing services[11]. The new policy rapidly decreased the number of ride-hailing vehicles on the Internet platform. However, there is continuous debate on whether the traditional regulation idea in this new type of business (ride-hailing) will either boost the development of the industry or bound it in "chains."

In recent years, the issue of ride-hailing regulation, which is a result of technological innovation, has been discussed in many studies. The discussions follow two main paths: one, discussion on the regulation of ride-hailing based on the regulation itself, including research on the evaluation and improvement strategies for current regulatory policies, enlightenment from foreign regulation policies, and comparison of regulatory approaches at home and abroad [12–14]. The other involves the study of regulatory policy based on the analysis of economic mechanism. For example, incorporating ride-hailing in the theory of "sharing economy," Belk [15] argues that ride-hailing refers to a typical "false sharing," just a temporary transfer of ownership of goods and benefit compensation. Moreover, when ride-hailing is placed in the traffic resources category, its weak "sharing" attribute is highlighted; although ride-hailing is an on-demand travel service under the technological innovation and profits, road resources are its main aspect [16]. When ride-hailing is considered in the category of industrial economics, the discussion on the regulation policy is based on the analysis of SCP (market structure-market behavior-market performance) [17]. Thus, although the existing research has further clarified ride-hailing regulation, these studies neglect the influences of confrontation, dependence, and restriction among the main subjects on the regulation effect in the market.

The government and network platform companies are the two biggest subjects in the ride-hailing market, and the discussion on regulation issues is more concerned with these two subjects. Ride-hailing regulation implies that to cope with a series of negative externalities in the development of ride-hailing enterprises, the government restricts and regulates the operation of these enterprises in accordance with the law. In fact, the diversification of participants, the complication of interest, and the virtualization of market transactions further complicate the economic law and the regulation of the ride-hailing market. The implementation of ride-hailing regulation is essentially a process of game between the government and ride-hailing companies. Game players constantly adjust their strategies through confrontation, dependence, and constraints [18, 19]. Therefore, it is necessary to analyze the interaction mechanism of the relevant subjects in the regulation system from the perspective of dynamic evolution and to reveal the universal laws of ride-hailing regulation.

The establishment of research model in this study originates from the evolutionary game theory (EGT) introduced by John Maynard Smith and George R. Price in 1973 [20, 21]. Different from classical game theory, the game process of EGT which is based on bounded rationality holds that the interaction between individuals in a group is a dynamic process based on changing situations (game environment and participants' state), and that the game situation and participants' behaviors are interdependent[22]. In EGT, the rationality of participants evolves continuously according to the changes in game situation; moreover, the bounded rationality is explicated as individuals' behavior rules in dynamic evolution according to the understanding and learning of

game situation [23, 24]. EGT can explain the sustainable cooperation in dilemma situation. Cooperation based on various dilemma games in two-player games has been mostly discussed on the premise of ideological situation either for defining cooperators or the defection exit. The replicator dynamics (RD) classifies the game into four classes: Prisoner's dilemma (PD), Chicken (Snowdrift), Stag Hunt and Trivial (nondilemma) games respectively having D-dominant, Polymorphic, Bi-stable, and C-dominant equilibria [25, 26].

EGT has been applied to various fields, such as biology, economics, and sociology with the support of mathematical science [27]. In particular, the mathematical framework of EGT has become essential to overcome the benefit disadvantage in the face of exploitation. Moreover, EGT generates important insights into the evolution of cooperation, many of which have been found applicable across a myriad of scientific disciplines. In recent years, the combination of EGT and traffic management research has produced a series of research results. Loukas [28] describes an evolutionary game-theoretic learning model for dynamic congestion pricing in urban road networks; Roumboutsos and Kapros [29] analyzed the Nash equilibrium of operational integration strategies for individual public transport operators, revealing that public and private transport operators provide the decision-makers a most cost-effective intervention form. Hernández [30] used EGT to examine carpooling in the construction of smart city. Xu and Kannan [31] introduced the reference effect in the sea-cargo supply chain and studied a multiple-period contract problem between the carrier and the forwarder. The above literatures provide a useful reference for us to explain the selection and evolution of strategy between ride-hailing platform and government in the process of industry regulation.

In this study, we focus on the game process of platform and the government regulation in the ride-hailing industry, which can be described by the EGT. The platforms are the main behavioral subjects, which are limited by some factors such as information asymmetry, contradictory interests, and cognitive bias of the decision-makers' environment in the government's regulation process. Hence, the two parties cannot obtain the optimal results in an instant and one time in economic activities without the "omniscience and omnipotence" of the behavior subject in the classical game theory. Based on the above analysis, this study builds a 2×2 game model between ride-hailing platform and government with EGT. In this model, both parties rely on "limited rationality" for behavior selection. In the process of evolution, their behavioral decisions are constantly revised and improved according to the environmental changes, opponents' behavior selection, cognitive adjustment, and other factors. Nash equilibrium could be achieved finally through multiple games. As can be seen from the above analysis of the economic decision-making behavior of market participants, the research model based on EGT has obvious advantages. On the one hand, it is more suitable for the reality of the subject decision-making. Because depending on the initial state of the market, the strategy can be adjusted dynamically, so as to obtain more satisfactory results. On the other hand, based on different initial conditions (strict regulation or deregulation of the government, scale expansion of the ride-hailing platform or improvement of service quality), it is more conducive to the in-depth analysis of the strategic evolution path and influencing factors of the behavioral subject in the process of ride-hailing regulation. Additionally, it can also anchor useful insights on the cooperation-competition relationship between the government and the new business.

In sum, the proposal of ride-hailing service regulation has been put forward globally [32, 33]. National governments are gradually participating in the development of the online platform. The analysis of existing literature elucidates that the current research focuses more on the rationality and feasibility of government's regulation policy, while research on behavioral interaction between regulatory subject and regulatory object is relatively scarce [34–36]. Furthermore, studies from the perspective of research methods are mostly qualitative; scientific tools and models are rarely used to objectively depict and quantitatively proved the issue of online car-hailing market regulation. Therefore, this study examines the two main subjects in the process of the ride-hailing regulation as well as establishes a 2 by 2 evolutionary game model between the government and ride-hailing platform [37, 38]. Based on the analysis of the evolutionary law and stabilization strategy of the two participants in the game [39, 40], this study investigates the regulatory thought and main influencing factors of the new format in the case of the government as the subject of supervision, which provides the theoretical basis for government to achieve effective supervision over new formats of sharing economy.

The remainder of this paper is structured as follows: Section 2 constructs the evolutionary game model and describes the game behavior and the payoff matrix of both sides; Section 3 discusses the distribution of equilibrium points in evolutionary game system in six situations and analyzes the evolutionary stability strategies under different situations; a numerical study to examine the theoretical results and reveals the influence mechanism of the parameter to the game process is proposed in Section 4; and finally, Section 5 presents the main conclusions, study limitations, and the future research direction.

2. Evolutionary Game Model

2.1. Game Behavior. We assumed that the government administrative department has two strategies: "strict regulation" (A) and "loose regulation" (a). Under "strict regulation" strategy, the government can punish the ride-hailing platforms by imposing fines, administrative penalties, and revocation of operating rights for the illegal expansion of the ride-hailing platforms, mainly by controlling the number of the vehicles to guide the high-quality development of enterprises. In this case, the cost of law enforcement increases significantly. Under "loose regulation" strategy, the violation risk of ride-hailing platforms decreases correspondingly. However, excessive vehicles have increased negative externalities in the market, causing traffic congestion and exhaust pollution, and subsequently increasing the governance cost of negative externalities in government expenditure.

We also assumed the ride-hailing platforms adopt two strategies: "scale expansion" and "service promotion." Although local governments have issued relevant management rules for ride-hailing, the law enforcement supervision is weak; therefore, ride-hailing platforms may continue to adopt a scale expansion strategy with lower marginal cost, simplify the audit of platform vehicle access qualification, and maintain low enterprise bicycle operating cost. However, under the strict government regulation, ride-hailing platforms increase expenditure to set preferential conditions to attract drivers to join the platform, while facing administrative penalties for not adhering to government regulations. However, if the platform companies remove the unqualified vehicles and drivers, strengthen the vehicle condition inspection and drivers' path tracking, and optimize the travel service according to government regulation, then their operating cost is expected to increase. However, the public's recognition and the social image of the enterprise have been significantly improved, which can be transformed into profit to a certain extent; moreover, the high-quality development of the industry can yield certain social benefits.

2.2. Assumptions and Notations. Ride-hailing platform regulation mainly involves two subjects: the government management department and the platform enterprises; in the process of regulation implementation, a game relationship develops between the two subjects due to the conflict of interest goals. In this study, an evolutionary game model of government administration and ride-hailing platforms is established. The relevant assumptions, notations, and the payoff matrix of the game are described as follows:

(1) Bounded Rationality and Learning Ability. In reality, ride-hailing platforms and government law enforcement departments cannot meet the perfect requirements of complete rationality. In other words, the game subjects have bounded rationality, implying that both sides cannot find the optimal equilibrium point in each game; therefore, the game's stability strategy is a result of long-term learning, imitation, and continuous strategic adjustment.

(2) Evolutionary Stability Strategy and Replicator Dynamics. In game theory, the core concepts are Evolutionary Stable Strategy (ESS) and Replicator Dynamics. ESS represents a stable state of the group that resists the mutation strategies' intrusion. It is defined as follows:

The strategy is an ESS, if and only if

(i) s^* constitutes a Nash equilibrium (that is, $u(s^*, s^*) \geq u(s^*, s)$, for any s);

(ii) there is $s^* \neq s$ satisfying $u(s^*, s^*) = u(s^*, s)$; there must be $u(s^*, s) > u(s, s)$.

(3) The replication dynamic is actually a dynamic differential equation describing the frequency of a particular strategy being used in a population. According to the evolutionary principle, if the gain or payment of a strategy is higher than the average fitness of the population, the strategy will develop in the population, and the growth rate (replication dynamic equation) of this strategy will be greater than zero. The copy dynamic equation can be given by the following differential equation:

$$F(k) = \frac{\partial x_k}{\partial t} x_k \left[u(k, s) - u(s, s)\right], \quad k = 1, 2, 3 \ldots, K \tag{1}$$

where x_k is the proportion that strategy$k$is adopted by population, $u(k, s)$ is the fitness of strategy k, $u(s, s)$ is the average fitness, k is different strategy, and K is Policy set.

(4) Variable Setting of Income Function. The income function variables of the two types of participants are set as follows:

(i) Ride-Hailing Platform. The current operating income of the platform is R and the operating cost is C; assuming that the platform chooses the scale expansion strategy and ΔN is the number of expanded vehicles, the single-car income is r and the operating cost of the single-car is c_1. If the enterprises do not respond to the government's proposals, the user scale and market are continuously expanded, resulting in government punishment. The penalty for a single car is p. Under the circumstance of government policy tightening, some drivers choose to withdraw from the market; when the platform adopts preferential measures to encourage these drivers to reenter the market, the cost for a single car is c_2. If, however, the platform chooses the service promotion strategy and the revenue is R_1, the operating cost and the early investment of improving service quality is C_1. The behavior parameters of the ride-hailing platform in game are shown as follows:

R: the revenue of the ride-hailing platform under current scale

C: the operation cost under current scale

ΔN: the volume of vehicle expansion

r: single-car income

c_1: single-car operation cost

c_2: the cost of attracting drivers to rejoin the platform

p: fines levied by the government when a platform chooses strategy B

R_1: the revenue of operation when a platform chooses strategy b

C_1: the operation cost when a platform chooses strategy b

(ii) Government Regulation Department. T is the tax revenue brought to the government by the ride-hailing enterprise. The regulation cost of government is C'. The average single-car regulation cost is c_3. At the same time, the negative externalities, such as resource waste, road congestion, and exhaust pollution, of each additional vehicle are converted into w. H is the social benefit brought by healthy development of industry and service promotion. The intensity of government enforcement is μ, $0 \leq \mu \leq 1$. The smaller the μ is, the weaker is the law enforcement. Government enforcement affects regulatory costs and penalties for illegal enterprises under loose supervision. The study assumed that the above variables are all greater than 0 and that all the parameters remained constant during the investigation. The behavior parameters of the government in game are as follows:

T: taxes paid by the platform company

t: the increase in tax revenue brought by each additional vehicle

C': the regulation cost when the government chooses strategy A

c_3: single-car regulation cost

w: the negative externalities brought by the expansion of ride-hailing vehicles

H: the social benefits when a platform chooses strategy b

μ: the intensity of government enforcement, $0 \le \mu \le 1$

(5) Game Strategy. The government authorities levy strict or loose regulation strategy on the ride-hailing platforms, assuming that the proportion of government choosing strict regulations is x, and that choosing loose regulation strategy is $1 - x$. The platform enterprises have the choice of expanding scale and improving service level. Assuming the proportion of enterprises choosing a scale expansion strategy is y, the proportion of those choosing service promotion strategy is $(1 - y)$. The payoff matrix of each strategy is shown in Table 1.

2.3. Evolutionary Game Model. Assume that G represents the government; P represents the online car-hailing platform; A and a represent the government's strict and loose supervision strategy, respectively; B and b represent the ride-hailing platforms' scale expansion strategy and service promotion strategy, respectively, then the benefits of the platforms and the government under different strategies can be represented by P_A^B, P_A^b, P_a^B, P_a^b, G_A^B, G_A^b, G_a^B, G_a^b, respectively. The game payment matrix is obtained, as shown in Table 2.

The fitness of strict regulation strategy when the government chooses strategy A is

$$f_1 = yG_A^B + (1 - y) G_A^b \tag{2}$$

The fitness of loose regulation strategy is

$$f_2 = yG_a^B + (1 - y) G_a^b \tag{3}$$

The average fitness is

$$f_{12} = xf_1 + (1 - x) f_2 \tag{4}$$

According to the Malthusian equation, the increasing rate $\dot{x}/x$ of government's strict regulation strategy is computed by formula (5).

$$\begin{aligned} \frac{\dot{x}}{x} &= (1 - x)(f_1 - f_2) \\ &= (1 - x)\left[y\left(G_A^B - G_a^B\right) + (1 - y)\left(G_A^b - G_a^b\right)\right] \end{aligned} \tag{5}$$

The fitness of network platforms' scale expansion strategy is expressed in formula (6).

$$f_3 = xP_A^B + (1 - x) P_a^b \tag{6}$$

The fitness of network platforms' service promotion strategy is expressed in formula (7).

$$f_4 = xP_A^b + (1 - x) P_a^b \tag{7}$$

The average fitness is computed in formula (8).

$$f_{34} = yf_3 + (1 - y) f_4 \tag{8}$$

Consequently, the increasing rate of the ride-hailing platforms' scale expansion strategy is computed by formula (9)

$$\begin{aligned} \frac{\dot{y}}{y} &= (1 - y)(f_3 - f_4) \\ &= (1 - y)\left[x\left(P_A^B - P_A^b\right) + (1 - x)\left(P_a^B - P_a^b\right)\right] \end{aligned} \tag{9}$$

By combining formulas (5) and (9), we obtain the replication power system of the government and ride-hailing platform, as shown in formula (11).

$$\begin{aligned} \dot{x} &= x(1 - x)\left[y\left(G_A^B - G_a^B\right) + (1 - y)\left(G_A^b - G_a^b\right)\right] \\ \dot{y} &= y(1 - y)\left[x\left(P_A^B - P_A^b\right) + (1 - x)\left(P_a^B - P_a^b\right)\right] \end{aligned} \tag{10}$$

The Jacobian matrix of the system is expressed in formula (11).

$$\begin{vmatrix} (1 - 2x)\left[y\left(G_A^B - G_a^B\right) + (1 - y)\left(G_A^b - G_a^b\right)\right] & x(1 - x)\left[\left(G_A^B - G_a^B\right) - \left(G_A^b - G_a^b\right)\right] \\ y(1 - y)\left[\left(P_A^B - P_A^b\right) - \left(P_a^B - P_a^b\right)\right] & (1 - 2y)\left[x\left(P_A^B - P_A^b\right) + (1 - x)\left(P_a^B - P_a^b\right)\right] \end{vmatrix} \tag{11}$$

The determinant of the matrix is computed by formula (12).

$$\begin{aligned} \det J = {} & (1 - 2x)\left[y\left(G_A^B - G_a^B\right) + (1 - y)\left(G_A^b - G_a^b\right)\right] \\ & \cdot (1 - 2y)\left[x\left(P_A^B - P_A^b\right) + (1 - x)\left(P_a^B - P_a^b\right)\right] \\ & - x(1 - x)\left[\left(G_A^B - G_a^B\right) - \left(G_A^b - G_a^b\right)\right] \\ & \cdot y(1 - y)\left[\left(P_A^B - P_A^b\right) - \left(P_a^B - P_a^b\right)\right] \end{aligned} \tag{12}$$

The trace of the matrix is computed using formula (13).

$$\begin{aligned} \operatorname{tr} J = {} & (1 - 2x)\left[y\left(G_A^B - G_a^B\right) + (1 - y)\left(G_A^b - G_a^b\right)\right] \\ & + (1 - 2y)\left[x\left(P_A^B - P_A^b\right) + (1 - x)\left(P_a^B - P_a^b\right)\right] \end{aligned} \tag{13}$$

In system (9), assuming $\dot{x} = 0$ $\dot{y} = 0$, the equilibrium of the system is O(0,0), A(1,0), B(1,1), C(0,1), we plug the equilibrium of the system into the expression of matrix determinant and trace, then the result is computed as shown in Table 3.

Table 1: Game return matrix between government and network platform.

	Scale expansion	Service promotion
Strict government regulation	$R - C + \Delta N(r - c_1 - c_2 - p)$, $T - C' + \Delta N(t + p - c_3 - w)$	$R_1 - C_1$, $T - C' + H$
loose government regulation	$R - C + \Delta N(r - c_1 - \mu p)$, $T - \mu C' + \Delta N(t + \mu p - \mu c_3 - w)$	$R_1 - C_1$, $T - \mu C' + H$

Table 2: Game return matrix between government and network platform.

	Scale expansion	Service promotion
Strict government regulation	P_A^B, G_a^B	P_A^b, G_A^b
loose government regulation	P_a^B, G_a^B	P_a^b, G_a^b

3. Evolutionary Game Strategy

3.1. Scenario Analysis. According to the evolutionary game theory, the equilibrium satisfying $\det J > 0$ and $\operatorname{tr} J < 0$ is the Evolutionary Stable Strategy of the system. Through discussing system equilibrium for $\det J$ and $\operatorname{tr} J$ under different scenarios, the stability strategy of the game players can be determined.

For the government, $G_A^b = T - C' + H$ and $G_a^b = T - \mu C' + H$. This can be derived from the expression $G_A^b < G_a^b$, and there are several possible relationships: (1) $G_A^b < G_a^b$, $G_A^B < G_a^B$; (2) $G_A^b < G_a^b$, $G_A^B < G_a^B$.

For the ride-hailing platforms, it is easy to derive from the expression that $P_A^B < P_a^B$, while other relationships are uncertain. There are several possible relationships including the following: (1) $P_a^B > P_a^b, P_A^B < P_A^b$; (2) $P_a^B > P_a^b$, $P_A^B > P_A^b$; (3) $P_a^B < P_a^b, P_A^B < P_A^b$; and (4) $P_a^B < P_a^b, P_A^B > P_A^b$. The following six scenarios are determined according to the possible revenue relationship between the government and the ride-hailing platforms and discussing the stabilization strategies of evolutionary game under different scenarios.

Scenario 1 ($P_a^B < P_a^b, P_A^B < P_A^b, G_A^B < G_a^B$). Regardless of the regulation strategy adopted by the government, the net profit from scale expansion is less than that from service promotion, the law enforcement revenue from the government's strict regulation is lower, and the ESS is (0,0). In other words, the government adopts a loose regulation strategy, and the ride-hailing platforms improve the quality of service, and so the market is in a healthy state of development.

Scenario 2 ($P_a^B < P_a^b, P_A^B < P_A^b, G_A^B > G_a^B$). Compared with Scenario 1, the ESS is still (0,0), and the government obtains greater enforcement revenue when it adopts a strict regulation strategy for scale expansion. This shows that the choice of the government's strategy depends on not only the income of its own behavior but also the result of interaction between subjects in the game system. When the possibility of scale expansion is low, the government tends to choose loose regulation for the regulation of the market.

Scenario 3 ($P_a^B > P_a^b, P_A^B < P_A^b, G_A^B < G_a^B$). When the government does not regulate the market strictly, the net income of scale expansion is greater than that of service-level promotion. When the government regulates the market strictly, the net income of the scale expansion strategy is less than that of the service promotion strategy, and in the case where ride-hailing companies choose the scale expansion strategy, the revenue of the government from strict regulation is less than that from loose regulation, and the ESS is (0,1). In other words, when the government adopts a loose regulatory strategy, and the network platforms adopt the scale expansion strategy, then the market is more chaotic.

The equilibrium point local stability of Scenarios 1–3 are listed in Table 4

Scenario 4 ($P_a^B > P_a^b, P_A^B > P_A^b, G_A^B < G_a^B$). Whether the government regulates the industry strictly or not, the net profit of the scale expansion strategy of the ride-hailing enterprises is greater than that of the service promotion strategy. Further, when the enterprises choose the strategy of scale expansion, the revenue of the government's strict regulation is less than that of the loose regulation, and the ESS is (0,1). In other words, when the government adopts a loose regulatory strategy, and the platform enterprises choose to expand their market size, then the development of the market is similar to the disordered state, like the state when the ride-hailing platforms are just entering the market.

Scenario 5 ($P_a^B > P_a^b, P_A^B > P_A^b, G_A^B > G_a^B$). Whether the government regulates the industry strictly or not, the net profit of the scale expansion strategy of the ride-hailing enterprises is greater than that of the service promotion strategy. Moreover, when the enterprises choose the strategy of scale expansion, the revenue of the government's strict regulation is greater than that of the loose regulation, and the ESS is (0,1). In other words, when the government adopts a strict regulatory strategy, and the platform enterprises choose to expand their market size, then the conflict between the government and the market is fierce, which easily leads to turbulence in the market.

Scenario 6 ($P_a^B > P_a^b, P_A^B < P_A^b, G_A^B > G_a^B$). When the government does not regulate the market strictly, the net income of scale expansion is greater than that of service-level promotion. However, when the government regulates

Table 3: Matrix determinant and trace expression corresponding to equilibrium.

Equilibrium (X,Y)	Matrix determinant and trace expression	
O(0,0)	det J	$(G_A^b - G_a^b)(P_a^B - P_a^b)$
	tr J	$(G_A^b - G_a^b) + (P_a^B - P_a^b)$
A(1,0)	det J	$-(G_A^b - G_a^b)(P_A^B - P_A^b)$
	tr J	$-(G_A^b - G_a^b) + (P_A^B - P_A^b)$
B(1,1)	det J	$(G_A^B - G_a^B)(P_A^B - P_A^b)$
	tr J	$-(G_A^B - G_a^B) - (P_A^B - P_A^b)$
C(0,1)	det J	$-(G_A^B - G_a^B)(P_a^B - P_a^b)$
	tr J	$(G_A^B - G_a^B) - (P_a^B - P_a^b)$

Table 4: Equilibrium point local stability (Scenarios 1, 2, and 3).

Equilibrium	Scenario 1			Scenario 2			Scenario 3		
	det J	tr J	stability	det J	tr J	Stability	det J	tr J	stability
(0,0)	+	-	ESS	+	-	ESS	-	uncertain	saddle point
(1,0)	-	Uncertain	saddle point	-	uncertain	saddle point	+	+	unstable
(1,1)	+	+	unstable	-	uncertain	saddle point	+	+	unstable
(0,1)	-	Uncertain	saddle point	+	+	unstable	+	-	ESS

the market strictly, the net income of the scale expansion strategy is less than that of the service promotion strategy, and in the case where the ride-hailing companies choose the scale expansion strategy, the revenue of the government from strict regulation is greater than that from loose regulation, and there is no ESS. In this scenario, we need to further analyze the local stability of game systems.

The equilibrium point local stability of Scenarios 4–6 are listed in Table 5.

From the above analysis of the local stability of equilibrium in different scenarios, the ESS obtained by both players can be divided into (0,0), (0,1), (1,1), and no equilibrium. The equilibrium results under different conditions are shown in Table 6.

In state (1), $\mu p > \mathrm{R}_{\mathrm{B}-b}/\Delta N + r - c_1$, the penalty for the scale expansion of the ride-hailing platform under the nonstrict regulation is higher than the expected return of the enterprise, so the enterprise eventually chooses to abide by the law, and the government departments relax the regulation and adopt the loose regulation strategy. The dynamic phase diagram of the evolution is shown in Figure 1(a). Such a situation usually happens when the supervision department's enforcement of law μ is strong, and the penalties for illegal business enterprises are relatively large. This scenario is what the government would prefer the most. For enterprises, the high administrative penalty makes illegal business behavior lose its attraction, and a more stable and standardized operation of the market makes the government lower its enforcement. This greatly saves the human, financial, and material resources of the supervision department and helps achieve a more significant effect of law enforcement with a lower cost.

In state (2), $p < R_{B-b}{}'/\Delta N + r - c_1 - c_2$ and $p < C'/\Delta N + c_3$, the penalty for the illegal scale expansion of ride-hailing platforms is lower than the income from large-scale expansion operation and the cost of law enforcement. This is the peak period for the illegal operation of enterprises. Enterprises find that regardless of the strategy that the government adopts, the revenue from scale expansion is greater than the expected revenue from service promotion, and so enterprises often take risks and eventually choose to violate the rules. As a rational decision-maker, government departments consider the high cost of strict regulation, and the logic of law-makes prompts the government to deregulate the illegal network platform. The corresponding phase diagram of the system is shown in Figure 1(b). At this point, the relevant provisions in the market perform practically no function. In order to change this situation, the government must enforce compulsory regulation not only to investigate and punish violators but also to impose severe penalties to reduce the attraction of enterprises to profit from violations.

In state (3), $C'/\Delta \mathrm{N} + c_3 < p < R_{B-b}{}'/\Delta N + r - c_1 - c_2$, the penalty for the illegal operation of the online contract platform is greater than the cost of the government's strict regulation of the ride-hailing platform, which means that the government can obtain a larger regulatory revenue by adopting a strict regulation strategy. For the ride-hailing enterprises, the administrative penalty for scale expansion is less than the revenue. The market is thus in chaos, the enterprises tend to choose the scale expansion strategy, the government departments regulate the market strictly, and there is an intense contradiction between the government and the market. The phase diagram of the evolution is shown in Figure 1(c).

In state (4), $c_2 + p(1 - \mu) > 0, p > C'/\Delta N + c_3$, the evolutionary game fails to achieve an equilibrium solution. The dynamic phase diagram is shown in Figure 1(d). For the government, if...

Table 5: Equilibrium point local stability (Scenarios 4, 5, and 6).

Equilibrium	Scenario 4			Scenario 5			Scenario 6		
	det J	tr J	stability	det J	tr J	stability	det J	tr J	stability
(0,0)	-	uncertain	Saddle Point	-	uncertain	saddle point	-	uncertain	saddle point
(1,0)	+	+	unstable	+	+	unstable	-	uncertain	saddle point
(1,1)	-	uncertain	Saddle Point	+	-	ESS	-	uncertain	saddle point
(0,1)	+	-	ESS	-	uncertain	saddle point	-	uncertain	saddle point

Table 6: Conditions of evolutionary stability strategy.

State	Condition	ESS
(1)	$\mu p > \frac{R_{B-b}}{\Delta N} + r - c_1$	(0,0)
(2)	$p < \frac{R_{B-b}}{\Delta N}' + r - c_1 - c_2$	(0,1)
	$p < \frac{C'}{\Delta N} + c_3$	
(3)	$\frac{C'}{\Delta N} + c_3 < p < \frac{R_{B-b}}{\Delta N}' + r - c_1 - c_2$	(1,1)
(4)	$p > \frac{C'}{\Delta N} + c_3$	null

$$\begin{aligned} \dot{x} &= F(x) \\ &= x(1-x)\left[y(1-\mu)\Delta N(p-c_3) - C'(1-\mu)\right] \\ &= 0 \end{aligned} \tag{14}$$

then the two stable states x = 0 and x = 1 can be obtained.

If the initial level is $y > C'/\Delta N(p - c_3)$, then it has...

$$\begin{aligned} &F(x) > 0, \\ &F'(0) > 0, \\ &F'(1) < 0 \end{aligned} \tag{15}$$

according to the stability theorem of differential equations, and only x = 1 is stable.

If the initial level is $< C'/\Delta N(p - c_3)$, then it has $F(x) < 0$, $F'(0) < 0, F'(1) > 0$, and x = 0 is stable.

For the ride-hailing enterprises,

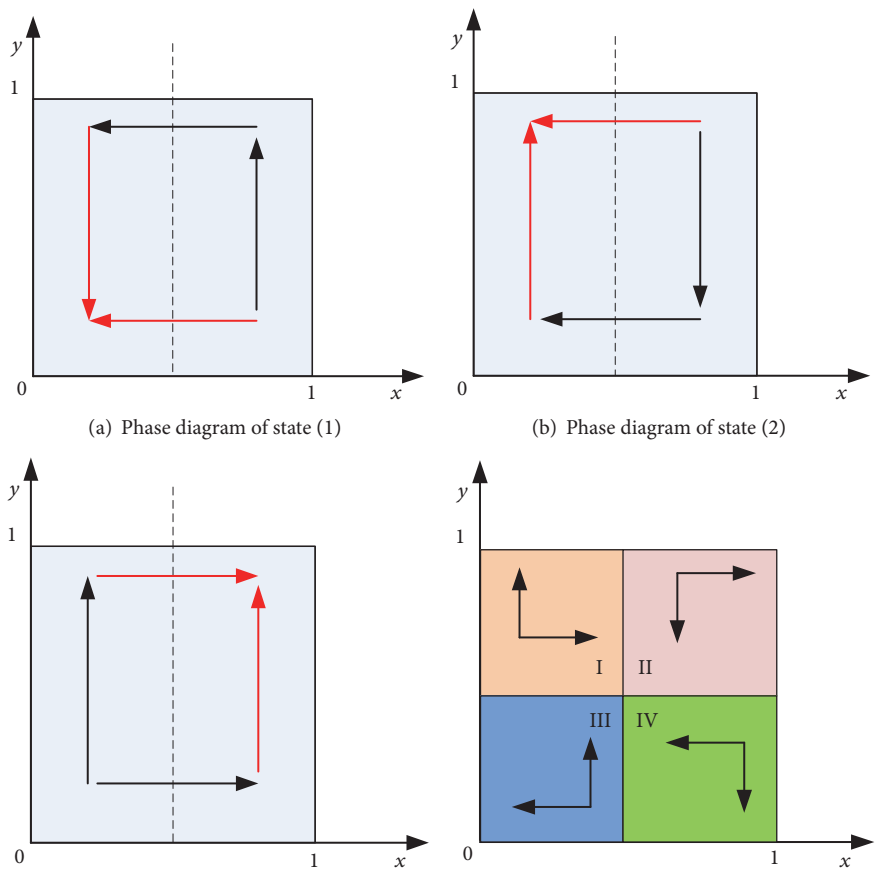
$$\begin{aligned} \dot{y} = y(1-y)\big[&x\Delta N(-c_2 - p + \mu p) \\ &+ (R - C - R_1 + C_1) + \Delta N(r - c_1 - \mu p)\big] = 0 \end{aligned} \tag{16}$$

If the initial level is $x > (R - C - (R_1 - C_1) + \Delta N(r - c_1 - \mu p))/\Delta N(c_2 + p - \mu p)$, then y = 0 is stable, and if the initial level is $x < [R - C - (R_1 - C_1) + \Delta N(r - c_1 - \mu p)]/\Delta N(c_2 + p - \mu p)$, then y= 1 is stable.

The critical value $y^* = C'/\Delta N(p - c_3)$ and $x^* = (R - C - (R_1 - C_1) + \Delta N(r - c_1 - \mu p))/\Delta N(c_2 + p - \mu p)$ divide the evolutionary game phase diagram into four regions: I, II, III, and IV (Figure 1(d)).

When the initial state of the system falls into region I, then the game converges to B (1,1), that is, the government chooses strict regulation, and the ride-hailing enterprises choose scale expansion. When the initial state of the system falls into region II, then the game converges to equilibrium A (1,0), that is, the government chooses strict regulation and the platforms choose to improve the quality of service. When the initial state of the system falls into region III, then the game converges to C (0,1), that is, the government chooses loose regulation, and the ride-hailing platforms choose to expand the scales. When the initial state falls into region IV, then the game converges to equilibrium O (0,0), that is, the government chooses loose regulation, and the enterprises improve the quality of service. In Figure 1(d), the larger the area of regions I and II, the more likely the government tends to regulate the ride-hailing market; and the larger the area of regions II and IV, the more likely the enterprises tend to improve the quality of service to achieve the purpose of increasing market share and profits.

3.2. Results and Discussion. Table 7 shows the evolutionary stability strategy of the game between the government and the ride-hailing enterprises. When $G_A^B - G_a^B < 0$ (Scenarios 1, 3 and 4), the cost of strict regulation on scale expansion is too high. The government tends to adopt loose regulation on the market. Simultaneously, the network platforms choose to expand the scale or improve the service according to the profits in different strategies under the policy environment. When $G_A^B - G_a^B < 0$ (Scenarios 2 and 5), the government receives some penalty income by regulating the platform's illegal operations. Compared with Scenario 1, Scenario 2 shows that the government has paid unnecessary regulatory cost for the regulation of the ride-hailing market. When the platforms choose to promote services, the government chooses loose regulation to reduce unnecessary costs and regulate the enterprises that tend to scale expansion strictly (Scenario 5). For Scenario 6, the larger the area of regions I and II, the more likely the government is inclined to choose strict regulations for the ride-hailing market. Assuming that the probabilities of all kinds of situations are the same in the process of the game, by increasing the revenue from the government's strict regulation for scale expansion and lowering the critical value y^* of the scale expansion strategy selected by the platforms, the area of regions I and II can be increased, forcing the government's stability strategy to evolve into a strict regulation strategy. By increasing the net revenue of services provided by the platforms and reducing the critical value x^* of strict regulation strategies selected



(a) Phase diagram of state (1)
(b) Phase diagram of state (2)
(c) Phase diagram of state (3)
(d) Phase diagram of state (4)

Figure 1: Phase diagram in different states.

by the government, the area of regions II and IV can be increased, urging the enterprises to choose the service promotion strategy.

Among the four equilibrium points of evolutionary game, Pareto's optimal equilibrium is (0,0); the government chooses loose regulation, and thus the cost of regulation is saved, the service quality of the ride-hailing enterprises is improved, and the market turns to high-quality development. In Scenarios 1 and 2, the two players of the game reach Pareto's optimum equilibrium in the evolutionary game process, and this can be realized when the government's supervision cost of platform's operation is reduced and the punishment intensity is increased. Throughout the current development of the ride-hailing market and the current situation of government regulation of the industry, this kind of evolutionary stable state has been difficult to achieve. Firstly, although the new policy of the ride-hailing business has appeared at the national level, and local management regulations have been introduced one after another, the supervision system has not been improved, and the cost of law enforcement is still relatively high. Considering the cost and other factors, the law enforcement departments still have a lot of space to supervise and enforce the law, and the lack of effective supervision means it is difficult for regulation to play a right role, and the regulatory effect of the industry is unsatisfactory. Secondly, at present, the profit model of the ride-hailing platforms is still based on extensive development with scale expansion; new profit growth points have not been established yet. The optimization and transformation of the profit model requires a large amount of capital, and the high input and noninstant profit limit the enthusiasm of the ride-hailing platforms to change their development model. Thirdly, due to the absence of government supervision, the development of the platforms and ride-hailing service is unsatisfactory under the current situation of blank regulation in the early development of the industry, resulting in market chaos, vicious competition, and frequent passenger safety accidents caused by blind expansion. Therefore, it is necessary for the government to regulate the market when operation mechanism of the platforms is not mature and the competition mechanism of the urban travel market is not excellent. In general, the current level of government regulation and the main profit model of the enterprises determine that the existing market environment has not reached the requirements of Pareto's optimum by the evolutionary game system.

Ride-hailing services are a new type of business that is different from the traditional taxi business as it embodies the attribute of sharing economy. The traditional way of regulation of the taxi business leads to a "regulatory dilemma" for the ride-hailing industry. However, the inapplicability

Table 7: Evolutionary stability strategies under different scenarios.

Scenarios	$P_a^B - P_a^b$	$P_A^B - P_A^b$	$G_A^B - G_a^B$	Evolutionary stability strategies
1	-	-	-	(loose regulation, service promotion)
2	-	-	+	(loose regulation, service promotion)
3	+	-	-	(loose regulation, scale expansion)
4	+	+	-	(loose regulation, scale expansion)
5	+	+	+	(strict regulation, scale expansion)
6	+	-	+	null

of the traditional policy does not mean abandoning the supervision of the ride-hailing platform. Nowadays, the extensive scale expansion strategy of "striving for customers, striving for money, striving for market share" of major ride-hailing platforms is no longer suitable for the current market development. The passenger safety problem has recently attracted increasing public attention, requiring the ride-hailing enterprises to strictly control and manage the quality of vehicles and drivers, protect passengers' safety and personal information, and turn to a healthy development model based on improving service quality. Under these circumstances, wherein the internal power of the ride-hailing industry to transform the development model is insufficient, it is necessary for the government to strengthen its regulatory role of the industry, and force the platform to transform the development mode and improve service quality. The analysis of the game results indicates that, due to the existence of bounded rationality in the game process, the game subject cannot adopt stability strategies as the government tends to improve the subject's service by a strict regulation strategy through its own evolution. Therefore, determining how to guide both sides of the game to adapt their behavior along the expectations of government regulation has become the key issue for the development of regulatory policy, and the key parameters affecting the game process need to be further explained.

In the process of the evolutionary game between the government and the ride-hailing enterprises, from the perspective of the government, to reduce the regulation cost of ride-hailing industry c_3, to increase the single-vehicle's penalty p if the platforms do not respond to the government's regulations to expand the scale of the market, $y^* = C'/\Delta N(p - c_3)$ can be lowered, urging the government to strictly regulate the ride-hailing market.

Simultaneously, the number of service providers continues to increase, making y^* decrease with the increase in the ride-hailing market. The contradiction between the market, resources, and environment is increasing gradually, prompting the government to adopt more stringent regulatory measures.

From the perspective of the enterprises, the proportion (n) of the service promotion strategy selected by platforms can be represented as a function of c_2, μ, a, which can be computed as $n = n(c_2, \mu, a)$ $0 \leq n \leq 1$, raising the additional cost c_2 of the platform to attract exiting drivers to rejoin the platform and increasing the single-vehicle's penalty p so that the platforms do not respond to the government's regulations to expand the scale of the market, which can decrease the value of x^*.

$$x^* = \frac{R - C - (R_1 - C_1) + \Delta N(r - c_1 - \mu p)}{\Delta N(c_2 + p - \mu p)}. \quad (17)$$

Therefore, the proportion of ride-hailing enterprises that improve services is increased. The influence of the specific parameter's changes on the evolution and stability strategies of the two subjects in the game are shown in Table 8.

Table 8 indicates that the government's administrative penalties p for the illegal operation of platforms play an important role, not only in encouraging the government to strictly regulate the industry but also in changing the development model of the platform to improve service quality. Because the government's enforcement index μ affects the intensity of the administrative penalty for the network platform, this study further investigates the influential mechanism of μ and p, and examines how they influence the equilibrium on game system. The following is a computer simulation example used to discuss the strategy selection of the ride-hailing platforms under the joint mechanism of government supervision and administrative penalty.

4. Calculation Example

Let us assume that the expansion scale of the ride-hailing platforms is ΔN, $\Delta N = 100$, the regulation cost of single-vehicle $c_3 = 1$, the costs of the government's strict regulation $C' = 100$, the attraction cost of single-vehicle $c_2 = 0.8$, the earning of single-vehicle r = 2, the cost of single-vehicle's operation on a large scale $c_1 = 0.5$, and the cost of single-vehicle's operation on a large scale c_1=0.5.

At the beginning of the transformation, the up-front costs of turning the development of the platform to a high-quality mode are high, the profit transformation mechanism is not mature yet, and the profit is lower than that in the scale expansion model (the profits can differ by 20). Setting the value of government supervision μ as $[0, 1]$, μ= 0.8 is the strong supervision; $\mu = 0.2$ is the weak supervision; setting the value of government punishment p as $[0, 2]$, $p = 2$ is the strong punishment; $p = 0.5$ is the weak punishment. Let us set four situations—strong supervision and strong punishment, strong supervision and weak punishment, weak supervision and strong punishment, and weak supervision and weak punishment—that analyze the influence of government supervision and punishment intensity on platforms' strategy selection.

Table 8: Parameters' effects on evolutionary game equilibrium.

Parameter change	Game between government and platforms		Evolution direction	
	x^*	y^*	government	platforms
$c_3 \downarrow$	—	$\downarrow$	strict regulation	uncertain
$p \uparrow$	$\downarrow$	$\downarrow$	strict regulation	service promotion
$c_2 \uparrow$	$\downarrow$	—	uncertain	service promotion
$\mu \uparrow$	$\downarrow$	—	uncertain	service promotion

Situation 1. In this situation, $\mu = 0.8$ and $p = 2$, so the government has strong supervision and punishment intensity over the network platform. The simulation results are shown in Figure 2(a). At this point, the platforms that do not respond to government policies are faced with high fines. The cost of attracting the driver to rejoin the network is increased. The platforms tend to abandon scale expansion and choose the conservative management strategy of upgrading services under a more stringent regulatory environment, and the market development tends to be stable and of high-quality.

Situation 2. In this situation, $\mu = 0.2$ and $p = 2$, so the supervision of the government is weak, but it still maintains high penalty intensity. Considering the high penalties faced by platforms in violation of relevant regulations, operators tend to choose the service promotion strategy. However, due to the weakening of the government's supervision, the speed at which platforms' move toward a stability strategy for improving the service obviously slows down.

Situation 3. In this situation, $\mu = 0.8$ and $p = 0.5$, so the government has strong supervision, but the penalty intensity has reduced. The cost of breaking the law is relatively low, and there is no effective punishment mechanism for the platform operators who do not respond to the government's policies. In this case, the choice of platform management is split; some radical enterprises still choose scale expansion, while conservative enterprises turn to improve the quality of service.

Situation 4. In this situation, $\mu = 0.2$ and $p = 0.5$, so the government's supervision and punishment intensity are at a relatively low level, the restriction effect of policy on the operation behavior of the ride-hailing market is low, and the platforms tend to choose the development strategy of scale expansion. This gives rise to the phenomena of nonstandard operation behavior and market chaos.

Through this simulation analysis, it is clear that government regulation of the ride-hailing market should be done mainly through improving the supervision of operators and increasing the penalties for violations. The government's strict regulation must have a strong penalty mechanism as a foothold, even if the government's supervision is maintained at a higher level. Once the penalty intensity decreases, some platform operators will still choose to pay low illegal costs in exchange for high market share and high returns brought by scale expansion, and other platforms that choose the strategy to enhance service will face greater operational pressure. Therefore, by analyzing the influence of government supervision and punishment intensity on platforms' choice of strategy, it can be concluded that, in the current ride-hailing market, only combining government supervision and punishment intensity can help to regulate the development of the market.

5. Conclusions

Based on the bounded rationality of both sides of the game, this study used the evolutionary game theory to analyze the game process between the government's law enforcement department and the ride-hailing platform enterprises. Through systematically investigating the strategic behaviors of both sides of the game and their influencing factors, we draw the following conclusions.

Firstly, the analysis of the evolutionary game's stabilization strategies of the two players in different scenarios indicated that the evolutionary stabilization strategies of one player are influenced by their own profits and the other player's choice of behavior, and as the main subject of administrative supervision, the government is more inclined to choose loose regulations when the financial pressure of strict supervision on the industry is great. Secondly, the analysis of the specific influencing factors shows that the government tends to choose a strict regulation strategy by reducing the regulatory cost of the ride-hailing industry and increasing the fines for platforms' violations, while the platforms tend to choose the strategy of upgrading service by changing the government's supervision, increasing the attraction cost of the platform to exiting drivers, and increasing the illegal cost of the operators. Thirdly, from the simulation results, it can be concluded that strengthening the government's supervision and punishment intensity of the ride-hailing industry can encourage the platforms to choose the strategy of enhancing their services. However, when the punishment intensity is reduced, some enterprises will still tend to choose to expand the market scale even if the market is supervised strongly. In addition, at present, the government has not formed an effective regulatory system for the operation of the network platforms, and the regulatory cost is high. Therefore, strengthening the punishment for platforms' violations is an effective way to encourage the ride-hailing enterprises to enhance service quality.

At present, the primary focus of both the government and the enterprises is how to develop the ride-hailing industry and how to effectively supervise and control the new business. The contradiction between "strict policy control" and "lack of supervision" has led to the difficulty of implementing a new policy; the legal operation of the ride-hailing enterprises is difficult, and a grey area still exists. Based on the above

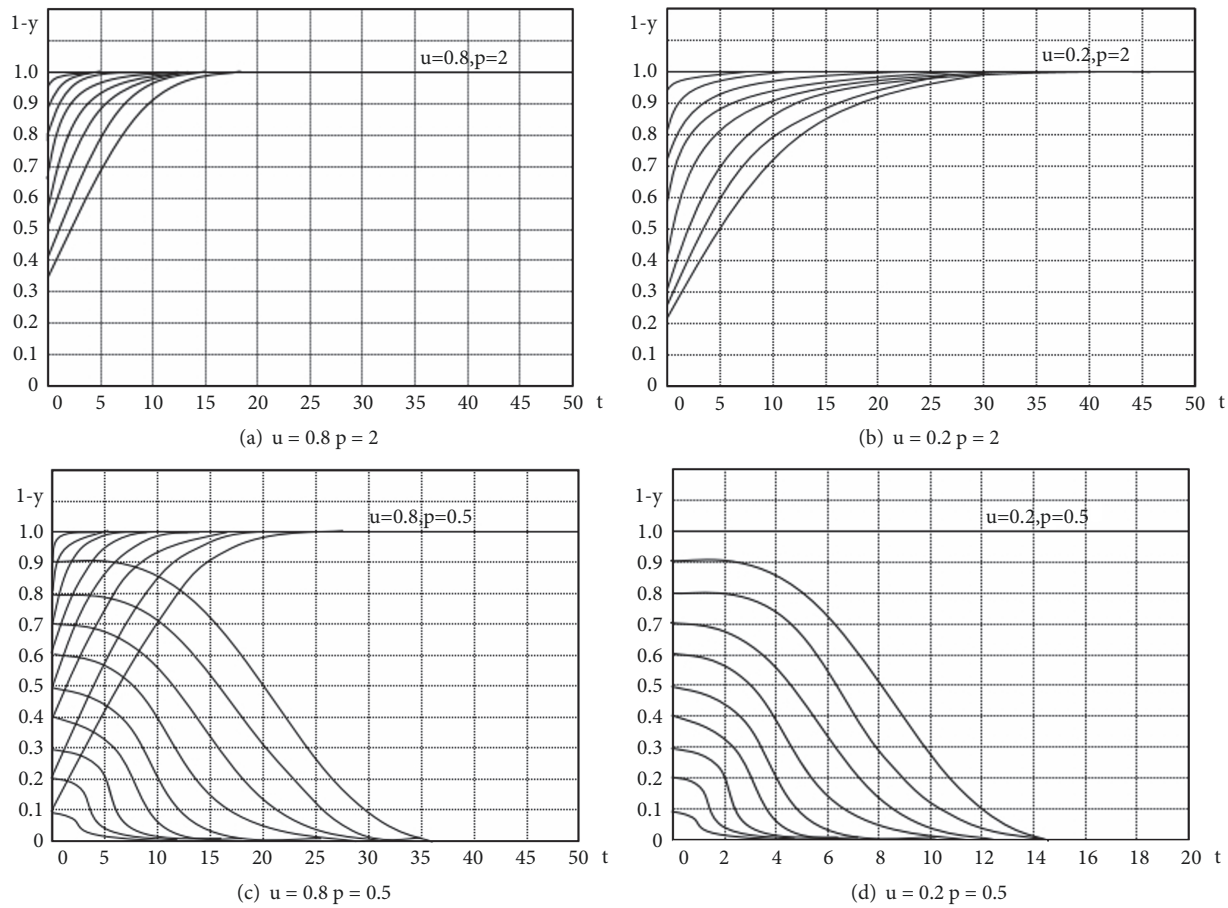


Figure 2: Simulation of the government's supervision and punishment intensity under different circumstances.

conclusions and the development of the ride-hailing industry, the following policy recommendations can be put forward:

(1) Strengthening the legislative guarantee for the regulation of the ride-hailing industry and emphasizing the details and quality in the legislative process. The national level of the new regulations on the ride-hailing industry leaves much room for local governments to specify the regulations according to the characteristics of the local travel market and to prevent operators from exploiting loopholes in the law. At the same time, more attention should also be paid to the details and quality of the regulation of the ride-hailing industry, as well as the feasibility of law enforcement.

(2) Strengthening law enforcement and government supervision and guiding the standard development of industries. The blind expansion of the network platforms leads to market chaos, vicious competition, and other problems, therefore, the government should increase punishment measures for illegal business behaviors and strictly enforce the law to reasonably guide and regulate the platform.

(3) Improving the technical means of supervision, exploring a supervision model based on big data, and encouraging platforms to share data with government regulators, as well as speeding up the construction of regulatory platforms. Ride-hailing services are a typical type of business that includes "Internet + traffic." To make efficient use of the dynamic travel data of the public, big data should be used to help strengthen government regulation, improve passengers' experience, standardize drivers' training, and improve the service level of online car-hailing.

(4) Subdividing the travel market and exploring a customized service model. The chaos of seizing the market, vicious competition with traditional taxis, and frequent safety problems in the operation of the ride-hailing market require the network platforms to change their concept and clear positioning accurately. Only by upgrading service quality, subdividing the market, customizing services, and implementing other innovations, can an enterprise be profitable in a large homogeneous market and firmly occupy the middle and high-end market that has the most profits.

In addition, this study also has some limitations, which provide directions for future research. First, concerning the complexity of participants' behavior, this study only analyzed two-dimensional participants in the process of regulation of the ride-hailing industry. In the future study, we will expand the number of participants in the game. Second, as the actual operation data of the current network platforms are still not open to the public, the lack of practical data in the empirical study of the theoretical model may have led to

some deviations. Therefore, further studies should design the government's regulation mechanism and combine it with a case analysis of this new type of business.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

Acknowledgments

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