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Evolutionary Game Analysis of Bike Sharing Management Strategy Under Social Supervision Mechanism*

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***Abstract*—This paper employs the evolutionary game theory to analyze the interactive mechanism between users and platforms on sharing bicycles parking in disorder, platform independent management and joining social supervision mechanism are analyzed separately. Research shows that the platform independent management cannot effectively restrict user behavior of illegal parking; join the social supervision mechanism, when the user's social costs outweigh the additional utility, the strategy evolution stability in the compliance parking bike sharing. Therefore, it is necessary to establish and improve an effective social supervision mechanism based on platform management.**

***Keywords*—bike sharing; illegal parking; social supervision mechanism; evolutionary game; replicator dynamics equation**

I. INTRODUCTION

Bicycle sharing is an emerging vehicle leasing business. Bicycles are used as carriers to provide time-sharing rent services in subway bus stations, campuses, commercial areas, and residential areas. As an extension of urban transportation, bicycle sharing effectively solves the traffic demand of people traveling in a short distance, saving the time cost and service cost of waiting for the vehicle, and also conforming to the concept of low-carbon travel. Compared with the traditional public bicycles led by the government, the newly-shared bicycles realize the no-pile operation and the mobile Internet payment, and the fetch and returning of the vehicles are flexible and cost-effective. Therefore, the user scale is growing rapidly. According to statistics from the China Business Research Institute, since the sharing of bicycles in 2014 to December 2017, the number of domestic shared bicycle users reached 221 million, accounting for 28.6% of the total domestic netizens. In the second half of 2017, users increased by 115 million, with a growth rate of 108.1%. According to the "2018-2023 Shared Bicycle Industry Market Prospects and Investment and Financing Strategy Research Report" issued by the China Industrial Research Institute, the market size of domestic shared bicycles will reach 17.82 billion yuan in 2018, with an estimated annual growth rate of 73.3%. The explosive growth of shared bicycles also brings many problems to urban management. For example, the place of distribution is mainly concentrated in large communities, office buildings, and subway stations, causing bicycles to occupy public roads. The platform does not timely obtain information for old and trouble bicycles and "zombie bicycles". Some users lack the correct parking awareness, who always park the bicycles in remote places to reduce the frequency of bicycle use and lead to increased management difficulty. Chaotic and unregulated riding, etc. not only increase the production and operation costs of the platform, but also affect the development of the platform. It also affects the public transport order, and especially the illegal parking behavior has invaded public resources such as roads and increased the difficulty of urban space management.

There are many reasons for the user's non-standard parking. First of all, from the user level, the separation of property rights and usage rights of shared bicycles may lead to the phenomenon of “no possession, no rejection, no responsibility” for users. And because some users are irresponsible or lack proper parking awareness, they don't park according to the specified scope just at their convenience. Secondly, from the government level, the current traffic planning lacks sufficient bicycle parking area, the scale of shared bicycles increases sharply and related laws and regulations and management policies lag behind. At the level, there is no fixed parking point for the return of the pileless bicycle. The existing restrictions on the user are limited to the means of GPS positioning, special personnel management reminders, user reports, etc. There are still no relevant punishment measures for users to illegally park the parking; the credit system is not perfect, and it is also an important factor to fail to properly restrain the user. The user operation depends mainly on his conscious awareness, and the penalty for the bicycle to be towed and suspended by the user in violation of the parking lot may be borne by the bicycle sharing platform. The platform lacks the power of active management because of the high management cost, resulting in the social dilemma of sharing bicycles without responsibility. For the problem of illegal bicycle parking, the platform can play a normative role if it is actively managed, but it needs to pay for this to manage operating costs, and

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may lose some critical users. Negative management saves operating costs, but it stops on the one hand and makes the platform punished by the traffic management department, and on the other hand it also causes social negative externalities. How to develop a penalty mechanism to standardize user parking under the condition of maximizing profits and reduce the negative externalities brought by shared bicycles has become an urgent problem to be solved.

The academic community has just started to research on shared bicycles, mainly focusing on the concept of sharing economy and shared bicycles and basic theories, development models, potential problems, supervision and governance. [1], [2], [3] In terms of bicycle sharing specification management, Zhou Yaping [4] proposed that the government supervision department should provide a good development environment for the sharing economic market entities by studying the diffusion mechanism of bicycles sharing. Song Shuning [5] proposed from the perspective of legal supervision to standardize the behavior of the platform, improve the supervision system of the administrative department, and introduce the credit system to regulate users. Zhang Yijin [6] explored how to solve the problems in the development of bicycle sharing platforms through the evolutionary game analysis between the platform and the government. Yang Liuhua [7] analyzed the main factors affecting the parking behavior of shared bicycles through the theory of diffusion planning behavior, and believed that the perception of the consequences and the perception of the system positively affected the user's intention of parking cooperation through the attitude of the users. The existing literature does not address the research on the interaction mechanism between bicycle sharing platforms and users, and lacks the economic analysis of platform supervision to regulate user behavior.

In view of the existing literature research, this paper uses the evolutionary game theory [8] to study the strategy of bicycle sharing platform and user groups for the parking problem of shared bicycles. With the goal of maximizing the utility of economic individuals, starting from the platform operation management cost and user utility, and adding the social supervision to the penalty variables of user violations, this paper analyzes the evolution path of the game's two strategies, and provides economic guidance for effectively regulating the user's parking behavior.

II. GAME MODEL CONSTRUCTION BETWEEN BICYCLE SHARING PLATFORM AND USERS

A. *Establishment of Evolutionary Game Model*

The evolutionary game model considers the problem of random parking and random release in the process of sharing bicycle use, sharing the game problem between the management strategy of the bicycle platform and the user parking strategy. The two sides of the game cannot make the optimal decision in one game. It is to improve their expected payment through continuous trial and error and imitation learning, so that they can obtain higher adaptability in this decision [9]. For the sake of convenience, this paper proposes the following basic assumptions:

First, the game participants are bicycle sharing platforms and users with limited rationality, the shared bicycle user group is recorded as D, and the platform group is recorded as S. The economic goals of both parties are maximizing their own profits and maximizing their own utility, regardless of the user’s intentional destructive behavior of shared bicycles, such as deliberately throwing a bicycle into the river for uneconomic behavior.

Second, the user's strategy selection is compliant parking and illegal parking. The strategy of bicycle sharing platform is positive management and negative management. The market is in an incomplete information state, and any user can choose to park in the white line area designated by the government after using the shared bicycles, so that other users can reuse and maintain the order of the municipal road; or choose to park the shared bicycles at a distance from the the nearest area to the destination to save time costs or to facilitate the next use. The bicycle sharing platform can choose to positively manage the users and bicycles, locate the shared bicycle parking places of the users through GPS, etc., and use the special patrol managers to discover and transfer the illegally parked bicycles and other standard shared bicycles at any time. Negative management can be selected to save management costs, and then the platform can process the shared bicycles.

Third, it is assumed that the proportion of users who use shared bicycles in compliance with the group is $x(0 \leq x \leq 1)$, and the proportion of users who use the shared bicycle strategy in violation of regulations is $1-x$. The proportion of shared bicycle platforms that adopt an active management strategy to the group is $\mathrm{y}(0 \leq y \leq 1)$, while the proportion of passive management strategies is $1-y$.

Forth, in order to further construct the income matrix, it is assumed that R represents the rental business fee of the bicycle sharing; C represents the management cost of the actively managed bicycle platform, including the R&D and upgrade of the bicycle related technology, the labor cost of the management personnel and other hardware inputs. For convenience, it can be assumed that the management cost of the platform for passive management is zero. Q indicates the benefits of active management. L indicates the losses incurred when the bicycle sharing platform to select the negative management strategy, including the maintenance cost of shared bicycles' damage, high depreciation rate, illegal administrative penalty and reputation decline. U represents the expected utility obtained by the user to park the shared bicycle in compliance, and the UI represents the additional utility obtained by the user in illegally parking the shared bicycle, such as the time cost saved by parking the shared bicycles in the nearest position. P indicates the penalty standard for illegally parking users during active management. Since the market is in an incomplete information state, the probability that the user violates the rules is θ, so the actual expected penalty of the offending user is θP.

According to the above assumptions, the income matrix of both sides of the game is shown in “Table I”.

TABLE I. ASYMMETRIC REVENUE MATRIX BICYCLE SHARING PLATFORM AND USER

Both sides of the game		**Bicycle sharing platform**	
		Positive management	***Negative management***
Bicycle sharing user	***Compliance***	(U − R, R − C)	(U − R, R)
	Violation	(U + UI − R − θP, R − C + Q)	(U + UI − R, R − L)

According to the model hypothesis, the expected income and average income of the shared bicycle users in the case of "compliance" and "violation" is E_x , E_{1-x} and $\bar{E}_D$, respectively. Then there will be

$$E_x = y(\mathrm{U-R}) + (1-y)(\mathrm{U-R}) = \mathrm{U-R} \quad (1)$$

$$E_{1-x} = y(\mathrm{U+UI-R}-\theta\mathrm{P}) + (1-y)(\mathrm{U+UI-R})$$
$$= \mathrm{U+UI-R}-y\theta\mathrm{P} \quad (2)$$

$$\bar{E}_D = xE_x + (1-x)E_{1-x} \quad (3)$$

The replication dynamic equation is a dynamic differential equation describing the frequency at which a particular strategy is used by the population in an evolutionary game [10]. The replication dynamic equation for a bicycle sharing user strategy is:

$$\mathrm{D}(x) = \frac{dx}{dt} = x(E_x - \bar{E}_D) = x(1-x)(E_x - E_{1-x})$$
$$= x(1-x)[y\theta\mathrm{P} - \mathrm{UI}] \quad (4)$$

Similarly, the expected income and average income of the shared bicycle platform "negative management" and "positive management" is E_y, E_{1-y} and $\bar{E}_S$, respectively.

$$E_y = x(R-C) + (1-x)(\ R-C+\mathrm{Q})$$
$$= R - C + (1-x)\mathrm{Q} \quad (5)$$

$$E_{1-y} = xR + (1-x)(R-\mathrm{L}) = R-(1-x)L \quad (6)$$

$$\bar{E}_S = yE_y + (1-y)E_{1-y} \quad (7)$$

The replication dynamic equation for the bicycle sharing platform strategy is:

$$\mathrm{S}(y) = \frac{dy}{dt} = y(E_y - \bar{E}_S) = y(1-y)(E_y - E_{1-y})$$
$$= y(1-y)[(1-x)(Q+L) - C] \quad (8)$$

B. Evolutionary Stability Analysis of Bicycle Sharing User Strategy

According to the replication dynamic equation of the shared bicycle user strategy, when $y = y_0 = \frac{UI}{\theta\mathrm{P}}$ is used, $\frac{dx}{dt} = 0$ is always true. At this time, no matter what value x takes, it is an evolutionary equilibrium state; when $y \neq y_0$ is used, $x_1 = 0, x_2 = 1$ are the two boundary fixed points of the dynamic equations. According to the stability theorem of differential equations [11], the evolutionary stability strategy of bicycle sharing users is required to satisfy:

$D'(x) = \frac{dD(x)}{dx} = (1-2x)[y\theta\mathrm{P} - \mathrm{UI}] < 0$, the different situations of $\frac{UI}{\theta\mathrm{P}}$ are analyzed as follows:

- If there are $0 < \frac{\mathrm{UI}}{\theta\mathrm{P}} < 1$ and $y < \frac{UI}{\theta\mathrm{P}}$, then $D'(0) < 0$, $D'(1) > 0$, $x_1 = 0$ is an evolutionary stability strategy, that is, when the penalty of the offending user is lower than the utility obtained by using the shared bicycle in violation of the rules, and the probability that the platform implements the active management strategy is lower than y_0, the user will eventually select the "violation" strategy by continuously learning.
- If there are $0 < \frac{\mathrm{UI}}{\theta\mathrm{P}} < 1$ and $y > \frac{UI}{\theta\mathrm{P}}$, then $D'(0) > 0$, $D'(1) < 0$, $x_2 = 1$ is an evolutionary stability strategy, that is, the penalty for violating the user is higher than the utility obtained by using the shared bicycle. If the probability of the platform implementing the active management strategy is higher than y_0, the user will eventually choose the "compliance" strategy.
- If $\frac{\mathrm{UI}}{\theta\mathrm{P}} > 1$, there is always $D'(0) < 0$, $D'(1) > 0$, $x_1 = 0$ for the evolutionary stability strategy, that is, when the penalty of the offending user is less than the utility obtained by using the shared bicycle in violation of the rules, regardless of whether the platform chooses "negative management" strategy or "positive management", the user will eventually choose the "violation" strategy.

C. Evolutionary Stability Analysis of Bicycle Sharing Platform Strategy

According to the replication dynamic equation of the bicycle sharing platform strategy, when $x = x_0 = 1 - \frac{\mathrm{C}}{\mathrm{Q+L}}$ is used, $\frac{dy}{dt} = 0$ is always true. At this time, no matter what value y takes, it is the evolutionary equilibrium state; when $x \neq x_0$ is used, $y_1 = 0, y_2 = 1$ is the two boundary fixed points of the dynamic equations. The evolutionary stability strategy for bicycle sharing users requires:

$S'(y) = \frac{dS(y)}{dy} = (1-2y)[-\mathrm{C} + \theta\mathrm{P} + \mathrm{L} - x(\mathrm{Q+L})] < 0$. $\mathrm{Q+L-C}$ is the difference between loose management loss and strict management loss. The different situations of $Q + L - C$ are analyzed as follows:

- If $\mathrm{Q+L-C} < 0$, there is always $S'(0) < 0$, $S'(1) > 0$, $y_1 = 0$ for the evolutionary stability strategy, that is, when the positive management loss is greater than the negative management loss, no matter which strategy the user chooses, the platform will eventually choose the "negative management" strategy.

- If there are $Q+L-C>0$ and $x>1-\frac{C}{Q+L}>0$, then $S'(0)<0, S'(1)>0, y_1=0$ is an evolutionary stability strategy, that is, when the positive management loss is less than the negative management loss, if the probability of the user using the shared bicycle more than the mathematical formula is greater than x_0, the platform will eventually select the "negative management" strategy.
- If there are $Q+L-C>0$ and $x<1-\frac{C}{Q+L}>0$, then $S'(0)>0, S'(1)<0, y_2=1$ is an evolutionary stability strategy. When the positive management loss is less than the negative management loss, if the probability of the user using the shared bicycles is less than x_0, the platform will eventually choose "active management" strategy.

III. EVOLUTIONARY STABILITY ANALYSIS OF BICYCLE SHARING PLATFORM AND USER STRATEGY

According to the replication dynamic equations (4) and (8), there are five Nash equilibrium points in the game dynamic system bicycle sharing platform and the user's two strategies, respectively

$E(0, 0), E(0, 1), E(1, 0), E(1, 1), E(x_0, y_0)$

Here is $x_0=1-\frac{C}{Q+L}$, $y_0=\frac{UI}{\theta P}$.

The stability of the equilibrium of the evolutionary game system can be obtained by the local stability analysis of the Jacobian matrix of the replica dynamic equation system [12]. According to the replication dynamic equations (4) and (8), the Jacobian matrix of the system is obtained as:

$$J=\begin{pmatrix}\frac{\partial D(x)}{\partial x} & \frac{\partial D(x)}{\partial y}\\ \frac{\partial S(x)}{\partial x} & \frac{\partial S(x)}{\partial y}\end{pmatrix}$$

$$=\begin{pmatrix}(1-2x)[y\theta P-UI] & x(1-x)\theta P\\ -y(1-y)(Q+L) & (1-2y)[(1-x)(Q+L)-C]\end{pmatrix}$$

According to the local stability theorem of Jacobian matrix, when the equilibrium point satisfies $\det(J)>0$, $tr(J)<0$ at the same time, the equilibrium point of the evolutionary dynamic process is a locally asymptotically stable state. Through the local stability judgment theorem of Jacobian matrix, the stability analysis of the above five equilibrium points under different conditions is carried out. The results are shown in "Table II".

TABLE II. EVOLUTIONARY STABILITY ANALYSIS RESULTS OF THE EQUILIBRIUM POINT

Condition \ Equilibrium point	$(0, 0)$	$(0, 1)$	$(1, 0)$	$(1, 1)$	(x_0, y_0)
$\theta P<UI,\ L<C-Q$	ESS	Saddle point	Saddle point	Unstable	Does not exist
$\theta P<UI,\ L>C-Q$	Saddle point	ESS	Saddle point	Unstable	Does not exist
$\theta P>UI,\ L<C-Q$	ESS	Unstable	Saddle point	Saddle point	Does not exist
$\theta P>UI,\ L>C-Q$	Saddle point	Saddle point	Saddle point	Saddle point	Center

From the results of "Table II", the dynamic evolution trend of the shared bicycle platform and user strategy is as follows:

Case 1: When $L<C-Q$, the system has four equilibrium points, $E(0, 0)$ is the evolution stability critical point, when is $\theta P<UI$, $E(1, 1)$is the unstable critical node, $E(0, 1), E(1, 0)$ is the saddle point. When $\theta P>UI$is used, $E(0, 1)$ is an unstable critical node, and $E(1, 0), E(1, 1)$ are the saddle points. In these two cases, the evolutionary game diagram of the shared bicycle platform and the user is shown in "Fig. 1" and "Fig. 2" respectively. The stability point $E(0, 0)$ indicates that the penalty for the user's illegal parking is too low. When the platform positive management cost too much, the platform does not have the power to implement strict management strategies, and the social credit punishment does not play a role in restraining user behavior and promoting cooperation. The system eventually evolves into a typical social dilemma.

Case 2: When $\theta P<UI, L>C-Q$, the system has four equilibrium points, where $E(0, 1)$ is the evolutionary stability critical state, $E(1, 1)$ is the unstable critical node, and $E(0, 0), E(1, 0)$ is the saddle point. At this time, the penalty for the user's illegal parking is small. Even if the platform chooses an active management strategy, it still cannot guarantee the long-term constraint on the offending user. For the purpose of maximizing its utility, the user eventually tends to choose the violation policy. The loss of passive management of the platform is greater. As shown in "Fig. 3", the platform strategy will be stable and actively managed in the long term. However, in reality, this strategy not only reduces the probability of users violating parking, but also increases the operating cost of platform operations.

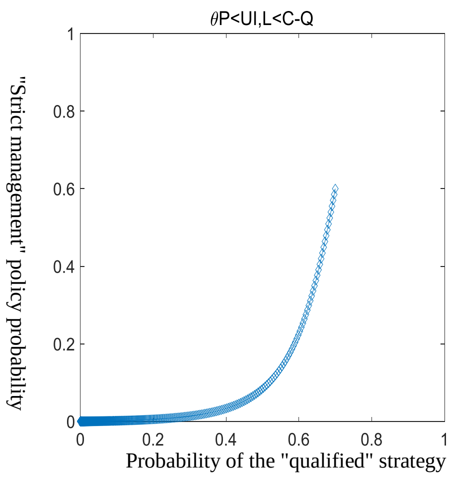

Fig. 1. Two-group strategy evolution path when θP<UI, L<C-Q.

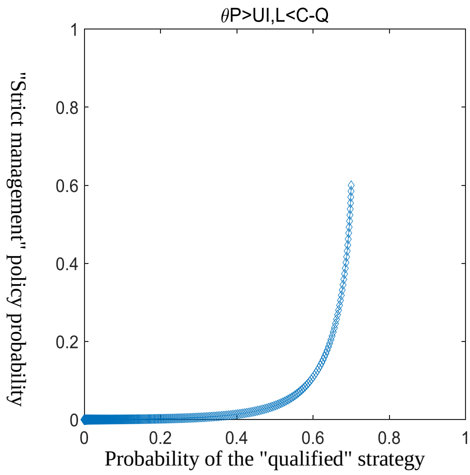

Fig. 2. Two-group strategy evolution path when θP>UI, L<C-Q.

Case 3: When $\theta P > UI$, $L > C - Q$, that is, the additional utility obtained by the user illegal parking is less than the penalty, and the platform active management cost is greater than the sum of the management income and the loss suffered by the negative management. The evolutionary system does not have a stable equilibrium point. There are only four saddle points in $E(0, 0)$, $E(0, 1)$, $E(1, 0)$, $E(1, 1)$. As shown in “Fig. 4”, the game evolution trajectory of the system is a closed-loop trajectory around the central point.

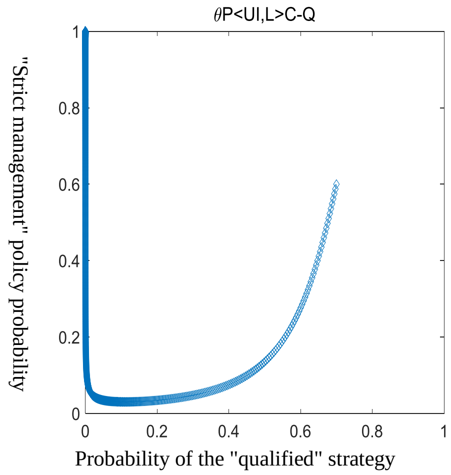

Fig. 3. Evolution path of two groups of strategies when θP<UI, L>C-Q.

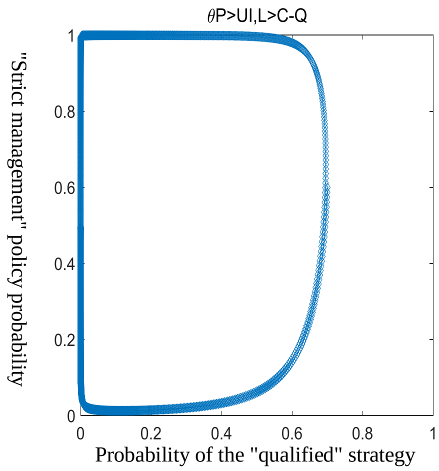

Fig. 4. Evolution path of two groups of strategies when θP<UI, L<C-Q.

It can be seen from the above evolution stability analysis that the evolutionary equilibrium point of the bicycle sharing platform and the user will be affected by the additional utility of the user's illegal parking and the punishment, the strict management of the platform and the net loss of loose management. When the platform's strict management net loss is greater than the loose management net loss, the system evolution is stable in the loose management and violation strategy; when the platform strict management net loss is less than the loose management net loss, if the penalty is less than the additional utility obtained by the user illegal parking, the system evolution is stable in strict management and violation strategies. If the penalty is greater than the additional utility obtained by the user's illegal parking, the system does not have a stable equilibrium point, and the strategies of the two groups change periodically.

IV. Evolutionary Stability Analysis of Bicycle Sharing Platform and User Game Under Social Supervision Mechanism

In the above analysis, when the bicycle sharing users illegally parked, only the platform penalized the violation of the platform. It is found that the shared bicycles' parking problem could not be effectively managed. In reality, in order to solve the problem of chaos and arbitrage, the government departments and the public have also taken corresponding measures. Many governments have introduced relevant policies. In addition, the masses have spontaneously organized “cycling hunters” to inspect the shared bicycles, thus forming a social supervision of bicycle sharing. Based on this, the social supervision of illegal parking is added on the basis of the existing variables. The social cost incurred by the illegal parking users under the social supervision mechanism is expressed by MC, and the income matrix of the bicycle sharing platform and the user game changes, as it shown in “Table III”.

TABLE III. ASYMMETRIC REVENUE MATRIX BICYCLE SHARING PLATFORM AND USER

Both sides of the game		**Bicycle sharing platform**	
		Positive management	***Negative management***
Bicycle sharing user	Compliance	$(U-R,\ R-C)$	$(U-R,\ R)$
	Violation	$(U+UI-R-MC-\theta P,\ R-C+Q)$	$(U+UI-R-MC,\ R-L)$

The replication dynamic equations for bicycle sharing users and platform strategies are:

$$D(x)=\frac{dx}{dt}=x(E_x-\bar{E}_D)=x(1-x)(E_x-E_{1-x})$$
$$=x(1-x)[y\theta P+MC-UI] \quad (9)$$
$$S(y)=\frac{dy}{dt}=y(E_y-\bar{E}_S)=y(1-y)(E_y-E_{1-y})$$
$$=y(1-y)[(1-x)(Q+L)-C] \quad (10)$$

According to the replication dynamic equations (9) and (10), there are five Nash equilibrium points in the game dynamic system bicycle sharing platform and the user's two strategies, respectively

$E(0,\ 0)$, $E(0,\ 1)$, $E(1,\ 0)$, $E(1,\ 1)$, $E(x_1,\ y_1)$

Here $x_1=1-\frac{C}{Q+L}$, $y_1=\frac{UI-MC}{\theta P}$

The Jacobian matrix of the system is:

$$J=\begin{pmatrix}\frac{\partial D(x)}{\partial x} & \frac{\partial D(x)}{\partial y}\\ \frac{\partial S(x)}{\partial x} & \frac{\partial S(x)}{\partial y}\end{pmatrix}$$
$$=\begin{pmatrix}(1-2x)[y\theta P+MC-UI] & x(1-x)\theta P\\ -y(1-y)(Q+L) & (1-2y)[(1-x)(Q+L)-C]\end{pmatrix}$$

Supposing $r_1=MC-UI$, $r_2=MC-UI+\theta P$, $r_3=Q+L-C$, through the local stability judgment theorem of Jacobian matrix, the stability analysis of the above five equilibrium points under different conditions is carried out. The results are shown in "Table IV".

TABLE IV. EVOLUTIONARY STABILITY ANALYSIS RESULTS OF EQUILIBRIUM POINTS

Condition \ Equilibrium point	$(0,\ 0)$	$(0,\ 1)$	$(1,\ 0)$	$(1,\ 1)$	$(x_0,\ y_0)$
$r_1<0,\ r_2<0,\ r_3<0$	ESS	Saddle point	Saddle point	Unstable	Does not exist
$r_1<0,\ r_2<0,\ r_3>0$	Saddle point	ESS	Saddle point	Unstable	Does not exist
$r_1<0,\ r_2>0,\ r_3<0$	ESS	Unstable	Saddle point	Saddle point	Does not exist
$r_1<0,\ r_2>0,\ r_3>0$	Saddle point	Saddle point	Saddle point	Saddle point	Does not exist
$r_1<0,\ r_2>0,\ r_3>0$	Saddle point	Unstable	ESS	Saddle point	Does not exist
$r_1>0,\ r_2>0,\ r_3>0$	Unstable	Saddle point	ESS	Saddle point	Center

It can be seen from the results in "Table IV" that when $r_1>0,\ r_2>0,\ r_3<0$ or $r_1>0,\ r_2>0,\ r_3>0$ is used, $E(1,\ 0)$ is the evolutionary stability critical state. At this time, the additional utility obtained by the user in violation of the parking is less than the social cost it receives. The binding force from the social side makes the user's illegal parking not improve its own utility. Therefore, regardless of the strategy chosen by the platform, the bounded rational users tend to choose the compliant parking strategy through learning and cognition. The platform will choose a negative management strategy regardless of the negative management cost. This is a more ideal state in practice. As shown in "Fig. 5" and "Fig. 6", when the social cost is higher than the additional utility obtained by the user illegally parking shared bicycles, the user behavior evolves stably in the "compliance" strategy. Users' fully cooperation, will save platform management and operation costs, and optimize urban standardized management.

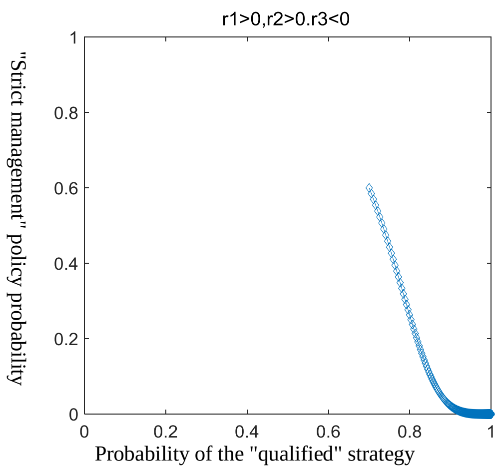

Fig. 5. r1>0, r2>0, r3<0, two groups of strategy evolution path.

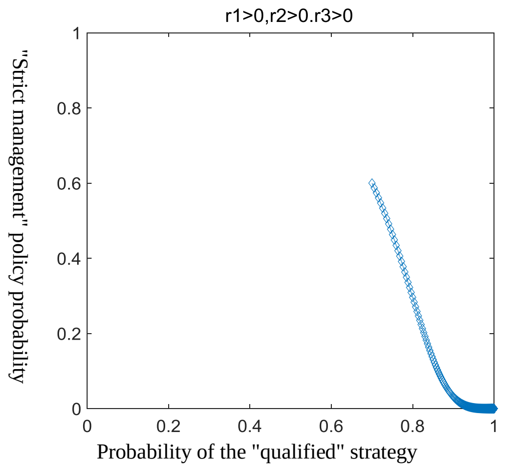

Fig. 6. r1>0, r2>0, r3>0 two group strategy evolution path.

V. CONCLUSION

In this paper, using the evolutionary game theory, the game evolution process of bicycle sharing platform and user strategy is studied for the problem of shared bicycle parking. The goal of maximizing the utility of economic individual is to start from the platform operation management cost and user utility, and join the social supervision to the user violation. The punishment variable of behavior systematically examines the influencing factors in the game process of user behavior strategy and platform management strategy. Studies have shown that social punishment and platform management are important determinants of user's behavior. When the social punishment is weak, the management of the platform to the user cannot make the user behavior evolve to be stable in the compliance strategy. When the social punishment is higher than the additional utility obtained by the user in violation of the bicycle sharing, the evolution of user behavior eventually stabilizes in the compliance strategy. To achieve this, governments, platforms, and individuals need to make the following changes and improvements:

First, the bicycle sharing platform uses Internet technology resources to assess the demand for vehicles in different regions at different times, and rationally allocates the number of shared bicycles, which does not cause excessive parking in large traffic areas and increases parking pressure, nor does it cause lack of shared bicycles in more remote areas so that it can satisfy the reasonable needs of users to the greatest extent, timely realize the "zombie bicycle" recycling and replacement, improve user experience, and save public space to reduce bicycle parking pressure.

Second, the original urban planning did not consider too many bicycle parking areas. The rapid development of the bicycle sharing market urgently required the government to increase the planning of bicycle parking areas, and clearly plans the reasonable parking area for bicycle sharing to legalize shared bicycle parking and reduce the random parking. It will also be necessary to establish a legal system to regulate parking, clarify the main body of responsibility, and reduce the irresponsibility caused by the separation of shared bicycle ownership and use rights.

Third, efforts should be made to promote the construction of an active and efficient social credit mechanism, and to improve the credit information system through docking with credit and online businesses. The platform should also clear the user credit reward and punishment mechanism, and gradually improve the user's sense of integrity. Users can rely on the credit scores to avoid deposits. It not only is convenient but also can urge self-discipline to enhance their credit. The platform restricts user behavior through credit mechanism, improves management operation efficiency, effectively reduces bicycle management and recycling costs, and reduces economic losses to achieve better development.

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