Evolutionary Game Analysis on Group Cooperation of Heterogeneous Chaoshan Firms

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In developing global trade and commerce, firms founded by Chaoshan merchants have gradually formed informal institutions of group cooperation. This study constructs an asymmetric evolutionary game model for Chaoshan firms from the HCIA (historical and comparative institutional analysis) perspective of group cooperation institutions. Furthermore, it analyses the evolutionary path and the constraint mechanism of group cooperation institutions of heterogeneous Chaoshan firms. The results suggest that if the net payoffs to one party from cooperation are less than those from a breach, it is detrimental for both parties to continue group cooperation. When the net payoffs from cooperation are more than those from a breach, both parties choose group cooperation if reputational compensation covers the losses. Otherwise, the ultimate cooperation between both parties depends on the distribution of benefits, the profitability of cooperation, the penalty cost of a breach, the cost of cooperation and the loss from a breach suffered by adhering to cooperation.

Keywords: Chaoshan firms, group cooperation, HCIA, evolutionary game, heterogeneity

INTRODUCTION

The Chaoshan group comprises merchants with a strong Chaoshan cultural background, mainly concentrating in the Chaoshan region of Guangdong, China. Moreover, it is one of the most legendary merchant groups that have survived today (Huang, 2008; Lin, 2008). For examples, Cihuang Chen's family, Yichu Xie's family and other Chaoshan merchants and their industries are still internationally active in industry and commerce. Obviously, they have had a lasting impact on the world economic landscape. In a word, Chaoshan firms have explored and nurtured their business secret over a long history, that is group cooperation. However, few researches have addressed the evolutionary process of such institutional behavior. Why does Chaoshan firms choose the group cooperation strategy? How does group cooperation become a mandatory option?

Chaoshan firms are one of the most important subjects of research in world economic history, but few economic historians follow and further study Chaoshan firms and their economic activities. Presently, the related research on Chaoshan merchants has focused on the history of the merchant group, the chambers of commerce, and their cultural ethos. However, these studies have been conducted their history and organizational systems from limited perspectives, with more historical and sociological perspectives on Chaoshan merchant. Generally speaking, the research related to the history of the merchant group has featured commercial industry, the Maritime Silk Road, and the commerce system (Chen, 1992; Wu, 2015a; Wu, 2016; Cai, 2021). These researches highlight the collectivist beliefs of the clans and their relatives (Yi, 2017; Zhao et al., 2019). Moreover, based on the history of the Chaoshan group and its religious beliefs, the cultural ethos of Chaoshan merchants has been summarized, such as risk-taking, teaming, and integrity (Huang, 2008; He, 2014; Wu, 2015a; 2015b). In the meantime, as an important vehicle for the merchant group and its spirit, organizations such as chambers of commerce and oversea Chinese postal agencies have also received much attention as they governed the economic activities of Chaoshan firms (Cai, 1991; Lin, 1997; Xu, 2018; Hu, 2021). It is admintted that the economic activities of Chaoshan firms are influenced by socially constructed and historical material practices, cultural beliefs, and merchant values. In this context, few studies have focused on and investigated the strategic choices of Chaoshan firms, especially the causes and results of the evolution of group cooperation, by combining historical, sociological, and economic perspectives and approaches. As a result, the related research on Chaoshan merchants is not realistic and valuable.

This study takes historical comparative system analysis as the theoretical framework and uses evolutionary game to analyze the evolution process and internal mechanism of heterogeneous Chaoshan merchant enterprises' group cooperation system. Moreover, it further simulates how Chaoshan firms select their group cooperation strategies. The results show that if the net payoffs to one party from cooperation are less than those from a breach, it is detrimental for both parties to continue group cooperation. When the net payoffs from cooperation are more than those from a breach, the parties choose group cooperation if reputational compensation covers the losses. If reputational compensation cannot cover losses, it can facilitate the evolution of the game system to a cooperative strategy in several ways, such as balancing the distribution of interests and improving the profit of cooperation This study delves into the governance system of Chaoshan merchants. Its possible contribution is to enrich the study of informal institutions from the HCIA perspective and expand the institutional analysis and evolutionary mechanism of Chaoshan firms' situation in China.

LITERATURE REVIEW

While inheriting neoclassical economics, economists such as Douglass Cecil North and Robert William Fogel found that technological progress alone cannot revolutionize economic growth. Nevertheless, the omitted institutional factors also contribute significantly to economic growth. It also laid the groundwork for neo-institutional economics, which studies the origin and evolution of institutions (Sun, 2009; Sun, 2009). Based on the research of property rights theory, contract theory and transaction cost theory, North coined an institutional change theory by combining historical econometrics and neo-institutional economics. The institutional change theory, consisting of property rights theory, state theory and ideology theory, has successfully interpreted the economic logic of major historical economic events. However, the logic of attributing institutional change to exogenous institutional factors was ill-conceived and seriously weakened the theory's explanatory power (Peng & Wei, 2011; Xu & Zhang, 2012). In the early 1990s, new institutional economists, including Masahiko Aoki and Avner Greif, criticized the exogenous logic of institutional change and the assumption of perfect rationality in earlier institutional analyses. Furthermore, they argued that institutional change was endogenous and self-enforcing. Thus, a new school of institutional change theory emerged.

Historical and comparative institutional analysis(HCIA), coined by Greif and Aoki, has gradually emerged in the research of institutional economists and other scholars in China and abroad and is widely used in institutional analysis. In the formal institutional analysis, Aoki reveals the origins and changes of the Japanese main banking system, corporate governance structure, the trajectory of economic institutions in China, Japan, and Korea, and the Qing government and the Tokugawa administration in Japan. It provides a complete normative research paradigm for interpreting the relevant institutions toward stability (Aoki, 2001; 2013; 2017). In addition, studies have also addressed the Spanish Francoist authoritarian institution and ecological protection, employment, legal, and patent institutions (Moriguchi, 2000; Miguez, 2004; Duai, 2009; Marchad, 2011). Nevertheless, most studies have mainly considered formal institutional changes, while the research on the change of informal institutions such as cultural beliefs is still relatively scarce. Culture is typical of informal institutions. Greif (1993; 1994) explained why the Muslim world and Europe took different trade paths based on the trade culture between the Maghreb and Genoese merchants in the Mediterranean in the Middle Ages. In addition, he illustrated the mechanisms that sustain cooperation with Chinese clan culture and European moral reputation, and explained the implied institutional basis and social structure. (Greif & Tabellini, 2010).

To further develop such institutional analysis, HCIA primarily employs the repeated and evolutionary games that game theory offers on equilibrium research. It examines institutions using equilibrium analysis. It tests static, intrinsic, and self-reinforcing constraints in strategic situations where there are no external constraints by treating institutions as products of equilibrium constraints. At the heart of applying equilibrium research is an inductive and empirical analysis of the relevance of particular institutions. It is based on evaluating and synthesizing micro, historical and comparative evidence and perceptions (from pre/post correlation models and micro-economic theoretical models). As an important informal institution in business, culture has also been highlighted in institutional economics and investigated for game equilibrium. Richard Dawkins (1994) introduced memes to reveal the clustering mechanism of genetic similarity in cultural evolution, triggering in-depth discussions among scholars. In further research, Greif (1994) investigated the evolutionary process of business social institutions in individualistic and collectivistic cultural traditions by applying the repeated game model. Scholars represented by Greif and Aoki suggested that the evolutionary game theory can also be used to examine the formation and change of their business systems and institutional equilibrium. For example, Given the contexts of altruistic behavior, cultural inertia, and adventure rates, institutionalists revealed the profound influence of cultural beliefs on institutional norms by developing evolutionary game models (Bowles, 1998; De et al., 2017).

To sum up, most scholars are interested in the institutional analysis of formal institutions of legal regulations and organizational norms but ignore the relationship between informal institutions and organizational behavior, which resulting in limitations in institutional research. In this context, Greif argued that the change of informal institutions needs to evolve over a long time, requiring historical deduction and generalization from practices and customs to norms. In other words, it has a historical path and does not happen overnight. Therefore, it is appropriate to apply evolutionary game theory for testing and analysis (Greif, 1998). Unfortunately, few studies have examined institutional change and the formation and evolution of cooperative institutions with traditional culture from the perspective of institutional equilibrium. Inspired by these, this study applies HCIA and evolutionary game tools to conduct research on cooperative strategy options of Chaoshan firms.

INSTITUTIONAL ANALYSIS

Different from inland areas, Chaoshan merchants are profoundly influenced by the great culture of Chaoshan region based on the geography of Chaoshan. As a result, the greatest influence of the geographical environment of Chaoshan merchants is the sea (Huang, 2008; Lin, 2008). Chaoshan region is surrounded by mountains on three sides and facing the sea on the other side, which encourages Chaoshan people to trade by sea. Through the international maritime trade pattern, Chaoshan merchants and Chaoshan firms could export agricultural and handicraft products with comparative advantages and import foreign goods needed in China (Wu, 2015a; 2015b). It stimulated Chaoshan merchants' enthusiasm for international trade. In the meantime, inland merchants in China could only trade on land by ordinary means, such as horse-drawn carriages, given the underdeveloped commodity markets and transportation technology, which severely restricted their earnings and economic and trade development. As for chaoshan merchant, despite the uncertainty of the sea, the risks were accompanied by greater rewards. History records that since the Sui and Tang dynasties, Chaoshan merchants engaged in maritime transportation and trade and set foot in Taiwan, Japan, and Southeast Asia. They gradually established the Shantou - Hong Kong - Siam - Singapore trade network (Wu, 2016; Cai, 2021). Chaoshan merchants established many companies and organizations in Southeast Asia and other maritime cities, such as Charoen Pokphand Group and Bangkok Bank. Prominent tycoons would start expanding their businesses after the initial capital accumulation, which promoted Chaoshan merchants to develop partnerships. Based on the principle of risk-sharing and benefit-sharing, they established companies with their clans to form a community of interests (Zhao et al., 2019). For example, no matter how big or small the trade scale is, most Chaoshan merchants will try their best to help and support the latecomers in the same township, and the latecomers will take advantage of their predecessors to stand firm, jointly safeguard the interests of the same township, and form commercial forces with geographical relations. In short, the ocean shapes the spirit of Chaoshan merchants to fight against hardships and dangers and, more importantly, their sense of cooperation in battling the storms.

Since ancient times, Chinese emphasize the differential pattern and value the blood and geographical ties, which is also reflected in the governance system of Chaoshan merchants. Chaoshan people tend to form clan by blood relationship. As a result, not only clan members can participate in trading activities, but also people not of the same clan may be introduced to participate in management. Moreover, Clan members and fellow township personnel participated in the operation to further build a community of common intertest. (Huang, 2008; Zhao et al., 2019). Business owners generally grant clan members implicit incentives such as positions and status, and the offspring of outsiders explicit incentives such as salaries and goods (Peng & Shao, 2014). In this way, it can enhance their sense of belonging and identity and reduce the cost of internal governance. Different from the gradual decline of Shanxi merchants and Huizhou merchants caused by feudal decline, Chaozhou merchants continued to carry out commodity trade with the use of "Chaozhou Guild Hall". Regardless of the heterogeneity of the Chaoshan merchants, the halls takes advantage of the cultural tradition of clan and township identity, which have an absolute advantage in realizing the common interests of the business and members. In addtion, traditional local clan conventions strictly require these members to abide by integrity. Once a member violates integrity, he or she will be expelled by the family and clan according to relevant historical records. Therefore, it not only further reduces the transaction cost of cooperation of hipster enterprises, but also forms a kind of multilateral punishmentalism, which limits the tendency of betrayal of hipster enterprises, so that the institution of group cooperation can be self-enforcing.

In the economic activities of Chaoshan groups and firms, business owners' religious beliefs specifically restrained their activities. Chaoshan was originally a barbarian land with no mainstream culture in ancient times. However, Han Yu, who was demoted to Chaoshan in the Tang Dynasty, introduced Confucian values to Chaoshan. In addition, due to the years of wars in the Song Dynasty, the people from the Central Plains were forced to migrate to Chaoshan, further penetrating the Confucian culture. As times goes on, the Chaoshan people recognizes the Confucianism of morality and profit, which gradually becomes one of the business philosophies of Chaoshan merchants. As some people suffered from wars, Guan Yu was worshipped in Chaoshan as a god of wealth and the embodiment of loyalty and righteousness. Until now, Guan Yu and Han Yu influence the values of the Chaoshan merchants implicitly. At the same time, Chaoshan merchants, who have earned their living at sea for a long time, believe in Mazu (also spelled as Matsu and Ma-tsu, is the Chinese goddess of the sea who is said to protect fishermen and sailors. Her birthplace was Meizhou in Putian County, Fujian Province) and recognize the values of Mazu's local sentiments. As a result, they have always been united and harmonious with their clansmen and townspeople (Huang, 2008; Zhao et al., 2019; Zheng, 2010). These beliefs drive Chaoshan firms to develop and self-reinforce a trust-based business ethic and to establish a multilateral credit-based penalty mechanism similar to that of Maghreb merchants and Hui merchants.

In conclusion, the interaction of regional environment, business governance and merchant belief is the key factor that distinguishes Chaoshan firms from other firms. On the one hand, although the two of the three major business groups, Shanxi merchants and Huizhou merchants, have the business govermance of the groups with historical precipitation, their Marine geography practice is relatively lacking, and their imperial power thought makes them decline and almost withdraw from the historical stage. On the other hand, although the modern Zhejiang and Guangdong merchants (businessmen in the Pearl River Delta region) and other merchant groups have maritime trade practices, the historical precipitation of their business governance systems such as convention and regulation is insufficient, and there are few moral constraints of religious belief. With geographical location near the sea and natural bay ports, Chaoshan region became a key trading port for China's maritime trade. The Chaoshan people ventured out to the sea and created business organizations in various industries. They gradually developed maritime trade partnerships within their merchant group, characterized by blood and geographical ties. In the context of partnerships, the religious belief with "propriety, righteousness, loyalty, and faithfulness" as the norm of behavior and the multilateral punishment mechanism with the chamber of commerce as the external supervision promote this cooperation system self-reinforcing Once any Chaoshan firm or enterprise is found to have acted dishonestly, it will be transmitted through the local Chaozhou Guild Hall to various places, and many other Chaoshan firms or enterprises will not cooperate with it. In this way, a multilateral collective penalty mechanism is formed.

Therefore, based on the HCIA perspective, we believe that the cooperation of Chaoshan firms is a joint profit-making economic behavior based on blood and geographical ties. And it regards honesty as faith, and accepts the supervision and punishment of the guild hall. Mathematically speaking, according to their own endowment differences, heterogeneous Chaoshan firms not only need to consider whether to continue cooperation or not profit, cost and other differences, such as the profit and cost of continued cooperation, the profit and cost of non-cooperation, but also need to carefully treat the external supervision from Chaozhou Guild Hall, and consider the punishment and compensation faced by cooperation or not.

EVOLUTIONARY GAME MODEL AND SIMULATION

Under the dual institutional logic of commercial culture tradition and benefit distribution system, the cooperation benefit and cost-sharing between Chaoshan firms naturally vary in subjects depending on the payoffs and losses from proportion allocation. Based on HCIA, Chaoshan firms also differ in the distribution of benefits and costs in group cooperation due to cultural distance, such as clan organization and geographical differences in economic activities. Until now, Chaoshan firms still maintain the business tradition of group cooperation in market development. Thus, in this chapter, the evolutionary game of Chaoshan firms' cooperation institutions is built by reaching a partnership.

Hypothesis 1: *Pairwise game*

Although individual Chaoshan firms deal with other Chaoshan firms in the group when making decisions, it can be assumed that the game is played pairwise between them.

Hypothesis 2: *Asymmetric game*

Two game players' different payoffs are related to their properties, meaning that the game payoffs are asymmetrically distributed with differences for both players. This chapter indicates that Chaoshan firms are heterogeneous. It is assumed that the two types of Chaoshan firms get different payoffs because of varied factors related to their attributes, such as resource endowment. In other words, Chaoshan firms are heterogeneous because of their resources, location and other factors. Also, the payoffs are unevenly distributed after they reach a partnership, indicating differences in the payoffs of both parties.

Hypothesis 3: *Myopia*

When a Chaoshan firm changes its strategy, it always takes the current strategy distribution as a known condition and transforms it into an optimal strategy accordingly.

The above hypotheses suggest that adopting the strategy of cooperating between Chaoshan firms is directly related to the number of payoffs. If both Chaoshan firms adhere to cooperation, both parties are willing to work and negotiate for better development opportunities and better sharing of resources. In turn, both parties can share resources, develop synergistically, and gain additional payoffs from the cooperation. Such payoffs cannot be obtained if both parties do not cooperate. At the same time, the efforts made by both parties to reach cooperation also entail costs. They must pay for implementing and maintaining cooperation projects such as establishing strategic partnerships and building infrastructure.

Suppose one party chooses to cooperate, but the other chooses not. Despite the initial costs invested in reaching a partnership, the party that chooses not to cooperate may use the partnership agreement and its facilities for personal gain, "free-riding" on the payoffs of the party that insists on cooperating. At the same time, the defaulting party must bear the losses from violating the merchant group's business ethics of cooperation, such as sanctions from the chamber of commerce. Furthermore, they must make compromises and sacrifices for cooperation, such as the opportunity cost of giving up part of the project payoffs through negotiation to prevent vicious internal competition. The party that consistently chooses to cooperate needs to pay a price to do so. They must invest in reaching agreements, building infrastructure, maintaining partnerships, and purchasing raw materials for their products. Such investment can be considered as the cost of choosing cooperation. However, at the same time, the contract-keeping party will also receive some compensation, the reputational payoffs from integrity. Their attitudes and actions may be spread by word-of-mouth and notification in the chambers of commerce. Thus, they can be recognized in trade and commerce and gain more benefits.

Based on the above analysis, the model was set as follows: Chaoshan firms have two strategies. One is Strategy 1 (cooperation), developing the market as a group and collaborating; the other is Strategy 2 (no cooperation), betraying the cooperation agreement reached and developing alone. In the strategy of cooperation by the Chaoshan firms, both partners are expected to obtain market payoffs $r(r>0)$, but because of their different resource endowments, $\alpha_1, \alpha_2(\alpha_1, \alpha_2 > 0, \alpha_1 + \alpha_2 = 1)$ is considered as the basis for the distribution of market benefits. At the same time, each party bears the cost $C_1, C_2(C_1, C_2 > 0)$ of entering into cooperation. Based on the partnership between the two parties and given that one party chooses to cooperate and the other party chooses not to cooperate, the party that chooses not to cooperate will get the payoffs $f_1, f_2(f_1, f_2 > 0)$ after deducting the initial cost of reaching cooperation but violating the cooperation agreement for private gain. At the same time, the losses caused by triggering the penalty mechanism of integrity are $P_1, P_2(P_1, P_2 > 0)$. The party that insists on cooperating must pay the costs $L_1, L_2(L_1, L_2 > 0)$ invested in continuing the cooperation. However, it reaps the reputational compensation $S_1, S_2(S_1, S_2 > 0)$ from the merchant group and the chamber, respectively, for its compliance with integrity.

After the heterogeneous Chaoshan firms enter into a partnership, the payoffs of the Chaoshan firms that insist on cooperation are $\alpha_1 r - C_1$, $\alpha_2 r - C_2$. However, both parties cannot benefit from the payoffs of cooperation if they do not cooperate. If one party insists on cooperation, but the other party chooses not to cooperate, the payoffs of the party that insists on cooperation are $S_1 - L_1$, $S_2 - L_2$, and the payoffs of the party that violates cooperation are $f_1 - P_1$, $f_2 - P_2$, respectively.

Accordingly, we can derive the payment matrix for heterogeneous groups of Chaoshan merchants (A and B) with different resource endowments when they adopt Strategy 1 (cooperation) and Strategy 2 (no cooperation), respectively (Table 1):

TABLE 1
PAYMENT MATRIX FOR HETEROGENEOUS CHAOSHAN FIRMS ENTERING INTO PARTNERSHIPS

		Chaoshan firm B	
		Strategy 1 (cooperation)	Strategy 2 (no cooperation)
Chaoshan firm A	Strategy 1 (cooperation)	$\alpha_1 r - C_1$, $\alpha_2 r - C_2$	$S_1 - L_1$, $f_2 - P_2$
	Strategy 2 (no cooperation)	$f_1 - P_1$, $S_2 - L_2$	0 , 0

Suppose p(0≤p≤1) denotes the proportion of Chaoshan firm A adopting Strategy 1 (cooperation), and q(0≤q≤1) denotes the proportion of Chaoshan firm B adopting Strategy 1 (cooperation). The proportions of Chaoshan firms A and B adopting Strategy 2 (no cooperation) are 1-p and 1-q, respectively. r1=(1,0) means that Chaoshan firms choose Strategy 1 (cooperation) with probability 1. r2=(0,1) means that Chaoshan firms choose Strategy 2 (no cooperation) with probability 1. From Table 1, it can be calculated that:

The fitness of Chaoshan firm A to choose Strategy 1 is:

$$f_{r^1} = p(\alpha_1 r - C_1) + (1-p)(S_1 - L_1) \tag{1}$$

The fitness of Chaoshan firm A to choose Strategy 2 is:

$$f_{r^2} = p(f_1 - P_1) \tag{2}$$

Then the average fitness of Chaoshan firm A is:

$$\bar{f} = pf_{r^1} + (1-p) f_{r^2} \tag{3}$$

The replicator dynamics equation for Chaoshan firm A choosing Strategy 1 is :

$$F_A(p) = p(1-p)\left[\ q(\alpha_1 r - C_1 - f_1 + P_1) + (1-q)(S_1 - L_1)\ \right] \tag{5}$$

Similarly, the replicator dynamics equation for Chaoshan firm B choosing Strategy 1 is:

$$F_B(q) = q(1-q)\left[\ p(\alpha_2 r - C_2 - f_2 + P_2) + (1-p)(S_2 - L_2)\ \right] \tag{6}$$

The above two replicator dynamics equations constitute a two-dimensional dynamically autonomous (without explicit time t) system. This system is required to have a steady state. The system of equations is derived by making the right-hand ends of the two replicator dynamics equations simultaneously 0 through (p_0, q_0), i.e.:

$$\begin{aligned} p_0(1-p_0)\left[\ q_0(\alpha_1 r - C_1 - f_1 + P_1) + (1-q_0)(S_1 - L_1)\ \right] = 0 \\ q_0(1-q_0)\left[\ p_0(\alpha_2 r - C_2 - f_2 + P_2) + (1-p_0)(S_2 - L_2)\ \right] = 0 \end{aligned} \tag{7}$$

Thus, (p_0, q_0) is the equilibrium point. The system is solved to have five equilibrium points:

$$(0,0)\ ,\ (0,1)\ ,\ (1,0)\ ,\ (1,1)\ ,\ \left(\frac{L_2 - S_2}{\alpha_2 r - C_2 - f_2 + L_2 - S_2}, \frac{L_1 - S_1}{\alpha_1 r - C_1 - f_1 + L_1 - S_1}\right)$$

According to the method proposed by Friedman (1991), a group dynamic is described by a system of differential equations. Its stability at the equilibrium point is obtained from the analysis of the local stability of the Jacobian matrix from the system. The Jacobian matrix from the system consisting of the above equations is:

$$J = \begin{bmatrix} \frac{\partial F_A(p)}{\partial p} & \frac{\partial F_A(p)}{\partial q} \\ \frac{\partial F_B(q)}{\partial p} & \frac{\partial F_B(q)}{\partial q} \end{bmatrix}$$

$$= \begin{bmatrix} (1-2p)[q(\alpha_1 r - C_1 - f_1 + P_1) + (1-q)(S_1 - L_1)] & p(1-p)(\alpha_1 r - C_1 - f_1 + P_1 + L_1 - S_1) \\ q(1-q)(\alpha_2 r - C_2 - f_2 + P_2 + L_2 - S_2) & (1-2q)[p(\alpha_2 r - C_2 - f_2 + P_2) + (1-p)(S_2 - L_2)] \end{bmatrix}$$

The determinant of the Jacobian matrix is:

$$\det J = (1-2p)\left[\ q(\alpha_1 r - C_1 - f_1 + P_1) + (1-q)(S_1 - L_1)\ \right](1-2q)\left[\ p(\alpha_2 r - C_2 - f_2 + P_2) + (1-p)(S_2 - L_2)\ \right]$$
$$- p(1-p)(\alpha_1 r - C_1 - f_1 + P_1 - S_1 + L_1)q(1-q)(\alpha_2 r - C_2 - f_2 + P_2 - S_2 + L_2)$$

The trace of the Jacobian matrix is:

$$trJ = (1-2p)\left[\ q(\alpha_1 r - C_1 - f_1 + P_1) + (1-q)(S_1 - L_1)\ \right] + (1-2q)[\ p(\alpha_2 r - C_2 - f_2 + P_2) + (1-p)(S_2 - L_2)\ ]$$

The determinants and traces of the Jacobian matrix at five equilibrium points are shown in Table 2.

TABLE 2
DETERMINANTS $\det J$ AND TRACES $\mathrm{tr}J$ OF EQUILIBRIUM POINTS

Equilibrium point	$\det J$	$\mathrm{tr}J$
(0,0)	$(S_1 - L_1)(S_2 - L_2)$	$S_1 + S_2 - L_1 - L_2$
(0,1)	$(\alpha_1 r - C_1 - f_1 + P_1)(L_2 - S_2)$	$\alpha_1 r - C_1 - f_1 + P_1 + L_2 - S_2$
(1,0)	$(\alpha_2 r - C_2 - f_2 + P_2)(L_1 - S_1)$	$\alpha_2 r - C_2 - f_2 + P_2 + L_1 - S_1$
(1,1)	$(\alpha_1 r - C_1 - f_1 + P_1)(\alpha_2 r - C_2 - f_2 + P_2)$	$-[(\alpha_1 r - C_1 - f_1 + P_1) + (\alpha_2 r - C_2 - f_2 + P_2)]$

Equilibrium point	det J	tr$J$
$\left(\frac{L_2-S_2}{\alpha_2 r-C_2-f_2+P_2+L_2-S_2}, \frac{L_1-S_1}{\alpha_1 r-C_1-f_1+P_1+L_1-S_1}\right)$	$-(L_1-S_1)(L_2-S_2)* \frac{\alpha_1 r-C_1-f_1+P_1}{\alpha_1 r-C_1-f_1+P_1+L_1-S_1} * \frac{\alpha_2 r-C_2-f_2+P_2}{\alpha_2 r-C_2-f_2+P_2+L_2-S_2}$	0

In the Jacobian matrix, by the nature of partial derivatives: (1) when the determinant is $\det J>0$, and the trace is $trJ<0$, the above requirement is satisfied. Then the point in the stable state, i.e., the strategy corresponding to this point, is the final ESS of the solved game model. (2) When $\det J>0$, $trJ>0$, the point is unstable. (3) In the case of $\det J<0$, the point is a saddle point (a point that is stable in one direction and unstable in the other). (4) In the case of $\det J>0$, $trJ=0$, the point is the central point. Also, there is no evolutionary equilibrium point in the game model.

According to the stability theory of differential equations and the table, the game model needs to analyze the local stability of each equilibrium point under 16 propositions. The results of the analysis are detailed as follows:

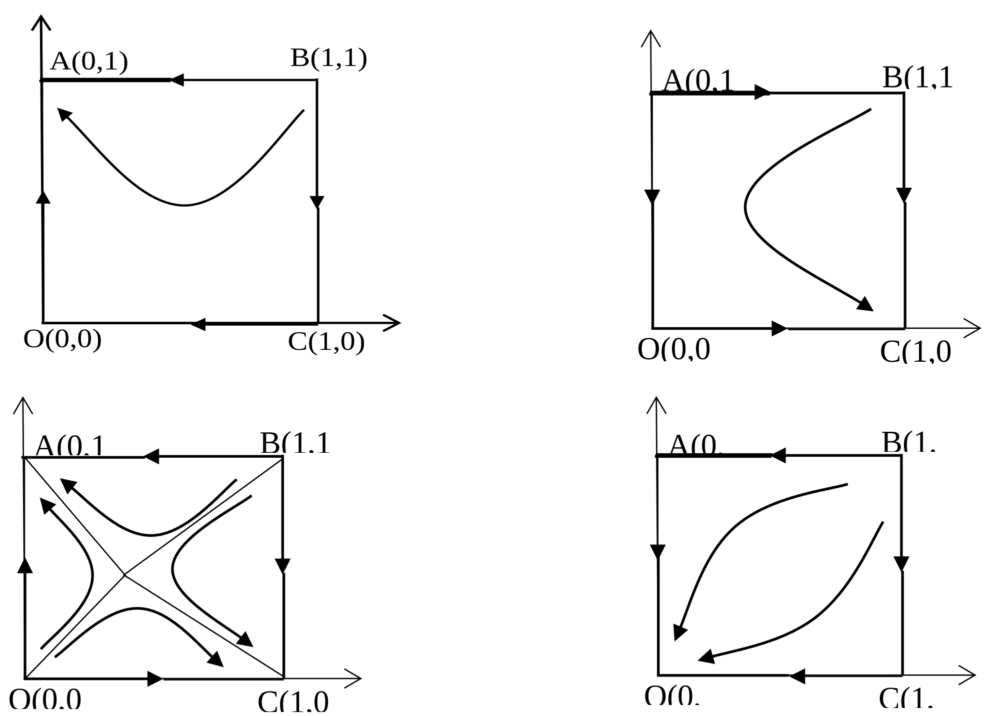
TABLE 2A
STABILITY ANALYSIS OF LOCAL EQUILIBRIUM POINTS UNDER DIFFERENT CONDITIONS

Proposition	Condition 1	Condition 2	Equilibrium point	detJ	trJ	Result
Proposition 4.1	$\alpha_1 r-C_1<f_1-P_1$, $\alpha_2 r-C_2<f_2-P_2$	$L_1>S_1$, $L_2<S_2$	(0,0)	-	Uncertain	Saddle point
			(0,1)	+	-	ESS
			(1,0)	-	Uncertain	Saddle point
			(1,1)	+	+	Unstable point
Proposition 4.2		$L_1<S_1$, $L_2>S_2$	(0,0)	-	Uncertain	Saddle point
			(0,1)	-	Uncertain	Saddle point
			(1,0)	+	-	ESS
			(1,1)	+	+	Unstable point

<table>
<tr><th>Proposition</th><th>Condition 1</th><th>Condition 2</th><th>Equilibrium point</th><th>detJ</th><th>trJ</th><th>Result</th></tr>
<tr><td rowspan="4">Proposition 4.3</td><td rowspan="8">`
$\alpha_1 r - C_1 < f_1 - P_1$,
$\alpha_2 r - C_2 < f_2 - P_2$</td><td rowspan="4">$L_1 < S_1$,
$L_2 < S_2$</td><td>(0,0)</td><td>+</td><td>+</td><td>Unstable point</td></tr>
<tr><td>(0,1)</td><td>+</td><td>-</td><td>ESS</td></tr>
<tr><td>(1,0)</td><td>+</td><td>-</td><td>ESS</td></tr>
<tr><td>(1,1)</td><td>+</td><td>+</td><td>Unstable point</td></tr>
<tr><td rowspan="4">Proposition 4.4</td><td rowspan="4">$L_1 > S_1$,
$L_2 > S_2$</td><td>(0,0)</td><td>+</td><td>-</td><td>ESS</td></tr>
<tr><td>(0,1)</td><td>-</td><td>Uncertain</td><td>Saddle point</td></tr>
<tr><td>(1,0)</td><td>-</td><td>Uncertain</td><td>Saddle point</td></tr>
<tr><td>(1,1)</td><td>+</td><td>+</td><td>Unstable point</td></tr>
</table>

The replicator dynamics phase diagrams in different cases can be drawn by analyzing the local equilibrium points in the table:

FIGURE 1
PHASE DIAGRAM OF THE CORRESPONDING DYNAMIC EVOLUTION IN TABLE 2A



Propositions 4.1-4.4 show that when the net payoffs to both Chaoshan firms for choosing cooperation are less than those for choosing to violate the agreement $(\alpha r - C < f - P)$, both parties will eventually choose (cooperation, no cooperation) or (no cooperation, cooperation). It is premised on the assumption that, at most, one party will receive sufficient reputational compensation for the loss from choosing cooperation $(L < S)$. If neither party receives enough reputational compensation for the losses from choosing cooperation $(L > S)$, both parties will eventually choose (no cooperation, no cooperation).

TABLE 2B
STABILITY ANALYSIS OF LOCAL EQUILIBRIUM POINTS IN DIFFERENT CONDITIONS

Proposition	Condition 1	Condition 2	Equilibrium point	detJ	trJ	Result
Proposition 4.5	$\alpha_1 r - C_1 > f_1 - P_1$, $\alpha_2 r - C_2 < f_2 - P_2$	$L_1 > S_1$, $L_2 < S_2$	(0,0)	-	Uncertain	Saddle point
			(0,1)	-	Uncertain	Saddle point
			(1,0)	-	Uncertain	Saddle point
			(1,1)	-	Uncertain	Saddle point
			(x^*, y^*)	+	0	Center
Proposition 4.6		$L_1 < S_1$, $L_2 > S_2$	(0,0)	-	Uncertain	Saddle point
			(0,1)	+	+	Unstable point
			(1,0)	+	-	ESS
			(1,1)	-	Uncertain	Saddle point
Proposition 4.7		$L_1 < S_1$, $L_2 < S_2$	(0,0)	+	+	Unstable point
			(0,1)	-	Uncertain	Saddle point
			(1,0)	+	-	ESS
			(1,1)	-	Uncertain	Saddle point
Proposition 4.8		$L_1 > S_1$, $L_2 > S_2$	(0,0)	+	-	ESS
			(0,1)	+	+	Unstable point
			(1,0)	-	Uncertain	Saddle point
			(1,1)	-	Uncertain	Saddle point

The replicator dynamics phase diagrams can be drawn in different cases by analyzing the local equilibrium points in the table:

FIGURE 2
PHASE DIAGRAM OF THE CORRESPONDING DYNAMIC EVOLUTION IN TABLE 2B

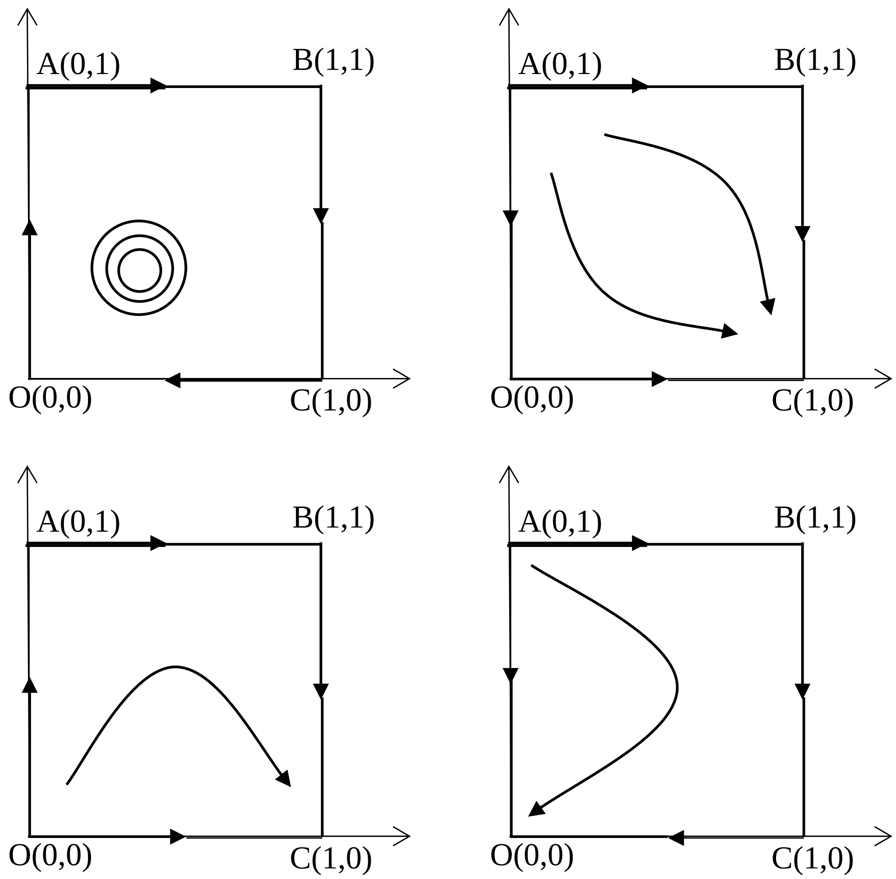


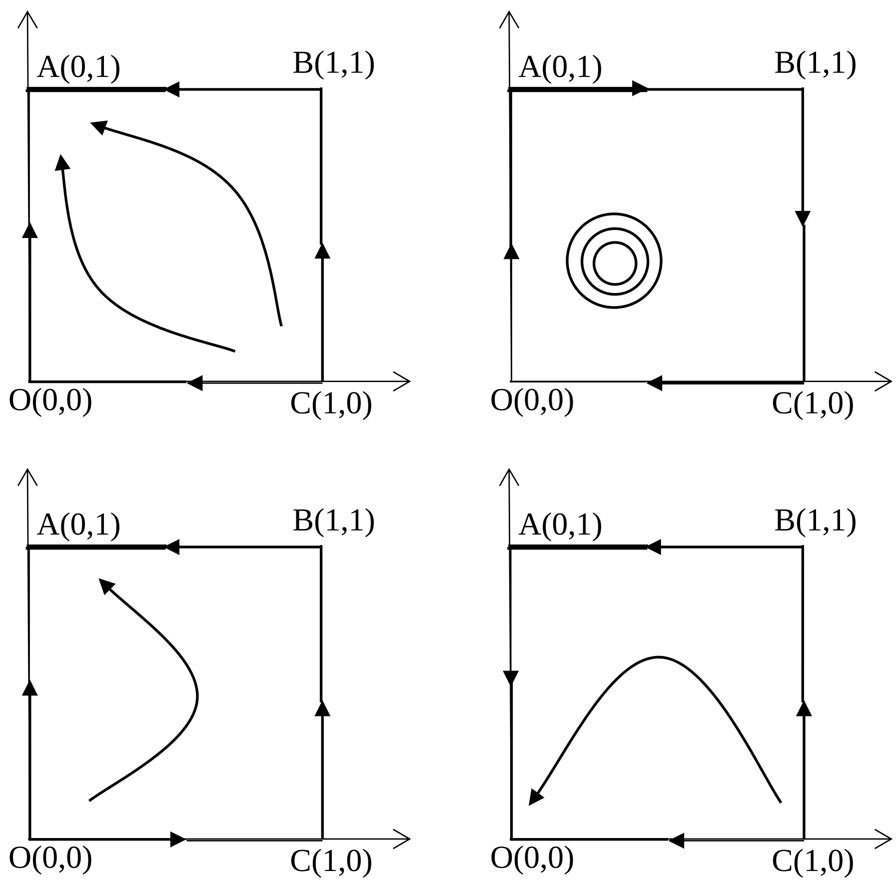
TABLE 2C
STABILITY ANALYSIS OF LOCAL EQUILIBRIUM POINTS IN DIFFERENT CONDITIONS

Proposition	Condition 1	Condition 2	Equilibrium point	detJ	trJ	Result
Proposition 4.9	$\alpha_1 r - C_1 < f_1 - P_1$, $\alpha_2 r - C_2 > f_2 - P_2$	$L_1 > S_1$, $L_2 < S_2$	(0,0)	-	Uncertain	Saddle point
			(0,1)	+	-	ESS
			(1,0)	+	+	Unstable point
			(1,1)	-	Uncertain	Saddle point
Proposition 4.10		$L_1 < S_1$, $L_2 > S_2$	(0,0)	-	Uncertain	Saddle point
			(0,1)	-	Uncertain	Saddle point
			(1,0)	-	Uncertain	Saddle point
			(1,1)	-	Uncertain	Saddle point
			(x^*, y^*)	+	0	Center

Proposition	Condition 1	Condition 2	Equilibrium point	detJ	trJ	Result
Proposition 4.11	$\alpha_1 r - C_1 < f_1 - P_1$, $\alpha_2 r - C_2 > f_2 - P_2$	$L_1 > S_1$, $L_2 < S_2$	(0,0)	+	+	Unstable point
			(0,1)	+	-	ESS
			(1,0)	-	Uncertain	Saddle point
			(1,1)	-	Uncertain	Saddle point
Proposition 4.12		$L_1 < S_1$, $L_2 > S_2$	(0,0)	+	-	ESS
			(0,1)	-	Uncertain	Saddle point
			(1,0)	+	+	Unstable point
			(1,1)	-	Uncertain	Saddle point
			(0,0)	+	+	Unstable point

The replicator dynamics phase diagrams can be drawn in different cases by analyzing the local equilibrium points in the table:

FIGURE 3
PHASE DIAGRAM OF THE CORRESPONDING DYNAMIC EVOLUTION IN TABLE 2C



Propositions 4.5-4.12 show that suppose the net payoffs obtained by either Chaoshan firm for choosing cooperation are greater than those obtained by choosing breach $(\alpha r - C > f - P)$, and the net payoffs obtained by the other for choosing cooperation are less than those obtained by choosing breach

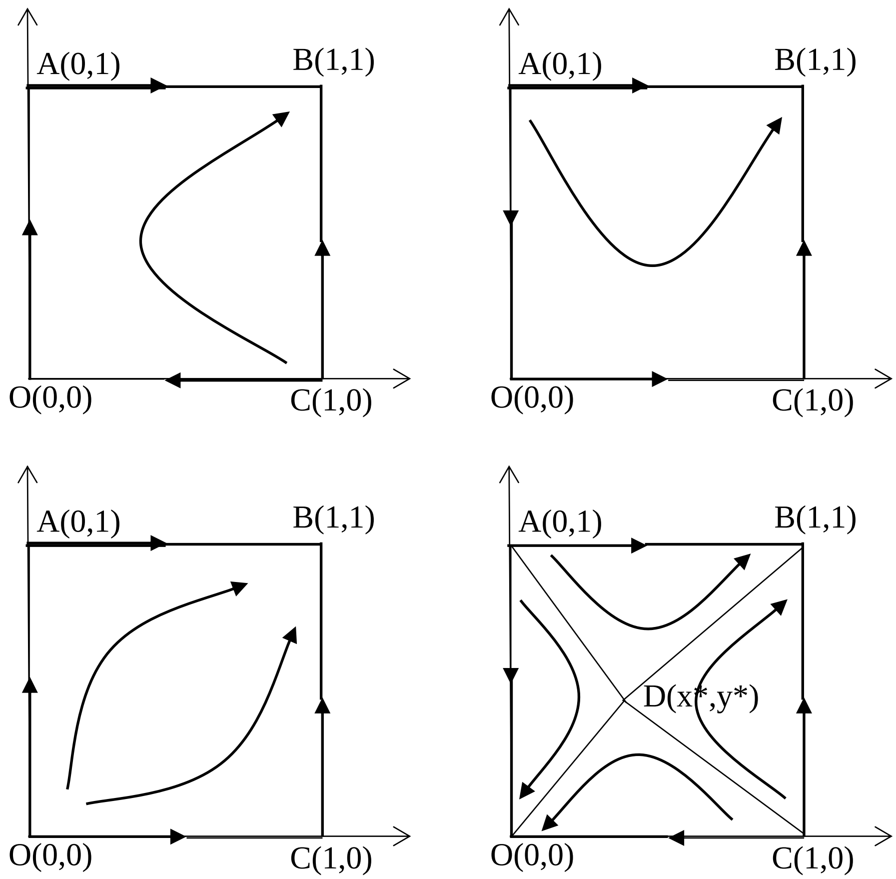
$(\alpha r - C < f - P)$. The latter will be the first to choose not to cooperate, while the former chooses to continue cooperation. It is assumed that the reputational compensation received by the former is sufficient to cover the loss of cooperation $(L < S)$. If the reputational compensation received by the former cannot cover the loss of cooperation $(L > S)$ and that received by the latter can cover the loss of cooperation $(L < S)$, both parties have no final and stable strategic choice. If the reputational compensation received by the former $(L > S)$ and the latter $(L > S)$ cannot cover the loss of cooperation, both parties will eventually choose not to cooperate.

TABLE 2D
STABILITY ANALYSIS OF LOCAL EQUILIBRIUM POINTS IN DIFFERENT CONDITIONS

Proposition	Condition 1	Condition 2	Equilibrium point	detJ	trJ	Result
Proposition 4.13	$\alpha_1 r - C_1 > f_1 - P_1$, $\alpha_2 r - C_2 > f_2 - P_2$	$L_1 > S_1$, $L_2 < S_2$	(0,0)	-	Uncertain	Saddle point
			(0,1)	-	Uncertain	Saddle point
			(1,0)	+	+	Unstable point
			(1,1)	+	-	ESS
Proposition 4.14		$L_1 < S_1$, $L_2 > S_2$	(0,0)	-	Uncertain	Saddle point
			(0,1)	+	+	Unstable point
			(1,0)	-	Uncertain	Saddle point
			(1,1)	+	-	ESS
Proposition 4.15		$L_1 < S_1$, $L_2 < S_2$	(0,0)	+	+	Unstable point
			(0,1)	-	Uncertain	Saddle point
			(1,0)	-	Uncertain	Saddle point
			(1,1)	+	-	ESS
Proposition 4.16		$L_1 > S_1$, $L_2 > S_2$	(0,0)	+	-	ESS
			(0,1)	+	+	Unstable point
			(1,0)	+	+	Unstable point
			(1,1)	+	-	ESS

The replicator dynamics phase diagrams can be drawn in different cases by analyzing the local equilibrium points in the table:

FIGURE 4
PHASE DIAGRAM OF THE CORRESPONDING DYNAMIC EVOLUTION IN TABLE 2D



Propositions 4.13-4.16 show that when the net payoffs to both Chaoshan firms for choosing cooperation are greater than those for violating the agreement $(\alpha r - C < f - P)$, both parties will eventually choose (cooperation, cooperation). It is premised on the assumption that, at most, one party will receive sufficient reputational compensation for the loss from choosing cooperation $(L < S)$. If neither party receives enough reputational compensation for the losses from choosing cooperation $(L > S)$, the final choice of both parties will change depending on the magnitude of the parameters.

Proposition 4.16 and the corresponding replicator dynamics phase diagram reveal that the position of point D affects the area of OADC and ABCD. Point D affects the chance of converging to the equilibrium point ESS (point O, point B). Then the final choice is O(0,0) or B(1,1) implies whether both parties ultimately choose Strategy 1 (cooperation, cooperation) or Strategy 2 (no cooperation, no cooperation). It is closely related to $D\left(\frac{L_2 - S_2}{\alpha_2 r - C_2 - f_2 + P_2 + L_2 - S_2}, \frac{L_1 - S_1}{\alpha_1 r - C_1 - f_1 + P_1 + L_1 - S_1}\right)$. The initial state at point D eventually yields different stable outcomes.

The final choice of the game players changes with the parameters when the reputational compensation from choosing cooperation cannot cover the loss of cooperation $(S < L)$ and the net payoffs from choosing cooperation are greater than those from violating the agreement $(\alpha r - C > f - P)$. Therefore, further parameter analysis and discussion are needed for the final choice of Strategy 1 (cooperation, cooperation) or Strategy 2 (no cooperation, no cooperation) by game players. In the following section, we discuss how the parameters affect strategic behavior by adjusting the parameters.

Parameters α_1 , α_2 . α_1 , α_2 represent the proportions of the market payoffs allocated to different Chaoshan firms after they have entered into a partnership, and they sum to 1. Other parameters being unchanged with $\alpha_1 > \alpha_2$, α_1 , α_2 are positive in the denominator according to the expression of point D. It can be found that point D converges to the lower right, the closer to point C(1,0). It indicates that the party with an increasing share of market benefits is more willing to cooperate. In contrast, those with a decreasing share of market benefits are less willing to cooperate. However, C(1,0) is an unstable point, and both parties will not reach cooperation in the end, with (no cooperation, no cooperation) being the final result.

Similarly, when other parameters remain unchanged with $\alpha_1 < \alpha_2$, point D converges to the upper left, closer to point B(0,1). It indicates that the party with an increasing share of market benefits is more willing to cooperate, while that with a decreasing share of market benefits is less willing to cooperate. However, B(1,0) is an unstable point, and both parties will not reach cooperation in the end, with (no cooperation, no cooperation) being the final result. In other words, the more α_1, α_2 converge to 0.5, the more willing both parties are to cooperate than in other cases. That is, it is more likely that the final result will be (cooperation, cooperation).

Based on this, it uses simulation to verify the effect of the parameter change on the strategy of both sides of the game by changing the parameter value. With other parameters remaining unchanged (L_1=10, L_2=10, S_1=5, S_2=5, r=40, C_1=1, C_2=1, f_1=4, f_2=6, P_1=2, P_2=4), it assigns the values (A. α_1=0.1, α_2=0.9; B. α_1=0.3, α_2=0.7; C. α_1=0.5, α_2=0.5; D. α_1=0.7, α_2=0.9; E. α_1=0.9, α_2=0.1). Thus, it verifies the previous parametric analysis (Figures 5 and 6).

FIGURE 5

SIMULATION DIAGRAM FOR PARAMETERS α_1 , α_2 IN THE CASES OF A, B AND C

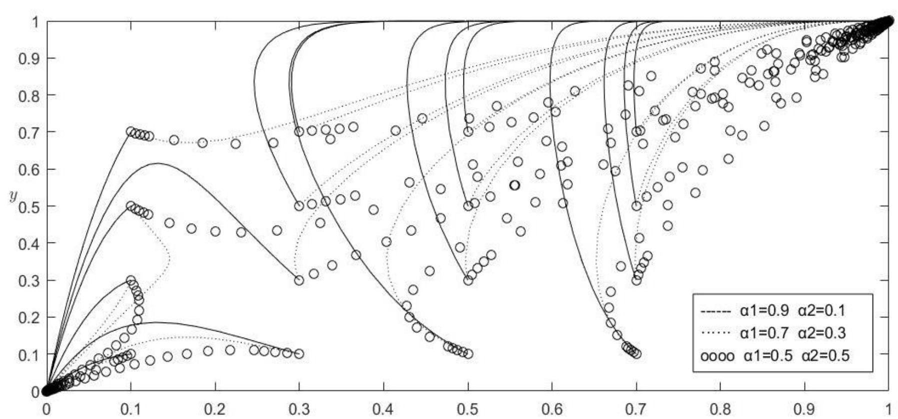
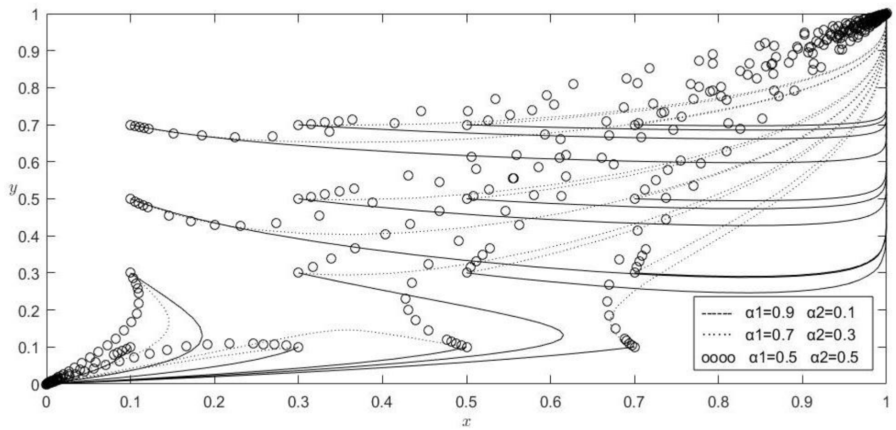


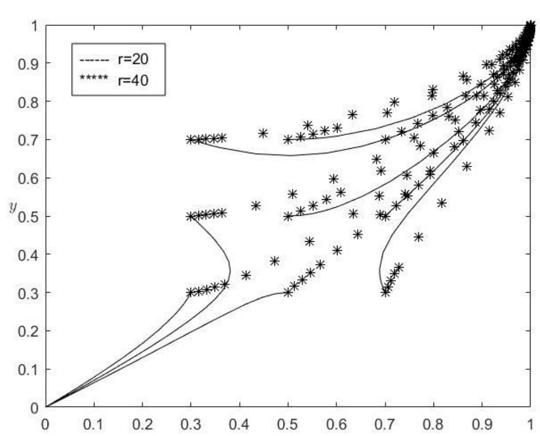
FIGURE 6
SIMULATION DIAGRAM FOR PARAMETERS α_1 , α_2 IN THE CASES OF C, D AND E



Parameter r . r represents the additional market payoffs of cooperation between different Chaoshan firms. With other parameters unchanged, when the additional market payoffs of cooperation r are larger, r is positive in the denominator according to the expression of point D. It can be concluded that the closer point D is to the lower left, the smaller the area of the area OADC, and the larger the area ABCD. It indicates that the area between point D and point B(1,1) becomes larger, implying a higher chance of choosing Strategy 1 (cooperation, cooperation). It shows that increased additional market payoffs for cooperation will improve insiders' willingness to choose cooperation. Conversely, decreased additional market payoffs will weaken insiders' willingness to choose cooperation.

Based on this, it uses simulations to verify the effect of parameter changes on the strategies of both game players by changing the parameter values. With other parameters remaining unchanged(L_1=10, L_2=10, S_1=5, S_2=5, C_1=1, C_2=1, f_1=4, f_2=6, P_1=2, P_2=4), it assigns the values (A. r =20 and B. r =40). Thus, it verifies the previous parametric analysis (Figure 7).

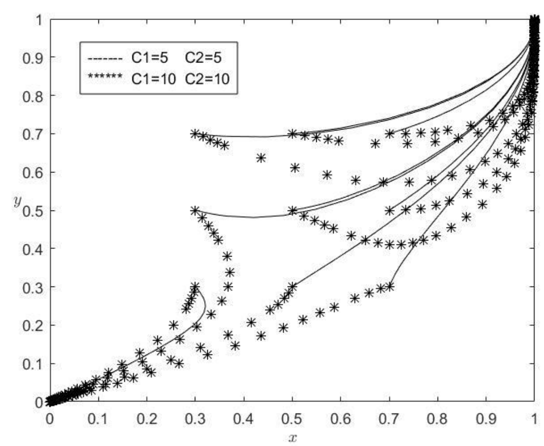
FIGURE 7
SIMULATION DIAGRAM FOR THE PARAMETER r IN THE CASES OF A AND B



Parameters C_1 , C_2 . C_1 , C_2 represent the costs of achieving cooperation for different Chaoshan firms. With other parameters unchanged and greater costs C_1 , C_2 of reaching cooperation for bother parties (parameters C_1 , C_2 often increase or decrease simultaneously), C_1 , C_2 are negative in the denominator according to the expression for point D. It can be concluded that the more the point D converges to the upper right, the larger the area of the area OADC, and the smaller the area ABCD. It suggests that the area between points D and O(0,0) becomes larger, implying a greater chance of choosing Strategy 2 (no cooperation). Thus, increased cooperation costs will reduce the players' willingness to choose cooperation. Conversely, decreased cooperation costs will increase the insiders' willingness to choose cooperation.

Based on this, it uses simulations to verify the effect of parameter changes on the strategies of both game players by changing the parameter values. With other parameters remaining unchanged(L_1=10, L_2 =10, S_1=5, S_2=5, α_1=0.6, α_2=0.4, r=40, f_1=8, f_2=8, P_1=4, P_2=4), it assigns the values (A. C_1 =5, C_2 =5; B. C_1 =10, C_2 =10). Thus, it verifies the previous parametric analysis (Figure 8).

FIGURE 8
SIMULATION DIAGRAM FOR PARAMETERS C_1 , C_2 IN THE CASES OF A AND B

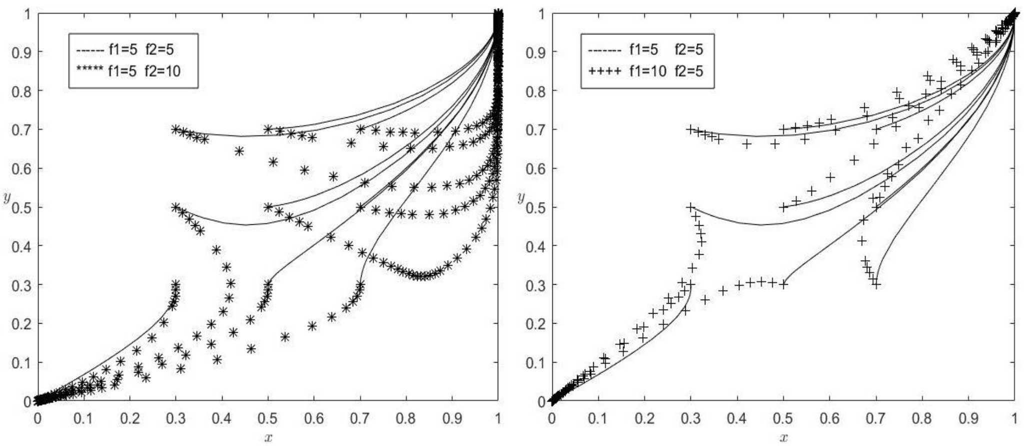


Parameters f_1 , f_2 . f_1 , f_2 represent the payoffs obtained by different Chaoshan firms for the breach of the cooperation agreement for private gain and the deduction of the previous cost of reaching the cooperation. Suppose other parameters remain unchanged but payoffs f_1 or f_2 increase from violating the cooperation agreement for personal gain, net of the initial costs of reaching cooperation(according to the definition of the parameter, f_1 , f_2 do not arise simultaneously). Both parameters are negative in the denominator according to the expression for point D. It can be concluded that the closer point D is to the X=1 or Y=1 axis, the larger the area OADC, and the smaller the area ABCD. It shows that the area between points D and O(0,0) becomes larger, indicating a greater chance of choosing Strategy 2 (no cooperation). It indicates that higher payoffs for violating the cooperation agreement for private gain, net of the initial cost of cooperation, will weaken the willingness of the insiders to cooperate. Conversely, lower payoffs from violating the cooperation agreement for private gain, net of the initial cost of cooperation, will increase the willingness of the insiders to cooperate.

Based on this, it uses simulations to verify the effect of parameter changes on the strategies of both game players by changing the parameter values. With other parameters remaining unchanged (L_1=10, L_2

=10, S_1=5, S_2=5, α_1=0.6, α_2=0.4, r=30, C_1 =5, C_2 =5, P_1=4, P_2=4), it assigns the values (A. f_1=5, f_2=5; B. f_1=5, f_2=10; C. f_1=10, f_2=5). Thus, it verifies the previous parametric analysis (Figure 9).

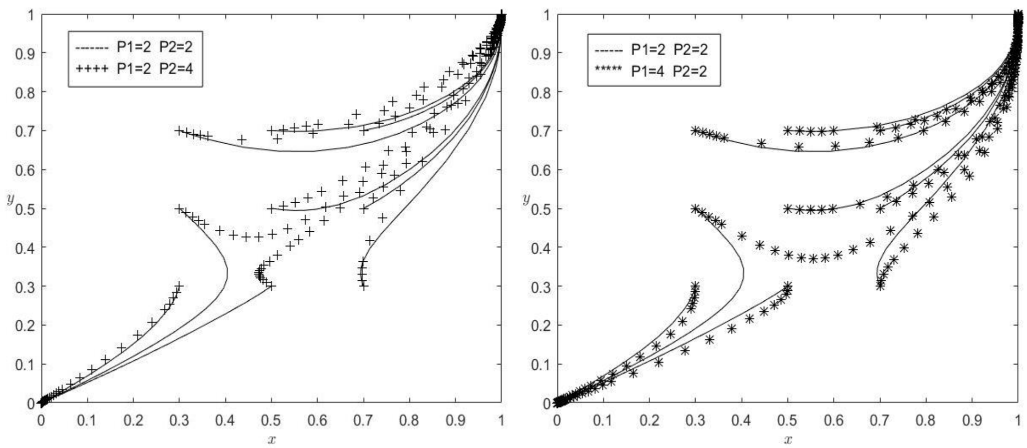
FIGURE 9
SIMULATION DIAGRAMS FOR PARAMETERS f_1 , f_2 IN THE CASES OF A AND B AND CASES OF A AND C



Parameters P_1, P_2 . P_1, P_2 represent the losses incurred by different Chaoshan firms triggering the penalty mechanism of integrity. With other parameters unchanged and greater losses P_1 or P_2 caused by the penalty (according to the definition of the parameter, P_1, P_2 do not arise simultaneously), they are positive in the denominator according to the expression for point D. It can be concluded that the more the point D converges to the X=0 or Y=0 axis, the smaller the area OADC, and the larger the area ABCD. It shows that the area between points D and B(1,1) becomes larger, implying a greater chance of choosing Strategy 1 (cooperation). Hence, the increased loss from the penalty will boost the insiders' willingness to cooperate. Conversely, the decreased loss from penalty will reduce the insiders' willingness to cooperate.

Based on this, it uses simulations to verify the effect of parameter changes on the strategies of both game players by changing the parameter values. With other parameters remaining unchanged (L_1=10, L_2 =10, S_1=5, S_2=5, α_1=0.6, α_2=0.4, r=30, C_1 =5, C_2 =5, f_1=5, f_2=5), it assigns the values (A. P_1=2, P_2=2; B. P_1=2, P_2=4; C. P_1=4, P_2=2). Thus, it verifies the previous parametric analysis (Figure 10).

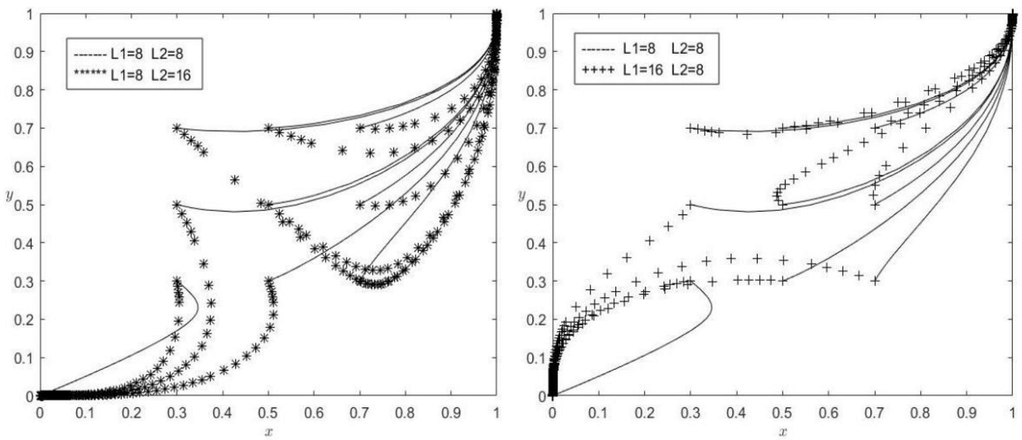
FIGURE 10
SIMULATION DIAGRAMS FOR PARAMETERS P_1, P_2 IN THE CASES OF A AND B AND CASES OF A AND C



Parameters L_1, L_2. L_1, L_2 represent the costs of Chaoshan firms continuing to cooperate. With other parameters unchanged, as the cost L_1 or L_2 for continuing to cooperate increases (according to the definition of the parameter, L_1, L_2 do not arise simultaneously), they are positive in the numerator and denominator, respectively, according to the expression for point D. It can be concluded that the closer the point D is to the X=1 or Y=1 axis, the larger the area OADC, and the smaller the area ABCD. It shows that the area between points D and O(0,0) becomes larger, indicating a greater chance of choosing Strategy 2 (no cooperation, no cooperation). It indicates that higher payoffs for violating the cooperation agreement for private gain, net of the initial cost of cooperation, will weaken the willingness of the insiders to cooperate. Conversely, lower payoffs from violating the cooperation agreement for private gain, net of the initial cost of cooperation, will increase the willingness of the insiders to cooperate.

Based on this, it uses simulations to verify the effect of parameter changes on the strategies of both game players by changing the parameter values. With other parameters remaining unchanged (S_1=5, S_2=5, α_1=0.6, α_2=0.4, r=30, C_1 =5, C_2 =5, f_1=5, f_2=5, P_1=2, P_2=2), it assigns the values (A. L_1=8, L_2=8; B. L_1 =8, L_2=16; C. L_1=16, L_2=8). Thus, it verifies the previous parametric analysis (Figure 11).

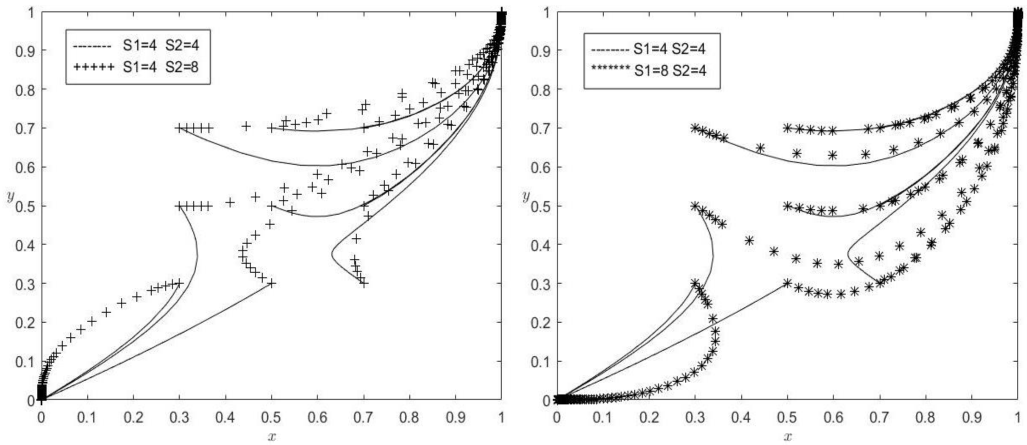
FIGURE 11
SIMULATION DIAGRAMS FOR PARAMETERS L_1, L_2 IN THE CASES OF A AND B AND CASES OF A AND C



Parameters S_1, S_2. S_1, S_2 represent the reputational compensation of different Chaoshan firms from the merchant group and the chamber, respectively, for compliance with integrity. With other parameters unchanged and higher costs S_1 or S_2 invested in continuing to cooperate (according to the parameter definitions, the two do not arise simultaneously), S_1, S_2 are negative in the numerator and denominator, respectively, according to the expression for point D. It can be concluded that the closer the point D is to the X=0 or Y=0 axis, the smaller the area OADC, and the larger the area ABCD. It indicates that the area between point D and point B(1,1) grows larger, suggesting a greater chance of choosing Strategy 1 (cooperation). Therefore, increased reputational compensation from compliance with integrity reinforces the insiders' willingness to cooperate. Conversely, decreased reputational compensation from compliance with integrity weakens the insiders' willingness to cooperate.

Based on this, it uses simulations to verify the effect of parameter changes on the strategies of both game players by changing the parameter values. With other parameters remaining unchanged (L_1=10, L_2 =10, α_1=0.6, α_2=0.4, r=30, C_1 =5, C_2 =5, f_1=5, f_2=5, P_1=2, P_2=2), it assigns the values (A. S_1=4, S_2=4; B. S_1=4, S_2=8; C. S_1=8, S_2=4). Thus, it verifies the previous parametric analysis (Figure 12).

FIGURE 12
SIMULATION DIAGRAMS FOR PARAMETERS S_1, S_2 IN THE CASES OF A AND B AND CASES OF A AND C



CONCLUSION AND DISCUSSION

Conclusion

Given the cooperation of heterogeneous Chaoshan firms with different resource endowments, it is concluded that both parties should not continue to cooperate in groups as long as the net payoffs from one party choosing cooperation are smaller than those from the other party choosing to breach the agreement. When the net payoffs from cooperation are greater than those from a breach, the parties choose group cooperation if reputational compensation covers the losses. If reputational compensation cannot cover losses, it can facilitate the evolution of the game system to a cooperative strategy in the following ways: balance the distribution of benefits, increase the profitability of cooperation, increase the penalty cost of the breach, decrease the cost of cooperation, decrease the profitability of betrayal, and increase the loss of breach for those insisting on cooperation.

Based on the parametric analysis and simulation, it was found that in facilitating group cooperation strategies, the net payoffs earned by Chaoshan firms in choosing cooperation are particularly crucial, despite the necessity of penalty and compensation mechanisms. Maximizing the payoffs of both parties from cooperation depends on a fair and equitable win-win concept of cooperation. The cooperation of Chaoshan firms also provides a model for modern corporate, industrial, and even international cooperation. Cooperation must grasp the "common" principle, work together to explore the market, share the results of construction, in order to achieve win-win results. In concrete actions, both partners can reach cooperation agreements fairly and openly without compromising their interests. They should minimize the acts of crowding out the weaker juniors and give the maximum concessions reasonably. Chaoshan merchants are risk-takers with first-class business networks and access to resources. However, they also care about their internal cultivation and moral integrity and value their credit and reputation.

On the one hand, a multilateral credit-based penalty mechanism is spontaneously formed for unfaithful Chaoshan merchants and their enterprises. Non-compliant Chaoshan merchants and their businesses will be expelled from the Chaoshan merchants' business circle and have to pay a heavy price. On the other hand, the honest Chaoshan merchants and their enterprises may be betrayed and suffer temporary losses, but they will be consoled by the merchant group and compensated accordingly. Moreover, their reputation is widely spread through the chambers of commerce and other channels, laying a sound foundation of a reputation for their future business cooperation. In short, in the Chaoshan group, credit can simultaneously create punishment and compensation mechanisms. Because of this, Chaoshan firms' group cooperation institution has been further self-enforced and enhanced.

Discussion

Due to the uncertainty of market information and the limited perception of Chaoshan firms, the defaulting firms cannot determine the payoffs of betraying cooperation but only know that they must pay the price for betrayal. In this way, it also contributes to the group cooperation strategy through a multilateral penalty mechanism. It should be noted that although this study establishes a reputational compensation mechanism, such reputational payoffs from integrity are often uncertain or lagging. In addition, reputational compensation cannot fully cover the loss for cooperation. Thus, reputational compensation may not be an advantageous incentive for the parties to cooperate but only a consideration. However, it does not mean that the incentive of reputational compensation can be ignored. In the increasingly competitive market, reputation advantages from third parties, such as chambers of commerce and the general public, are increasingly becoming one of the competitive edges. Chaoshan firms have made it a business ethic to be faithful. Third parties spread the reputation of Chaoshan firms through word of mouth and announcements. It is a credit investment for the firms as it connects them to their business and creates new areas for business growth.

Undeniably, this paper also has shortcomings and limitations. First, this study has some limitations on the collection, sorting, analysis and interpretation of historical materials such as historical materials and local Chronicles, but it has also been proved by other studies to achieve better interpretation results. Second, this paper focuses on deducing the evolutionary game model from the theoretical point of view. Unfortunately, due to the incompleteness of relevant materials and incomplete openness of corporate information, it is difficult to find and verify cases consistent with the assumed conditions in real life. However, based on the perspective of historical comparative institutional analysis, the assumptions in this paper are logical and historical. The group cooperation strategy and its constraint factors have withstood the test of history and are still the hidden rules and internal mechanism of the cooperation relationship between Chaoshan firms.

ACKNOWLEDGEMENT

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