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Resources Sharing Behavior of Science and Technology Service Platform: An Evolutionary Game Approach

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Abstract

As the increasingly complex demand for scientific and technological innovation and explosive growth of scientific and technological resources, all participants of the scientific and technological service platform need to actively share resources to provide support for scientific and technological innovation activities. Therefore, it is of great practical significance to use evolutionary game theory to study the sharing behavior of science and technology resources of users of science and technology service platforms. This paper provides an evolutionary game model based on the analysis of user resource sharing behavior of science and technology service platform, discusses the dynamic evolution process and influence factors of game equilibrium strategy of science and technology resource sharing behavior. The results show that the less the extra cost of positive sharing, the more the extra benefits and the less the defection benefits are, the more users in the platform will choose the positive resource sharing strategy. The research results have an important guiding role in establishing and managing the science and technology service platform, and in making decision about science and technology resource sharing behavior.

Keywords

Science and Technology Service Platform, Science and Technology Resources, Resource Sharing Behavior, Evolutionary Game

1. Introduction

In the age of big data, the rapidly development and progress of the new information technology, such as the Internet of Things, cloud computing, artificial intelligence, it has spawned an unprecedented wave of scientific and technological innovation. As the needs of diversified and personalized scientific and technological innovation is growing, to provide relevant service for scientific and technological innovation activities, the scientific and technological service platform integrates different types of scientific and technological resources in different fields. Relying on the original accumulation of Internet technology and massive scientific and technological resources, the scientific and technological service platform focuses on the interconnection and open sharing of scientific and technological resources, and all participants of the platform form a collaborative network to promote regional collaborative innovation by complementing each other's advantages.

Since 2004, China has officially started the construction of the national science and technology platform, which is basic. To establish an institutional system with sharing as the core is the one of main tasks. It is emphasized to strengthen the construction of the platform with basic scientific and technological function in *The Outline of the National Medium and Long Term Science and Technology Development Program* (2006-2020). As a result, a large number of science and technology service platforms have emerged, led by the government or scientific research institutes, science and technology information enterprises. It values the role of innovation and technological development. Therefore, the number is increasing in the scientific and technological service platform, such as scientific and technological enterprises, scientific research institutions and others. The science and technology service platform provides support for cross-border integration and collaboration of science and technology resources, and different knowledge exchanges for knowledge innovation. Under the digital economy, the science and technology service platform reflects the ecological development trend of sharing, cocreating, cogoverning and win-win of science and technology resources. It is an important means for individuals and enterprises participating in the science and technology service platform for resource sharing and knowledge innovation, with the rapid development of society in the digital economy era (Carcia et al., 2018).

The open sharing of science and technology resources among the participants of the science and technology service platform is a process of repeated games, which requires the participants to make a decision on whether to positive share based on interest driven, mutual learning and imitation. Therefore, from the perspective of game theory, this paper introduces evolutionary game theory to analysis the resource sharing behavior among different users, unlike the existing literature, which mostly carries on the qualitative analysis form a static perspective. This paper builds a mathematical model to analysis the impact of extra cost, excess return, betrayal benefit and other factors on the system evolution from a dynamic perspective. The main contribution of the study are shown as follows: (a) This paper establishes an evolutionary game model to identify the key factors that affect the users' sharing behavior strategy in the science and technology service platform, which is helpful to understand users' resource sharing behavior; (b) The conclusion of this research has important theoretical and practical significance for promoting the development of science and technology service platform, strengthening the construction of resource sharing service system and giving full play to the role of science and technology service platform. In addition, this study provides policy implications not only for China, but also for other developing countries to promote scientific and technological collaborative innovation.

2. Literature Review

Science and technology services are the driving force for the sustainable development of the national economy, and play a key role in deepening the reform of the science and technology system and driving economic transformation and upgrading. The science and technology service platform is an important part of the science and technology service system, and plays a fundamental role in optimizing the allocation of science and technology resources, promoting specialization technology, consulting and incubating science and technology and other services. According to the research on the functions of science and technology service platform, it integrates the service functions of sharing science and technology resources. On the one hand, it can be used as a sharing platform to gather and integrate scientific and technological resources, and has the service function of providing integrated and systematic solutions for resource demanders and providers in scientific and technological activities (Nucciarelli et al., 2017); On the other hand, it can serve as a technology platform to provide special technical services for the development of emerging technologies and industries, and form a distributed innovation organization system (Alblas & Wortmann, 2014).

The optimal allocation and open sharing of science and technology resources is an important part of science and technology services. In recent years, it has become the research focus of scholars at home and abroad, among which the sharing science and technology resources is the main concern. This is mainly because the resources sharing can open and integrate the existing resources, and constantly create new resources in the process of sharing and create greater value. Otcenaskova et al (2014) pointed out that carrying out open and shared cooperation on science and technology resources can provide collaborative service support for regional innovation. Based on user needs and experiences, Jin et al. (2018) believed that resource sharing is a process of effectively using different subjects and different types of science and technology resources to serve customers.

Evolutionary game theory has been put forward for decades (Gao et al., 2019; Chen et al., 2020). The hypothetical agent of the game is bounded rational, which is very suitable for studying the behavior evolution between individuals. It focuses on the dynamic process of achieving balance, in which participants gradually modify strategies through learning and finally achieve the best choice. Scholars have conducted extensive research on evolutionary game. Zhang & Sun (2019) established a dynamic competition model to analyze the cooperative innovation behavior of high-tech enterprises. Wang et al. (2020) constructed a tripartite evolutionary game in the green innovation system to analyze the behavior strategy choices of the government, enterprises and consumers.

This paper applies evolutionary game theory to study the users' resource sharing behavior of science and technology service platform in order to solve the following problems: Do users actively choose resource sharing behavior strategies? What factors will affect users' sharing behavior? How should we do to improve resource sharing behaviors among users in the science and technology service platforms?

3. Resource Sharing Behavior of Science and Technology Service Platform

3.1. Resource Sharing Requirements of Science and Technology Service Platforms

Science and technology service platform is an important measure to promote the sharing of science and technology resources, and an important way to optimize the sharing mode of science and technology resources. According to the specific requirements of deepen the reform of the science and technology system, the resource sharing needs faced by building a science and technology service platform are mainly reflected in the following two aspects.

1) Transformation of science and technology achievements. Universities and research institutes mainly focus on the theme of transformation of science and technology achievements, that is, when such users complete the innovation of science and technology achievements, they need timely and effective information docking with the results demanders. This shows that universities and research institutes still dwell on the stage of supply-oriented scientific research mode, they lack of cooperation experience with enterprises and channels to promote the achievements (Gu et al., 2020). The way to solve this problem is through the science and technology service platform. The science and technology service platform not only brings the relevant parties together, but also becomes the bridge and link to connect relevant parties. Science and technology resource sharing service provided by the platform can effectively promote the integration and optimal allocation of science and technology resources, and professional problem of science and technology achievement transformation, so as to realize the self-operation of service platform and the efficient and orderly sharing of resources.

2) Technological innovation. Science and technology enterprises, innovative enterprises and other entities mainly focus on the theme of technological innovation. In particular, small and medium-sized enterprises have insufficient technological precipitation, so they rely on external access to get technological innovation resources. However, science and technology service platform provides places to obtain resources related to technological innovation for enterprises, which stimulates the innovation demand of enterprises to a greater extent.

In addition to the guidance of other science and technology institutions, enterprises have paid more attention to technological innovation after joining the platform. Through the cooperation of relevant subjects, enterprises can promote the realization of technological innovation. Innovation activities will generate new resources to join the service platform, then, science and technology enterprises and innovative enterprises are both providers and demanders of science and technology resources, which formed a spiral and progressive development path of technological innovation.

3.2. Resource Sharing Behavior of Science and Technology Service Platform

As a resource subject, users of the science and technology service platform generate more resource demands based on their own science and technology resources. By sharing their own resources on the science and technology service platform, they hope to achieve resource docking and form collaborative activities with other resource subjects to create shared value. Science and technology resources also have external attributes. The more subjects shares resources on the platform, the richer the science and technology resources appear on the platform, which will attract more resource subjects to join the platform and share resources, and the more benefits will be brought by resource sharing.

4. Evolutionary Game Model

Evolutionary Game Theory describes the system equilibrium and the process of achieving equilibrium with a dynamic analytical framework, which can more accurately describe the development and change of the whole system (Taylor & Jonker, 1978; Zhao et al., 2020). Users in the science and technology service platform is positive to share their resources to enrich the resources of the platform, but in fact, some users share resources negatively because of concerns about intellectual property protection and other issues. The alternative strategies for users of science and technology service platform are to share resources positively or negatively. Therefore, this paper introduces the evolutionary game theory to research on users' sharing resources behavior on the public service platform. Firstly, hypotheses are put forward as follow:

Hypothesis 1: Users i and j are the two main players in the resource sharing game, they are users of science and technology service platform. Both players are bounded rational. It indicates that both parties pursue the minimum cost and maximum benefit, and it is impossible for both parties to directly find the optimal equilibrium point through a game.

Hypothesis 2: When users i and j of science and technology services share resources negatively, they have no related interests with each other, and their benefits can be expressed by $\left(V_i, V_j\right)$. In this case, the benefits take into account the time cost and search cost invested by each user in this strategy.

Hypothesis 3: When users i and j share resource positively, they will get additional sharing benefits which can be represent by ΔV, because of the increase of science and technology resources in the platform when users positive share, and it will improve the sharing effect. The distribution of the additional revenue for user *i* is α ($0<\alpha<1$), and the distribution for user *j* is $(1-\alpha)$. The difference in the distribution of additional benefits between the two parties is mainly caused by the different absorption and application of science and technology resources by users themselves. When the two parties share science and technology resources positively, they will need to make additional cost investment C due to energy investment, time investment and other issues, in which the proportion of cost paid by user *i* is β ($0<\beta<1$), and the proportion of cost paid by user *j* is $(1-\beta)$. The difference in the allocation of additional input costs between the two parties is mainly caused by the differences in technical complexity and resource characteristics.

Hypothesis 4: When one party adopts an positive sharing strategy and the other party takes the negative sharing strategy, the former pays the cost of sharing strategy but has no additional benefit, while the negative sharing party can obtain additional benefit ("betrayal benefit"), which can be represent by *E*, and the betrayal gains of user *i* and user *j* are respectively by (E_i, E_j). It meets the following conditions $E_i<\alpha\Delta V$, $E_j<(1-\alpha)\Delta V$.

Assuming that the probability is *x* that user *i* chooses the positive sharing strategy, and the negative sharing strategy is (1 − *x*). And the probability is *y* that user *j* chooses the positive sharing strategy, and the negative sharing strategy is (1 − *y*). Without considering other factors, the Revenue matrix of user *i* and user *j* can be obtained as shown in **Table 1**.

According to the above analysis, the benefits of the two players are shown in **Table 2** and **Table 3**.

Table 1. The payoffs matrix of two players in the evolutionary game.

		User *j*	
		Positive Sharing (*y*)	Negative Sharing (1 − *y*)
User *i*	Positive Sharing (*x*)	$V_i+\alpha\Delta V-\beta C;V_j+(1-\alpha)\Delta V-(1-\beta)C$	$V_i-\beta C;V_j+E_j$
	Negative Sharing (1 − *x*)	$V_i+E_i;V_j-(1-\beta)C$	$V_i;V_j$

Table 2. Revenue expectation function of user *i*.

The average expected benefits of sharing behavior	$U_{i_1}=y(V_i+\alpha\Delta V-\beta C)+(1-y)(V_i-\beta C)$
Expected benefits of positive sharing behavior	$U_{i_2}=y(V_i+E_i)+(1-y)V_i$
Expected benefits of negative sharing behavior	$\bar{U}_i=xU_{i_1}+(1-x)U_{i_2}$

Table 3. Revenue expectation function of user *j*.

The average expected benefits of sharing behavior	$U_{j_1} = x\left(V_j + (1-\alpha)\Delta V - (1-\beta)C\right) + (1-x)\left(V_j - (1-\beta)C\right)$
Expected benefits of positive sharing behavior	$U_{j_2} = x\left(V_j + E_j\right) + (1-x)V_j$
Expected benefits of negative sharing behavior	$\bar{U}_j = yU_{j_1} + (1-y)U_{j_2}$

4.1. Stable Strategy Solution Based on Replication Dynamic Equation

The dynamic replication equation is a differential equation describing the frequency or probability that a particular strategy is adopted in a population during evolutionary games (Yang et al., 2020; Zhu et al., 2020). It is the most widely used dynamic equation of selection mechanism. According to the general principle of evolutionary games, the strategy will be adopt by increasing users when the revenue of a strategy is greater than the average revenue, that is the survival of the fittest effect has occurred. In this case, the growth rate of the strategy is >0. Because of the change of the environment and the continuous learning and communication between the users, the sharing behavior of science and technology resources between the two players is balanced, so the equilibrium conditions can be solved. The condition for the evolution stability of strategy *k* is: $F(k) = \mathrm{d}x_k/\mathrm{d}t = 0$, and $F'(k) < 0$. According to the replicator dynamic equation formulation and the condition of evolutionary stability, we have

1) The replicated dynamic equation of user *i* is as follows:

$$F(x) = \mathrm{d}x/\mathrm{d}t = x\left(U_{i_1} - \bar{U}_i\right) = x(1-x)\left(y\alpha\Delta V - yE_i - \beta C\right) \tag{1}$$

$$F'(x) = \frac{\partial(\mathrm{d}x/\mathrm{d}t)}{\partial x} = (1-2x)\left(y\alpha\Delta V - yE_i - \beta C\right) \tag{2}$$

Let $F(x) = 0$, hence we can obtain $x_1^* = 0$, $x_2^* = 1$, $y^* = \dfrac{\beta C}{\alpha\Delta V - E_i}$.

According to the stability theorem of the replicated dynamic equation and the property of evolutionary stability, the following discussion can be made:

a) If $y = y^* = \dfrac{\beta C}{\alpha\Delta V - E_i}$, for any given $x \in [0,1]$, we have $F(x) = 0$, $F'(x) = 0$. In this case, the evolutionary stable strategy of user *i* is uncertain, that is, user *i* may choose to share science and technology resources positively or negatively.

b) If $y < y^* = \dfrac{\beta C}{\alpha\Delta V - E_i}$, for any given $x_1^* = 0$, $x_2^* = 1$, we have $F'(x_1^*) < 0$, $F'(x_2^*) > 0$. In this case, $x_1^* = 0$, that is, the negative resource sharing strategy becomes the only globally evolutionary stable strategy. When the probability of user *j*'s positive sharing of science and technology resources gradually decreases to a certain extent, the possibility of user *i*'s negative sharing behavior increases, and ultimately the negative resources sharing behavior becomes the optimal strategy.

c) If $y > y^* = \frac{\beta C}{\alpha \Delta V - E_i}$, for any given $x_1^* = 0$, $x_2^* = 1$, we have $F'(x_1^*) > 0$, $F'(x_2^*) < 0$. In this case, $x_2^* = 1$, that is, the positive resource sharing strategy becomes the only globally evolutionary stable strategy. When the probability of user *j*'s positive sharing of science and technology resources gradually increases to a certain extent, the possibility of user *i*'s positive sharing behavior increases, and ultimately the positive resources sharing behavior becomes the optimal strategy.

2) The replicated dynamic equation of user *j* is as follows:

$$F(y) = \mathrm{d}y/\mathrm{d}t = y\left(U_{j_1} - \bar{U}_j\right) = y(1-y)\left(x(1-\alpha)\Delta V - xE_j - (1-\beta)C\right) \quad (3)$$

$$F'(y) = \frac{\partial(\mathrm{d}y/\mathrm{d}t)}{\partial y} = (1-2y)\left(x(1-\alpha)\Delta V - xE_j - (1-\beta)C\right) \quad (4)$$

In the same way, let $F(y) = 0$, hence we can obtain $y_1^* = 0$, $y_2^* = 1$, $x^* = \frac{(1-\beta)C}{(1-\alpha)\Delta V - E_j}$.

According to the stability theorem of the replicated dynamic equation and the property of evolutionary stability, the following discussion can be made:

a) If $x = x^* = \frac{(1-\beta)C}{(1-\alpha)\Delta V - E_j}$, for any given $y \in [0,1]$, we have $F(y) = 0$, $F'(y) = 0$. In this case, the evolutionary stable strategy of user *j* is uncertain, that is, user *j* may choose to share science and technology resources positively or negatively.

b) If $x < x^* = \frac{(1-\beta)C}{(1-\alpha)\Delta V - E_j}$, for any given $y_1^* = 0$, $y_2^* = 1$, we have $F'(y_1^*) < 0$, $F'(y_2^*) > 0$. In this case, $y_1^* = 0$, that is, the negative resource sharing strategy becomes the only globally evolutionary stable strategy. When the probability of user *i*'s positive sharing of science and technology resources gradually decreases to a certain extent, the possibility of user *j*'s negative sharing behavior increases, and ultimately the negative resources sharing behavior becomes the optimal strategy.

c) If $x > x^* = \frac{(1-\beta)C}{(1-\alpha)\Delta V - E_j}$, for any given $y_1^* = 0$, $y_2^* = 1$, we have $F'(y_1^*) > 0$, $F'(y_2^*) < 0$. In this case, $y_2^* = 1$, that is, the positive resource sharing strategy becomes the only globally evolutionary stable strategy. When the probability of user *i*'s positive sharing of science and technology resources gradually increases to a certain extent, the possibility of user *j*'s positive sharing behavior increases, and ultimately the positive resources sharing behavior becomes the optimal strategy.

4.2. Stability Analysis of Equilibrium

According to the differential equation and the stability theorem, we can determine whether a certain equilibrium point is a stable strategy of the evolutionary game (Friedman, 1998). Base on the above, there are five equilibrium points when the two parties have two alternative strategies. These five points are $O(0,0)$, $A(0,1)$, $B(1,1)$, $C(1,0)$, $D(y^*,x^*)$. And these five points is not necessarily the evolutionary stable strategy of the system. In this situation, the stable resource sharing strategies can be obtained by judging the local stability of the Jacobian matrix of the system. The local equilibrium point satisfying condition $\det(J) > 0$, $\text{tr}(J) < 0$ is the evolutionary stable strategies (ESS). The stability analysis results of the local equilibrium points are shown in **Table 4**. It can be seen that the local equilibrium points O and B are the stable points of the game, and the corresponding strategies are {Negative sharing, Negative sharing} and {Positive sharing, Positive sharing}, while the local equilibrium points A and C are the unstable points of the game, and the corresponding strategies are {Negative sharing, Positive sharing} and {Positive sharing, Negative sharing}. In addition, the local equilibrium point $D(y^*,x^*)$ is the saddle point, which is the critical point of the game.

4.3. Influence Factors of Users' Sharing Resource Behavior

The above dynamic replication relationship between user i and user j is described by two-dimensional coordinates, as shown in **Figure 1**. For users of science and technology service platform, whether they positive share science and technology resources mainly depends on the extra cost (C), excess return (ΔV), betrayal benefit (E). The change of each parameter will directly affect users' choice of sharing strategy, and make the evolution process converge to different equilibrium points. Connecting unstable points A and C in the evolution phase diagram with saddle point D can form a critical line for the dynamic evolution of user sharing behavior. When the initial state of the game between users i and j is in OADC, that is, in the non-shaded area, the evolution result of their sharing behavior will gradually converge to the stable point O, that means both users choose the negative sharing strategy. At this time, both users can not obtain revenue. And the system finally reaches Pareto inferior equilibrium. In contrary,

Table 4. The stability analysis results of the local equilibrium points.

Equilibrium point	det(J)	tr(J)	Results
$O(0,0)$	$\det(J) > 0$	$\text{tr}(J) < 0$	Stable
$A(0,1)$	$\det(J) > 0$	$\text{tr}(J) > 0$	Unstable
$B(1,1)$	$\det(J) > 0$	$\text{tr}(J) < 0$	Stable
$C(1,0)$	$\det(J) > 0$	$\text{tr}(J) > 0$	Unstable
$D(y^*,x^*)$	$\det(J) > 0$	$\text{tr}(J) = 0$	Saddle point

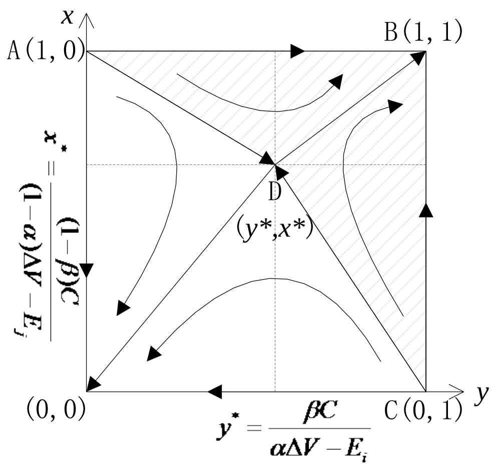

Figure 1. Phase diagram of the evolutionary game between two users.

when the initial game state of users i and j is in the BADC, that is, the shaded area, the evolution result of their sharing behavior will gradually converge to the stable point B, that means both users will chose the positive sharing strategy as a rational choice strategy. At this time, both users can obtain excess revenue. And the system finally reaches Pareto optimal equilibrium. On this basis, the science and technology service platform will realize the function of scientific and technological resource sharing.

Furthermore, the area of the shadowed part S and the area of the unshaded part S' jointly affect the probability of the evolution result. When $S < S'$, it is more likely that both two parties would take positive sharing resources strategy in the science and technology service platform; otherwise, when $S > S'$, it is more likely that both two parties would take negative sharing resources strategy in the science and technology service platform; and when $S = S'$, the possibility of evolution of two parties maybe the same. According to formula (5), the factors affecting the area of shadow part are analyzed as follows:

$$S = 1 - \frac{1}{2}\left(\frac{\beta C}{\alpha \Delta V - E_i} + \frac{(1-\beta)C}{(1-\alpha)\Delta V - E_j}\right) \tag{5}$$

Theorem 1. As users increase the input cost of sharing resources behavior, the probability that the two sides of the game will not take positive sharing strategy increases.

Proof: Find the partial derivatives of C in Equation (5) and get $\frac{\partial S}{\partial C} = -\frac{1}{2}\left(\frac{\beta}{\alpha \Delta V - E_i} + \frac{1-\beta}{(1-\alpha)\Delta V - E_j}\right) < 0$. That is, S is a monotonically decreasing function of C. The larger C is, the smaller S is. This indicates as the total cost of the users' positive sharing strategy increases, the possibility of positive sharing behavior between both parties decreases.

Theorem 2. As the additional revenue generated by positive sharing increases, the probability that the two sides of the game will take positive sharing strategy increases.

Proof: Find the partial derivatives of ΔV in Equation (5) and get $\frac{\partial S}{\partial \Delta V}=\frac{1}{2}\left(\frac{\alpha\beta C}{(\alpha\Delta V-E_i)^2}+\frac{(1-\alpha)(1-\beta)C}{((1-\alpha)\Delta V-E_j)^2}\right)>0$. That is, S is the monotone decreasing function of ΔV. The larger ΔV is, the larger S is. This indicates that as additional benefits increase, the possibility of positive sharing between the two parties increases.

Theorem 3. As betrayal benefit increases, the probability that the two sides of the game will take positive sharing strategy increases.

Proof: Find the partial derivatives of E_i in Equation (5) and get $\frac{\partial S}{\partial E_i}=-\frac{1}{2}\frac{\beta C}{(\alpha\Delta V-E_i)^2}<0$, that is, when user j take positive strategy and users i take negative strategy, with the increase of betrayal benefit, the willingness of the users to pay for the strategy of actively sharing decease, and then the possibility of positive sharing decrease. Similarly, from $\frac{\partial S}{\partial E_j}=-\frac{1}{2}\frac{(1-\beta)C}{((1-\alpha)\Delta V-E_j)^2}<0$, with the increase of betrayal benefit, the possibility of positive sharing science and technology resources decrease. In fact, there is dependency between users. If user j relies on user i, the betrayal benefit it gains are quite small, when user i chooses the strategy of positive sharing resources and user j chooses the strategy of negative sharing resources.

Theorem 4. In the conditions that other factors remain unchanged, there is an optimal allocation proportion of excess benefits, which maximizes the possibility of both parties positive sharing science and technology resources.

Proof: Find the partial derivatives of α in Equation (5) and get $\frac{\partial S}{\partial \alpha}=\frac{1}{2}\left(\frac{\beta C\Delta V}{(\alpha\Delta V-E_i)^2}-\frac{(1-\beta)C\Delta V}{((1-\alpha)\Delta V-E_j)^2}\right)$. It can be known the influence of α on S is non monotonic, then S calculates the second derivative of α, and get $\frac{\partial^2 S}{\partial \alpha^2}=-\left(\frac{\beta C\Delta V^2}{(\alpha\Delta V-E_i)^3}+\frac{(1-\beta)C\Delta V^2}{((1-\alpha)\Delta V-E_j)^3}\right)<0$, which proof that S has a maximum value. If $\frac{\partial S}{\partial \alpha}=0$, then $\left(\frac{\alpha\Delta V-E_i}{(1-\alpha)\Delta V-E_j}\right)^2=\frac{\beta}{1-\beta}$, the possibility of positive sharing science and technology resources between the two sides is the largest. That is, the sharing relationship can be improved by appropriately adjusting the distribution proportion of excess benefits.

Theorem 5. When there is a positive correlation between the input cost users pay for positive sharing strategy and the difference between the distribution of excess income generated by sharing and the betrayal benefit, the probability that the two sides of the game will take positive sharing strategy increases.

Proof: from $\frac{\partial S}{\partial \beta}=-\frac{1}{2}\left(\frac{C}{\alpha\Delta V-E_i}-\frac{C}{(1-\alpha)\Delta V-E_j}\right)$, it can be aware that with the increase of the proportion of the cost of positive sharing resources paid by user *i*, the possibility of positive sharing also increases on the following conditions: $\alpha\Delta V-E_i>(1-\alpha)\Delta V-E_j$, at this time, we get $\frac{\partial S}{\partial \beta}>0$. That means the difference between the user *i*'s distribution of excess income generated by sharing and the betrayal benefit is greater than user *j*'s. The same applies to user *j*. Based on these two conclusions, only when the cost paid by both parties for positive sharing of science and technology resources and the difference between positive sharing of excess income distribution and betrayal benefit are positively correlated, both parties feel fair, and then the possibility of both parties positive sharing resources will increase.

In general, the possibility of users *i* and *j* positive sharing science and technology resources will increase with the reduction of sharing cost, the increase of sharing benefits, or the decrease of betrayal benefit. There is an optimal benefits distribution ratio that maximizes the possibility of both users actively sharing science and technology resources. Only when the cost paid by both users for actively sharing science and technology resources and the difference between the excess benefits distribution and the betrayal benefits generated by active sharing are positively related, the possibility of both users actively sharing science and technology resources will increase.

5. Conclusion and Suggestion

In the age of big data, the explosive growth of science and technology resources, the increasingly complex demand for innovation and the breakthrough development of emerging technologies all provide a realistic situation and possibility for the resource sharing of science and technology service platforms. Therefore, in order to accelerate the open sharing of resources among the participants of the science and technology service platform and realize the sustainable development of the platform, the evolutionary game theory is introduced in this paper to build an evolutionary game model for the users' sharing behavior of science and technology resources, and have an exploration on the learning process and influencing factors of the sharing behavior of science and technology resources of users. The conclusions are as follows: 1) The users' sharing behavior of science and technology resources in science and technology service platform may evolve to {positive sharing, positive sharing} strategy, or {negative sharing, negative sharing} strategy. This is mainly due to the interaction of multiple factors in the payoffs matrix. 2) Users' resources sharing behavior in service and technology service platform are affected by sharing cost, sharing excess income, betrayal benefit, income distribution ratio etc. In order to promote users to actively share science and technology resources, it is necessary to set a reasonable proportion of income distribution and reduce the level of betrayal benefits.

In order to further promote users to actively share science and technology resources in science and technology service platform and help realize technology innovation, the suggestions of this paper are as follows:

1) For the sharing of science and technology resources, it is necessary to break the traditional resource supply mode, innovate the supply paradigm, broaden the supply scope of science and technology resources and increase the proportion of users' actively sharing resources. As an open platform, if only a small number of users share science and technology resources in this platform, the resources provided by the platform will be fragmented and homogeneous, which will be detrimental to the sharing of science and technology resources in a wider range. Only when more users actively share science and technology resources, the time for achieving the equilibrium of science and technology resources sharing becomes shorter, and the range of science and technology resources sharing becomes larger. Therefore, if the resources sharing of this platform can reach the equilibrium in the maximum range as soon as possible, it is necessary to ensure that there are more participating users actively sharing resources in the early stage of the platform establishment, and the potential science and technology resources demanders can quickly and accurately obtain the required resources.

2) Establishing a dynamic mechanism for optimizing resource sharing mode. In the early stage of platform establishment, the government or relevant departments can use fiscal and tax policies as a driving force to improve the additional benefits of actively sharing science and technology resources, and encourage different entities to join the science and technology service platform and participate in science and technology resources sharing activities. The platform accelerates resource integration and demand integration, and promotes deeper shared services in more fields. In this process, the continuous accumulation of science and technology resources by this platform will stimulate more science and technology resource sharing behavior and demand, and this cyclic process will promote the continuous optimization of science and technological service platform sharing. After the external effect has formed a good driving force, the pursuit of the economic value and social value of science and technology resources by all participants in the platform has encouraged them to participate more actively in resource sharing activities, forming a continuous source of resource sharing within the platform. The supply and demand parties of science and technology resources complete information docking, the depth of service scope continues to expand, and carry out collaborative science and technology innovation among multiple entities based on the sharing of science and technology resources. Under the guidance of demand, the docking and interaction between the supply and demand of resources are realized, and the transmission and coupling of platform power are formed.

3) Establishing a coordination mechanism for two-way flow of resources. The science and technology service platform can rely on big data technology to subdivide the platform participants, analyze the basic needs and resource characte-

ristics of different subjects based on user portrait technology, and use data mining algorithms to accurately match the supply and demand sides. In order to promote the two-way flow of science and technology resources, the bridge of interaction between supply and demand should be established, the timeliness and interactivity of communication should be improved, and the dilemmas in the two-way flow of resources should be analyzed. This platform establishes the credit mechanism of the main body in the process of two-way flow of resources, and realizes the self-organization and self-service of the science and technology resource ecosystem on this basis. After facilitating the cooperation between the providers and demanders of science and technology resources, a mutual evaluation mechanism between the suppliers and demanders should be established to provide different non-standard services for different subjects on this basis, and help resource providers and demanders solve the problem of information asymmetry.

This paper has some shortcomings, such as a failure to take account of the incentive measures of science and technology service platform, characteristics of shared resources, and other factors affecting science and technology resources sharing behaviors of users in the science and technology service platform. Future work will address these limitations and go on to study the three-way evolutionary game of different types of users and the platform.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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