Research Article

Effects of Informal Contracts on Innovative Cooperation among Enterprises in Industrial Clusters: An Evolutionary Game Analysis

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Industrial cluster theory has important guiding significance for regional industrial development and industrial agglomeration advantages. Cooperation among enterprises is the corner stone of industrial clusters. The purpose of the paper is to explore the effects of cluster informal contracts on cluster enterprises and the behavior of external partners. Based on the dynamic evolutionary game theory, this paper constructs a model, which incorporates several main factors influencing the innovative cooperation among local and external cluster enterprises. By calculating the replicator dynamics equations and analyzing the evolutionary stable strategies, this paper discusses the evolution process of cooperation strategies of enterprises in different situation. Furthermore, by using MATLAB software to simulate the model, this paper verifies the accuracy and reliability of the game model. Results show that, in addition to the formal market contract, effective implementations of cluster informal contracts can reduce opportunistic behavior in innovative cooperation among internal and external enterprises. Meanwhile, we should pay attention to strengthen the external innovative cooperation, increase severity of penalties, enhance the credit network externality, and avoid the relevant risks. The paper enriches our understanding about how informal contracts can help promote and cultivate good cooperative order in innovative cooperation of clusters.

1. Introduction

Nowadays, the development issues about industrial cluster is becoming increasingly compelling, as cluster development is still one of the most effective ways to increase competitiveness [1]. For a long time, industrial clusters have played an important role in the process of international division of labor, to strengthen the industrial giants and national competitive advantage. There are many scientific studies related to cluster theory currently [2–6]. Collaborative facilities in the cluster provide cluster participants with the opportunity to optimize engineering and manufacturing processes in order to minimize nonmanufacturing costs. As a result, all cluster members gain a competitive advantage [7].

Industrial clusters are a practical example of a synthesis of organization and complexity. One striking feature of

industrial clusters is their ability to enable efficient production organization with high levels of space diversity, time variability, and uncertainty in the field of possibilities [8]. The cluster creates an ecosystem that is conducive to local development, providing technology courses, research centers, and scientific assistance unique to the local industry. Although enterprises compete in certain areas, such as sales and distribution, they collaborate in other areas, such as creating labor and technical issues in some common and partial personal strategies [9]. The behavior of the entire cluster is the product of a combination of a subset of organizational choices that allow each enterprise to find its position vis-à-vis other enterprises based on classic swarm dynamics. From this perspective, industrial clusters have all the typical characteristics of complex adaptive systems [8].

The main point of the interactive cooperation is to obtain higher profits, enhance the competitive advantage, and ultimately ensure long-term survival and development. Innovation is an effective way for enterprises to increase profits. Cooperative innovation model has become increasingly prevalent, and it is a suitable model for further innovation. SMEs are in great need for innovative cooperation as they have limited resources to increase productivity and fuel creativity. However, as mentioned above, the cluster itself has a very important feature with complex adaptive characteristics [4, 8]. From the perspective of complex adaptive system theory, cooperative innovation is helpful to improve the adaptability of the main entities in the industrial cluster, which means that, after a period of adaptation, in order to overcome the difficulties of independent innovation, the cluster enterprises take the initiative to find partners to create and share cooperative innovation common value [1, 10, 11].

Cooperation can reduce transaction costs and share knowledge, but it also involves risks related to opportunistic behavior and lack of trust [9]. According to the research of Porter [2] and Lin et al. [12], clusters are interrelated businesses and institutions that are geographically concentrated. They consist of competitors, suppliers, consumers, peripheral industries, local governments, and universities that participate in industry value chains. Most of the member enterprises in the cluster choose to participate and are aware of their mutual interdependencies [3, 13, 14]. In such a cluster, the families, friends, and relatives work together in the same geographical area, and because they are acquainted with each other, as compared to other innovative cooperation between ordinary enterprises, the cluster enterprises innovative cooperation will exhibit less opportunistic behavior and benefit from better cooperative behavior [15, 16]. Furthermore, the cluster regulations may include formal ones, such as rules issued and implemented by local governments on clusters, and also informal ones, such as behavioral norms, industry rules, and cultural cultivation embedded in the cognitions of cluster enterprise to reduce the opportunistic behavior and promote the integrity of cooperation between enterprises in the cluster [14]. The informal contract refers to the governance mechanism by which informal norms formed over the years in the region influence the economic interactions between cluster firms. This governance mechanism is based on informal and implicit systems, especially in historical embedded clusters. Therefore, more and more scholars focus on the cluster government regulatory mechanism, which promote the innovative cooperation among cluster enterprises in this special relationship. In the case of effective government implementation, transaction costs between firms can be reduced, and cooperation between firms in the same cluster is promoted through nonmarket coordination. Both informal and formal contracts are ways to reduce opportunistic behavior in the transactional relationship [14].

Industrial clusters are widely recognized as an important way of promoting regional innovation, entrepreneurship, and high-tech industries [11, 13, 17, 18]. With the advent of globalization and Internet technology advances, the development of industrial clusters has expanded the geographical scope and available resources [6, 10, 19]. More and more cluster

enterprises choose to cooperate with not only the local cluster enterprises, but also the external enterprises. Over the past decade, economic geographers and regional scientists have recognized that the power of globalization has increased the level of competition while increasing the potential “trade gains” from resource flows between enterprises in different clusters [20]. Knowledge gained from global pipelines can be transferred to local networks to further create innovation within the cluster [21]. Moreover, the external enterprises are attracted to have innovative cooperation with cluster enterprises for their agglomeration of skilled personnel, availability of risk capital, favorable market, reduced transaction costs, and regional competitiveness, such as regional prestige and priorities for their agglomeration of technical talent [8, 19, 22, 23]. However, for these external cluster enterprises, their kinship and geography relationship characteristics are unlike internal cluster enterprises. This cross-region competition can reduce transaction costs and increase innovation, but it also involves risks related to opportunistic behavior and lack of trust [24, 25]. So, what kind of impact will the external enterprises face if they cooperate with cluster enterprises? Will the cluster governance regulations affect the innovative cooperation behavior of the external enterprises? These areas are worth exploring.

In recent years, there has been an improvement in the understanding of industrial clusters [26–28]. However, there are still some unresolved problems in the analysis of innovative cooperation in industrial clusters [7, 15]. Besides, current research does not pay enough attention to the informal governance management mechanism [14], and the lack of cluster government supervision in cooperative innovation among cluster enterprises may lead to ambiguity in understanding the cooperation in innovation decision-making game process [19]. Therefore, this paper investigates the effect of cluster informal contracts to the behavior of cluster external enterprises in innovative cooperation using the game-theory techniques, finds that the informal contracts can keep the behavior of external enterprises in check, and can effectively reduce the occurrence of opportunistic behavior in the industrial cluster.

The paper is organized as follows. In Section 2, the basic assumptions of game model are established to analyze the construction and application of the evolutionary game theory model for innovative cooperation in industrial clusters. Then, we solve the model and analyze the innovative cooperation behavior of the external enterprises under different conditions. In Section 3, there are the numerical simulation model and discussions to verify the accuracy and reliability of the evolutionary game model. The last section is conclusions.

2. Evolutionary Game Model

2.1. Model Variables and Hypothesis. The model variables were proposed based on the above description about characteristics of cluster informal contracts and innovative cooperation behavior in industrial cluster. In addition, it also puts forward the hypothesis for the evolutionary game of innovative cooperation in industrial cluster.

H1: Internet technology has opened up a number of opportunities for multiple clusters and promotes cooperation initiatives at the regional and cross regional level [29]. In combined long and short range interactions, the local cluster can access global information and transmit them within the cluster. This ease of accessible information helps cluster-based regions acquire knowledge and achieve innovation [21]. However, external enterprises are not like the cluster enterprises, which have the geography, affinity, and other cooperation advantages, and are not necessarily subjected to the cluster informal contracts. The open relationships and changeable membership in the cluster may encourage opportunistic behavior [30]. Therefore, part of the external enterprises in cluster innovative cooperation often show opportunistic behavior in shirking, holding up or terminating contracts, falsifying information, stealing business ideas, and the like [31].

M-The benefits of external enterprises from innovative cooperation with cluster enterprises. When innovative cooperation between cluster external and internal enterprises happens, it will create a certain benefit.

ρ - The cooperation preferences of external enterprises. The cooperation between external enterprises and the enterprises within the cluster needs to take into account various factors as the degree of knowledge complementarity, the matching technology, and so on. We can see $0 \leq \rho \leq 1$, $\rho = 1$ represents that the external enterprises actively carry out innovative cooperation.

α - Cooperative coefficient of innovative cooperation. The concentration of industrial clusters allows for the exploration of synergies and complementarities, creating collective competitive advantages [32]. As the majority of enterprises in the clusters from the same industry, which also exists in related universities, research institutes, intermediaries, and other auxiliary industries continue to develop, so the cooperation between enterprises can produce synergies [7].

γ - Innovative cooperation risk coefficient. Coopetition also involves risks related to opportunistic behavior and lack of trust when it helps improve innovation [9].

c- The cost with honesty behavior. However, some opportunistic behaviors will try to use opportunistic behavior to reduce the necessary costs, in order to earn part of the opportunity benefit; thus, the cost of opportunistic behavior is λc , $0 < \lambda < 1$.

H2: From the perspective of industrial clusters, cluster enterprises are often subject to informal contracts in addition to being restricted by formal market rules [14]. Whether these are endogenous or exogenous clusters, there always exist informal groups based on geography, kinship, learning, or peers relationships, as trade associations, chambers of commerce, associations, families, and so on. These have led to the emergence of informal norms. The main logic of informal contract is the collective compliance of all cluster participants with the behavioral norms spontaneously formed in local populations [33]. Benefited from the existence of informal contracts, industrial clusters have less opportunistic behavior to obtain higher returns in innovative cooperation, at the

same time, for the maintenance and operation of informal contracts will need a certain cost.

U- The benefit of the overall cluster. For the industrial cluster, the valid informal contract will help the formation of good cooperation between the cluster enterprises, and the overall benefits of industrial clusters will get positive returns.

β - Excitation coefficient. Due to the existence of informal contracts, it will form a positive circle in the innovative cooperation among the cluster enterprises, then further encourage the cooperation, and enhance the overall benefit of the cluster.

e- Maintenance cost of informal contracts. For the maintenance and operation of informal contracts, the cluster government must manage the civil associations, regularly organize industry activities, and create cohesive cluster culture. They all require money to organize.

ν - The punishment of opportunistic behavior. Under the valid informal contracts, if the external enterprises have opportunistic behavior, they will be punished by the informal contracts.

ε - The degree of opportunistic behavior. The intensity of punishment is positively related to the degree of opportunistic behavior. Therefore, the punishment of opportunistic behavior is $\varepsilon \nu$.

K- The benefit loss of industrial cluster. If the informal contracts in the industrial cluster are invalid, the opportunistic behavior of the external enterprises will not be punished and will also bring problems to the innovative cooperation in the cluster, like disrupting the existing rules of cooperation and damaging the overall interests of industrial cluster.

θ - The extent of formal market contracts. In the case of invalid informal contracts, the general formal market contracts will be valid. To some extent, it will also restrict the opportunistic behavior of external enterprises. Besides, the overall image of the industrial cluster will also have a negative impact, as the reputation damage, the lack of partners, and so on.

When the informal contracts in the industrial cluster are valid, the overall benefit of an industrial cluster is $\beta U - e$; when informal contracts loses validity, if the external enterprises are honest, there will not be any cost or damage borne by the industrial cluster, but if the external enterprises have opportunistic behavior, the overall benefit of industrial cluster is $-\theta K$. For the external enterprises, if they are honest in the innovative cooperation, their benefit will be $(1 + \alpha)(1 - \gamma)\rho M - c$. If they have opportunistic behavior, in the valid informal contracts, the benefit of external enterprises is $(1 + \alpha)(1 - \gamma)\rho M - \lambda c - \varepsilon \nu$; however, when the informal contracts are invalid, the benefit is $(1 + \alpha)(1 - \gamma)\rho M - \lambda c - \theta \varepsilon \nu$. The payoff matrix of the innovative cooperation can be obtained based on the above analysis; please see Table 1.

2.2. Model Construction

2.2.1. Game Payoff Matrix. Supposing that the probability when the cluster chooses strategy “valid informal contracts” is x , the probability to choose strategy “invalid informal

TABLE 1: Payoff matrix of two game sides.

		Industrial Cluster	
		Valid Informal Contracts	Invalid Informal Contracts
External Enterprises	Honest Behavior	$(1 + \alpha)(1 - \gamma)\rho M - c, \beta U - e$	$(1 + \alpha)(1 - \gamma)\rho M - c, 0$
	Opportunistic Behavior	$(1 + \alpha)(1 - \gamma)\rho M - \lambda c - \varepsilon v, \beta U - e$	$(1 + \alpha)(1 - \gamma)\rho M - \lambda c - \theta \varepsilon v, -\theta K$

contracts" is $1 - x$; supposing that the probability when external enterprises choose strategy "honest behavior" is y , the probability to choose strategy "opportunistic behavior" is $1 - y$, of which $0 < x < 1$ and $0 < y < 1$. The value of x and y changes in constant imitating and learning process of external enterprise and industrial cluster, but the initial value is established.

Expected benefit of industrial cluster when it chooses strategy "valid informal contracts":

$$u_c^1 = y(\beta U - e) + (1 - y)(\beta U - e) = \beta U - e \quad (1)$$

Expected benefit when it chooses strategy "invalid informal contracts":

$$u_c^2 = (1 - y)(-\theta K) = y\theta K - \theta K \quad (2)$$

Average expected benefit of industrial cluster is

$$\bar{u}_c = xu_c^1 + (1 - x)u_c^2 \quad (3)$$

Similarly, expected benefit of external enterprise when it chooses strategy "honest behavior":

$$\begin{aligned} u_e^1 &= x[(1 + \alpha)(1 - \gamma)\rho M - c] \\ &\quad + (1 - x)[(1 + \alpha)(1 - \gamma)\rho M - c] \\ &= (1 + \alpha)(1 - \gamma)\rho M - c \end{aligned} \quad (4)$$

Expected benefit when it chooses strategy "opportunistic behavior":

$$u_e^2 = x[(1 + \alpha)(1 - \gamma)\rho M - \lambda c - \varepsilon v] + (1 - x)[(1 + \alpha)(1 - \gamma)\rho M - \lambda c - \theta \varepsilon v] = (1 + \alpha)(1 - \gamma)\rho M - \lambda c - \theta \varepsilon v - x\varepsilon v + x\theta \varepsilon v$$

Similarly, average expected benefit of external enterprise is

$$\bar{u}_e = yu_e^1 + (1 - y)u_e^2 \quad (5)$$

2.2.2. Replicator Dynamics Game Model and Jacobi Matrix Partial Stability Analysis. The replicator dynamic evolutionary game model describes the progressive process of the transformation of both sides' favorable strategy. Both sides are not adjusting their strategies at the same time. One side needs to decide its strategy by considering the other side's strategy and the payoff the strategy brings. Hence, it is a learning process. The specific calculation process is as follows [34].

Replicator dynamic equation of industrial cluster and external enterprise is, respectively,

$$\begin{aligned} \dot{x} &= \frac{dx}{dt} = x(u_c^1 - \bar{u}_c) \\ &= x(1 - x)(\beta U - e + \theta K - \theta Ky) \\ \dot{y} &= \frac{dy}{dt} \\ &= y(u_e^1 - \bar{u}_e) \\ &\quad - y(1 - y)[x\varepsilon v(1 - \theta) - (1 - \lambda)c + \theta \varepsilon v] \end{aligned} \quad (6)$$

2.3. Analysis of Game Process. In order to obtain the ESS of this evolutionary game, get a stable point of the replication dynamics equation, the premise, and stable points x^* and y^* should meet the condition $f(x^*) = f(y^*) = 0$, and the five (x^*, y^*) are resolved accordingly:

$$A(0, 0), B(0, 1), C(1, 0), D(1, 1)$$

$$\text{and } E\left(\frac{(1 - \lambda)c - \theta \varepsilon v}{\varepsilon v(1 - \theta)}, \frac{\beta U - e + \theta K}{\theta K}\right) \quad (7)$$

2.3.1. Jacobian Matrix Partial Stability Analysis. The stability of the evolution system can be studied by using the local stability of the Jacobian matrix by the proposed method of Friedman and Fung [35]. Jacobian matrix J can be obtained by using $f(x)$ and $f(y)$ to get partial derivative of x and y :

$$J = \begin{pmatrix} \frac{\partial \dot{x}}{\partial x} & \frac{\partial \dot{x}}{\partial y} \\ \frac{\partial \dot{y}}{\partial x} & \frac{\partial \dot{y}}{\partial y} \end{pmatrix} = \begin{pmatrix} (1 - 2x)(\beta U - e + \theta K - \theta Ky) & -x(1 - x)\theta K \\ y(1 - y)(1 - \theta)\varepsilon v & (1 - 2y)[x\varepsilon v(1 - \theta) - (1 - \lambda)c + \theta \varepsilon v] \end{pmatrix} \quad (8)$$

TABLE 2: Local stability analysis of the evolution system.

Stable Points	DetJ	TrJ	Local Stability
A(0, 0)	+	-	ESS
B(0, 1)	-	Uncertainty	Saddle point
C(1, 0)	+	+	Unstable
D(1, 1)	-	Uncertainty	Saddle point

TABLE 3: Local stability analysis of the evolution system.

Stable Points	DetJ	TrJ	Local Stability
A(0, 0)	-	Uncertainty	Saddle point
B(0, 1)	-	Uncertainty	Saddle point
C(1, 0)	-	Uncertainty	Saddle point
D(1, 1)	-	Uncertainty	Saddle point

In order to obtain the ESS, it must meet the condition $\text{Det}J > 0$ and $\text{Tr}J < 0$; as for $\text{Tr}J_E = \partial\dot{x}/\partial x + \partial\dot{y}/\partial x = 0$, it can exclude E to be the ESS. Therefore, the following section will consider the range of both values U and v to analyze the possibility of the other four points.

2.3.2. Analysis of Game Process of Different Situation

(1) *Case 1.* when $U < e - \theta K/\beta$ and $v < (1 - \lambda)c/\theta\epsilon$, local stability analysis is shown in Table 2. It can be seen from Table 2 that ESS is only realized at point A (0, 0), point C (1, 0) is unstable point, and points B(0, 1) and D(1, 1) are saddle points.

In this case, when the benefit the informal contracts bring to the industrial cluster is less than the difference between the maintenance cost of informal contracts and the loss of invalidity, and the expected punishment for the opportunistic behavior is less than the opportunistic benefits, the informal contracts will be completely invalid, and the external enterprise and cluster enterprise will also exhibit opportunistic behavior; this will be the serious impediment to the development of industrial clusters.

(2) *Case 2.* When $e - \theta K/\beta < U < e$ and $v < (1 - \lambda)c/\theta\epsilon$, it can be seen from Table 3 that there is no ESS in this situation; all points are the saddle points.

The Table 3 show that when the benefit brought by informal contracts is greater than the difference between the cost of the informal contracts and the invalid contracts but still less than the maintenance cost of informal contracts, and for external enterprises, the punishment of the opportunistic behavior is less than its opportunistic benefit, with the whole system in a cycle of shock state, ESS does not exist.

(3) *Case 3.* When $U < e/\beta$ and $v < (1 - \lambda)c/\theta\epsilon$, it can be seen from Table 4 that ESS is only realized at point D (1, 1), point B (0, 1) is unstable point, and points A (0, 0) and C (1, 0) are saddle points.

Case 3 shows that when the informal contracts bring more benefit to the industrial cluster than its maintenance cost, and the expected punishment of the opportunistic behavior

TABLE 4: Local stability analysis of the evolution system.

Stable Points	DetJ	TrJ	Local Stability
A(0, 0)	-	Uncertainty	Saddle point
B(0, 1)	+	+	Unstable
C(1, 0)	-	Uncertainty	Saddle point
D(1, 1)	+	-	ESS

TABLE 5: Local stability analysis of the evolution system.

Stable Points	DetJ	TrJ	Local Stability
A(0, 0)	-	Uncertainty	Saddle point
B(0, 1)	+	-	ESS
C(1, 0)	+	+	Unstable
D(1, 1)	-	Uncertainty	Saddle point

TABLE 6: Local stability analysis of the evolution system.

Stable Points	DetJ	TrJ	Local Stability
A(0, 0)	+	+	Unstable
B(0, 1)	+	-	ESS
C(1, 0)	-	Uncertainty	Saddle point
D(1, 1)	-	Uncertainty	Saddle point

TABLE 7: Local stability analysis of the evolution system.

Stable Points	DetJ	TrJ	Local Stability
A(0, 0)	+	+	Unstable
B(0, 1)	-	Uncertainty	Saddle point
C(1, 0)	-	Uncertainty	Saddle point
D(1, 1)	+	-	ESS

of external cluster is less than the opportunistic benefits, the development of the industrial cluster presents a virtuous cycle: on one hand, industrial clusters informal contracts can be well maintained and implemented; on the other hand, the external enterprises and cluster enterprises can have an honest cooperative relationship.

(4) *Case 4.* When $U < e - \theta K/\beta$ and $v > (1 - \lambda)c/\theta\epsilon$, it can be seen from Table 5 that ESS is only realized at point B (0, 1), point C (1, 0) is unstable point, and points A (0, 0) and D (1, 1) are saddle points.

(5) *Case 5.* When $e - \theta K/\beta < U < e$ and $v > (1 - \lambda)c/\theta\epsilon$, it can be seen from Table 6 that ESS is only realized at point B (0, 1), point A (0, 0) is unstable point, and points C (1, 0) and D (1, 1) are saddle points.

In cases 4 and 5, it can be found that when the benefits of informal contracts are less than their maintenance cost, and the expected punishment of the opportunistic behavior is greater than the opportunistic benefits, even if the informal contracts are invalid, the external enterprises will be genuine in innovative cooperation and not be deceitful.

(6) *Case 6.* When $U > e$ and $v > (1 - \lambda)c/\theta\epsilon$, it can be seen from Table 7 that ESS is only realized at point D (1, 1), point

FIGURE 1: Innovative cooperation evolutionary game results of case 1 ($U = 0.1; \nu = 15$).

A (0, 0) is unstable point, and points B (0, 1) and C (1, 0) are saddle points.

When the benefits that informal contracts can bring to the industrial cluster are more than the maintenance cost, and expected punishment of the opportunistic behavior is greater than the opportunistic benefits, the informal contracts can be sustainably developed in the industry cluster, and honest behavior in the innovative cooperation can be also increased. Similar to situation 3, at this time, the industrial cluster will also show a good momentum of development; the innovative cooperation can be operated under the order of informal contracts.

3. Numerical Simulation and Discussions

Based on the evolutionary game in Section 2, the nonlinear characteristic is introduced to the evolutionary game process between entities. To further verify the contents of the game analysis, we use MATLAB software to simulate the different situation as following. Assuming that $\theta = 0.5; e = 6; K = 10; c = 10; \lambda = 0.5; \beta = 0.9; \varepsilon = 0.5$, we discuss the evolution path of the game strategy when one's probability of the game is 0.9 and the initial value of the other is 0.2, 0.4, 0.6, and 0.8, respectively.

The following can be seen from the simulated analysis results: (1) As shown in Figure 1, the informal contracts become invalid when the maintenance cost is relatively high, and the punishment for the opportunistic is lenient. At the same time, the behavior of external enterprises gradually becomes opportunistic. In this case, the innovative cooperation is full of backplane and mistrust. It will eventually lead industrial clusters to recession. (2) As shown in Figure 2, if the maintenance cost of the informal contract is at a moderate level, but the punishment for the opportunistic behavior is still not enough severe, the cluster informal contracts

can be maintained. However, its state is extremely unstable. Similarly, the cooperative behavior of external enterprises also shows an uncertain state. (3) Figure 3 shows that if the maintenance cost of informal contracts is less, even if the penalty of opportunistic behavior is less severe, from the simulation results, cluster informal contracts can be maintained at stable and effective state, and the innovative cooperate behavior of external enterprises also tends to honest. (4) As shown in Figure 4, when the informal contracts cannot make up the maintenance cost from the benefits of the industrial cluster, but the expectation punishment for the opportunistic behavior is severe, although the informal contracts is invalid, the cooperation behavior of external enterprises shows that they are still honest. (5) Figure 5 shows that if the benefits from valid informal contracts are greater than the maintenance costs of informal contracts, and it has severe expectation punishment for the external enterprises, in such case, industrial clusters informal contracts are stable and effective; the innovative cooperation can also show good honest behavior. Compared to Figure 3, in this case, the external enterprises behavior tends to be honest earlier. This shows a better role of informal contracts to external enterprises in this case.

The empirical evidence from clusters in Jinjiang City can also demonstrate the impact of informal contracts. We use Jinjiang industrial cluster as a typical case because it is famous for its listed companies, which has the highest number of all the counties in China, and represents an upgrading process from made to innovation. Although Jinjiang maintains a high economic growth rate, Jinjiang's manufacturing clusters have traditionally been mainly labor-intensive, and these industries have been facing fierce competition from domestic and overseas markets. However, local industrial clusters, especially the footwear and apparel industries, have achieved significant industrial upgrades in global competition [36]. To

FIGURE 2: Innovative cooperation evolutionary game results of case 2 ($U = 5$; $v = 15$). FIGURE 3: Innovative cooperation evolutionary game results of case 3 ($U = 7$; $v = 15$).

figure out the reason for the Jinjiang's accomplishments, the informal contracts have an important effect.

In Jinjiang cluster, there exist many kinds of informal organization, like Jinjiang textile association, Jinjiang equipment manufacturing industry association, Jinjiang footwear industry association, and so on; the mission of these informal organization is to gather resources, build platform for resource sharing, complementary advantages, as well as exchange, cooperation, and development and thus formed the informal contract. Jinjiang's informal contracts restrict cluster enterprises' behavior mainly through the way of

collective sanction. Informal organizations usually formulate relevant industry norms to punish and exclude behaviors that violate the overall interests such as cluster norms and values, including gossip, rumors, and ostracism. [37] Collective sanctions can form a credible threat to guarantee the efficiency of transaction and restrain the opportunistic behavior by increasing the intensity of punishment and effectively spreading the cost of punishment. Collective sanction of cluster enterprises is not only the punishment of opportunistic behavior, but also a kind of institutional arrangement to encourage and restrain cluster enterprises.

FIGURE 4: Innovative cooperation evolutionary game results of cases 4 and 5 ($U = 0.5$; $v = 40$).

FIGURE 5: Innovative cooperation evolutionary game results of case 6 ($U = 7$; $v = 40$).

On this basis, the enterprises with good reputation in the cluster will be known by others. Transaction restrictions enable the cluster enterprises to conduct the transaction among the “good identity” traders, reduce the coordination cost and the expected deviation, facilitate the flow of information, avoid the occurrence of opportunistic behavior, and improve the cooperation efficiency. At present, there are more than 200 million Chinese overseas in Jinjiang, and the concentration in Southeast Asian countries is relatively high. These kinship-based networks help local residents’ access to scarce resources, such as financial capital and innovative partnerships with foreign countries. It is also because of the

informal contracts that cluster local residents and foreign enterprises are able to conduct high-quality innovative cooperation. It can be seen that informal contracts play an effective role in promoting the cooperation between enterprises inside and outside the cluster.

4. Conclusions

Industrial clusters have generated conducive scenarios to cooperation to compete at the global level [38]. The interaction between local buzz and global pipelines can create the innovation knowledge that helps cluster development [21].

Cooperation with external enterprises can gain advantages from the collaboration process. The innovative contract within industrial clusters can allow a breakthrough in the geographical restrictions and use Internet technology to achieve greater cooperation and interaction, so as to find more favorable and reasonable resources to promote transformation and upgrading for traditional industrial clusters. In this paper, theoretical analysis is conducted to demonstrate the effects of cluster informal contracts on cluster enterprises and the behavior of external partners in innovative cooperation. The main conclusions of this paper are summarized as follows:

First, innovative cooperation is a way of strategizing for enterprises to maintain market share. It means establishing long-term relations of innovation between economically and legally independent firms [4]. Research indicates that the maintenance costs for informal contract, expected punishment of the opportunistic behavior, and opportunistic benefits can influence the innovative cooperation between cluster enterprises and external enterprises. To achieve the most conducive environment for the development of industrial clusters (that is, the cluster informal contracts can be well maintained), and the cluster enterprises can find external partners with honest cooperative behavior, it requires further consolidation with the cluster informal contracts, reducing maintenance costs and, at the same time, increasing punishment of opportunistic behavior to jointly build a good and orderly environment in the industrial cluster, in order to promote innovative cooperation and sustainable development of industrial clusters.

Second, the informal contracts of industrial cluster can positively restrain the opportunistic cooperative behavior of cluster enterprises. We can observe the underlying factors relevant to the causal logic and dynamic interaction between cluster informal contracts and enterprises innovative cooperation behavior. From the game results, it can be seen that there are few opportunistic behaviors between the cluster enterprises and external enterprises in valid cluster informal contracts. The current research has not paid enough attention to the informal governance management, such as tradition and local culture, including the reputation and trust of informal institutions. However, in reality, we can see that large amount of enterprises opportunistic behavior will cause great losses to their partners; thus, the cooperation without governance is not reliable. In the practice of cluster enterprises' cooperation, valid informal arrangements to regulate the cooperative behaviors of enterprises are of vital importance. Therefore, with the evolution of these clusters, the participation of cluster informal contracts will restrict the generation of opportunistic behavior of enterprises.

Third, when industrial clusters expand their scope of cooperation, the industrial enterprises should also pay attention to avoid the relevant risks. The combination of external and internal sources of knowledge can enhance the success of innovation [39]. However, while acquiring external knowledge, the company's classified information may be revealed in knowledge exchange, resulting in the leakage of core technologies. Thus, these risks will cause enterprises to discern how they should apply the external and internal

knowledge in innovative cooperation [40]. The innovative literature highlights the advantages of combining external knowledge with internal capabilities. In reality, even if a firm's inventive success depends on more internal knowledge, it also requires the capability to acquire and combine knowledge from external sources. Therefore, in the process of cooperation with external enterprises, we should pay attention to preventing the loss of the core competitiveness of cluster enterprises [40].

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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