frontiers | Frontiers in Physics

TYPE Original Research
PUBLISHED 13 November 2023
DOI 10.3389/fphy.2023.1307672

OPEN ACCESS

EDITED BY
Jianbo Wang,
Southwest Petroleum University, China

REVIEWED BY
Tan Zhidong,
Nanjing Audit University, China
Nengzhi Yao,
Nanjing Normal University, China

*CORRESPONDENCE
Yuqing Zhu,
846763679@qq.com

RECEIVED 05 October 2023
ACCEPTED 01 November 2023
PUBLISHED 13 November 2023

CITATION
Wu M, Zhu Y, Yang T and Xu Y (2023), Game-theoretic approach to understanding status transition dynamics and employee performance enhancement in organizations. *Front. Phys.* 11:1307672. doi: 10.3389/fphy.2023.1307672

Game-theoretic approach to understanding status transition dynamics and employee performance enhancement in organizations

Mengyun Wu[1,2], Yuqing Zhu[2]*, Ting Yang[2] and Yifan Xu[2]

[1]School of Accounting, Shanghai Lixin University of Accounting and Finance, Shanghai, China, [2]School of Finance and Economics, Jiangsu University, Zhenjiang, Jiangsu, China

To foster high-quality economic development, it is critical to not only enhance the "hard environment," such as infrastructure, but also to make significant strides in the "soft environment," such as the relationship between government and businesses. This study posits that the government, industry associations, and enterprises should collectively participate in fostering a "cordial and clean" government-business relationship. By resolving the equilibrium solution of the three-party game, it has been identified that achieving the goal of constructing a cordial and clean government-business relationship and aligning with the ambitions of enterprises necessitates policy guidance and a balance of interests among the government, industry associations, and enterprises. The research also contributes to the beneficial exploration of game theory, by constructing a network model from the perspective of public management and integrating it with the practice of local administrative reform. This integration is particularly relevant for industry associations, and their systematic analysis further enhances the practical applicability of the research.

KEYWORDS

economic development, industry associations, three-party game, governance, public management

1 Introduction

The government-business relationship is a timeless subject of discourse. It can be examined from a macroscopic perspective, where it pertains to the connection between the government and enterprises, or from a microscopic viewpoint, where it concerns the relationship between officials and entrepreneurs [1]. The proposition of a "cordial" and "clear" reformation of the existing government-business relationship provides innovative solutions to the challenges inherent in the current dynamics between enterprises and the government. It also outlines a direction for adjusting these existing relationships. Existing research on the government-business relationship primarily focuses on two levels: the macro and the micro. (1) Macro level: the relationship between the government and the market. Liberal economic theory, represented by thinkers such as Adam Smith, posits that the government's role should be limited to establishing and maintaining a strict law enforcement system, providing minimum public services like education, and minimally interfering with economic activities of enterprises. [2] further elaborates on this role from the perspective of the digital content industry, underscoring the government's various functions in the creation

of government-business relationships, including policy formulation and resource provision. Nationalistic economic theory, represented by [3], argues that a "visible hand" government can alleviate economic depression and unemployment through judicious and correct fiscal and monetary policy interventions. [4] also emphasizes that, considering the challenges to China's economic structure, the government should shift from a management focus to a service provider role, hence emphasizing the "cordial" aspect of the government-business relationship. (2) Micro level: the relationship between officials and entrepreneurs. The limited government theory, represented by [5], posits that the government is merely an agent entrusted by the people. It suggests that an alienation of the government-business relationship can occur, necessitating the establishment of a "limited government" subject to strict legal regulations. The distortion of the government-business relationship, evident in rent-seeking between the government and enterprises [6], underlines the importance of a "clear" relationship. On the other hand, public choice theory, represented by [7], views politics as essentially an exchange process. Here, the government, as a rational economic agent, acts as a 'shrewd buyer' providing paid services to enterprises. This results in enterprises receiving property protection and development opportunities, reflecting the "cordial" aspect of the government-business relationship. The shared interests and responsibilities between government and citizens reaffirm the importance of a "cordial" and "clear" relationship at the micro level.

In conclusion, a wealth of research on the construction, evolution, and governance of government-business relationships has been conducted by scholars both domestically and abroad [8]. Nonetheless, given that the concept of cordial and clean relationship between government and business is distinctively Chinese, most Chinese scholarly investigations have concentrated on its connotation or practical significance. A limited number of studies have attempted to develop network models within the realm of public management [9]. Furthermore, there is a scarcity of game-theoretic investigations that integrate with the practice of local administrative reform, particularly with regard to industry associations. These areas have not received systematic analysis and in-depth consideration. This study aims to redress this gap by embarking on a beneficial exploration of these less-explored aspects of government-business relations. The contributions of this paper are as follows: firstly, through the tripartite game model of government, industry association and enterprise, (1) it helps to promote the high-quality development of non-public economy; (2) It helps create a positive image of the government as friendly to the people and clean, and optimizes the business environment; (3) It helps to purify the political ecology and lead the social atmosphere. Secondly, the game model is used to simulate the influence of the cordial and clean relationship between government and business on the different decisions of the government, industry associations and enterprises, so as to provide practical support for narrowing the regional gap in the future and realizing the leapfrog development of the latecomer regions. Finally, the conclusions of this paper can enrich the relevant literature on the economic consequences of the pro-clean relationship between government and business and regional economic development, and also provide valuable decision-making reference for realizing the strategic goal of coordinated development of regional economy and common prosperity of all people.

2 The methods

This study postulates that the government, industry associations, and enterprises are all participants in the construction of a cordial and clean relationship between government and business. For the government, there are two strategic alternatives: to construct "cordial" and "clean" policies that encourage enterprise behavior devoid of rent-seeking, or to abstain from constructing such policies. The probability of the government choosing to construct these policies is denoted by x, and the probability of refraining from construction is $1 - x$. In response to the government's policies, industry associations also have two strategic options: to supervise enterprises in promoting their actions, or to refrain from such supervision. The probability of choosing supervision is denoted by y, while the probability of not supervising is $1 - y$. In accordance with government policies, enterprises also have two strategic alternatives: proactive action or passive action. The probability of choosing a proactive action is symbolized by z, and the probability of choosing a passive action is $1 - z$. Simultaneously, this study assumes that the three participants in the dynamic game are rational economic actors, each pursuing the maximization of their self-interests in the process of constructing a "cordial" and "clean" policy for government-business relations. The government's interests primarily manifest in an increase in fiscal revenue and the maintenance of a positive governmental image. Trade associations' benefits are chiefly reflected in promoting economic development and enhancing government performance assessment. For businesses, the benefits mainly lie in increased operational income and profit. Given that the tripartite game involving the government, industry association, and enterprise is sequential, each subsequent actor can observe the behavior of the preceding actor and adjust their actions accordingly. Therefore, this study establishes a tripartite dynamic game model involving the government, industry association, and enterprise. The game tree is illustrated in Figure 1.

The corresponding benefit-cost parameters of participants in the dynamic game model are as: (1) The Government: B_1: Basic benefits for local governments (credibility, performance assessment and regional economic benefits, etc.); C_1: The cost of building a cordial and clean relationship between government and business; S_1: For the strong supervision of industry associations, the government subsidizes them; S_2: For the positive actions of enterprises, the government subsidizes them; R_1: For the positive actions of enterprises, the government gains benefits; R_2: For the strong regulation of industry associations, the government gains benefits. (2) Industry associations: B_2: Gains from participation in supervision by trade associations; C_2: Strong supervision costs for industry associations (construction labor costs, equipment costs and policy publicity, etc.); C_3: Weak regulatory costs for industry associations (policy advocacy); T_1: The additional benefits gained by industry associations for the establishment of cordial and clean relationship between

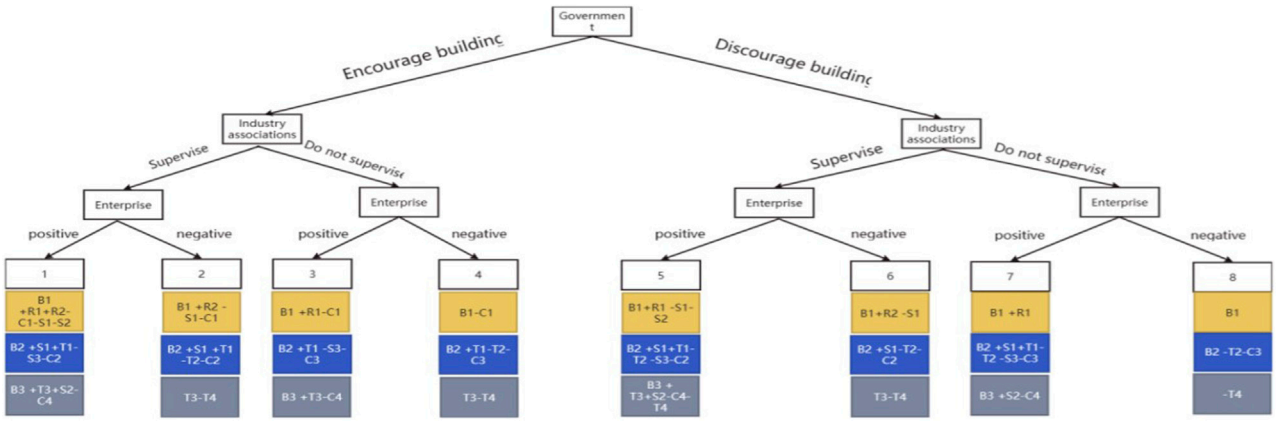

FIGURE 1
Dynamic game tree of government, industry association and enterprise.

TABLE 1 Income payment matrix under different strategy combinations of government, industry association and enterprise.

Id	Strategy combinations	Payoff matrix		
		The government	Industry associations	Enterprises
1	{construction, strong regulation, positive}	$B_1 + R_1 + R_2 - C_1 - S_1 - S_2$	$B_2 + S_1 + T_1 - S_3 - C_2$	$B_3 + T_3 + S_2 - C_4$
2	{construction, strong regulation, negative}	$B_1 + R_2 - S_1 - C_1$	$B_2 + S_1 + T_1 - T_2 - C_2$	$T_3 - T_4$
3	{construction, weak regulation, positive}	$B_1 + R_1 - C_1$	$B_2 + T_1 - S_3 - C_3$	$B_3 + T_3 - C_4$
4	{construction, weak regulation, negative}	$B_1 - C_1$	$B_2 + T_1 - T_2 - C_3$	$T_3 - T_4$
5	{no construction, strong regulation, positive}	$B_1 + R_1 - S_1 - S_2$	$B_2 + S_1 + T_1 - T_2 - S_3 - C_2$	$B_3 + T_3 + S_2 - C_4 - T_4$
6	{no construction, strong regulation, negative}	$B_1 + R_2 - S_1$	$B_2 + S_1 - T_2 - C_2$	$T_3 - T_4$
7	{no construction, weak regulation, positive}	$B_1 + R_1$	$B_2 + S_1 + T_1 - T_2 - S_3 - C_3$	$B_3 + S_2 - C_4$
8	{no construction, weak regulation, negative}	B_1	$B_2 - T_2 - C_3$	$-T_4$

government and business or the active actions of enterprises; T_2: The extra cost paid by industry associations for the government's failure to build a cordial and clean relationship between government and business or the passive actions of enterprises; S_3: For enterprises to actively act, industry associations to subsidize them. (3) Enterprises: B_3: The basic profit for the enterprise actively acts; C_4: The cost of doing something positive for the business; T_3: Build a cordial and clean relationship between government and business or strong supervision of industry associations, and the additional benefits obtained by enterprises; T_4: For the government does not build a cordial and clean relationship between government and business or the negative actions of enterprises, the additional losses caused by enterprises. Therefore, according to the assumptions of the model and the benefit-cost parameters mentioned above, there are eight strategy combinations among the three stakeholders of the government, industry associations and enterprises, which are 1 {construction, strong regulation, positive}, 2 {construction, strong regulation, negative}, 3 {construction, weak regulation, positive}, 4 {construction, weak regulation, negative}, 5 {no construction, strong regulation, positive}, 6 {no construction, strong regulation, negative}, 7 {no construction, weak regulation, positive}, 8 {no construction, weak regulation, negative}, the payoff payment matrix of the three-game players under different strategy choices is shown in Table 1.

3 Results

3.1 Construction of dynamic equation

Based on the aforementioned game analysis, we can formulate the dynamic equation for the tripartite participants—government, industry association, and enterprise—as follows:

3.1.1 The government

(i) The expected return of constructing the cordial and clean relationship between government and business x

$$\begin{aligned} EX_1 &= yz(B_1 + R_1 + R_2 - C_1 - S_1 - S_2) + y(1-z)(B_1 + R_2 - S_1 - C_1) \\ &\quad + (1-y)z(B1 + R1 - C1) + (1-y)(1-z)(B_1 - C_1) \\ &= -S_2yz + (R_2 - S_1)y + R_1z + B_1 - C_1 \end{aligned}$$

(ii) The expected return of $1-x$ without constructing the "pro-clean" relationship

$$\begin{aligned}EX_2 &= yz(B_1+R_1-S_1-S_2)+y(1-z)(B_1+R_1-S_1-S_2)\\&\quad+(1-y)z(B1+R1)+(1-y)(1-z)(B_1)\\&=-R_1yz+(R_1-S_1-S_2)y+R_1z+B_1\end{aligned}$$

(iii) Average expected return

$$\begin{aligned}EX &= xEX_1+(1-x)EX_2\\&=x(EX_1-EX_2)+EX_2\\&=x\left[(R_1-R_2)yz+(R_2-R_1+S_2)y-C_1\right]-R_1yz\\&\quad+(R_1-S_1-S_2)y+R_1z+B_1\\&=(R_1-S_2)xyz+(R_2-R_1+S_2)xy-R1yz-C1x\\&\quad+(R1-S1-S2)y+R_1z+B1\end{aligned}$$

(iv) Government replicates dynamic equations: $F(x)=\frac{dx}{dt}=x(EX_1-EX)$

$$\begin{aligned}F(x) &= x(EX_1-EX)\\&=x(1-x)(EX_1-EX_2)\\&=x(1-x)\left[yz(R_2-C_1)+y(1-z)(R_2-R_1+S_2-C_1)\right.\\&\quad\left.+(1-y)z(-C_1)+(1-y)(1-z)(-C_1)\right]\\&=x(x-1)\left[C_1+(R_1-R_2-S_2)y+(S_2-R_1)yz\right]\end{aligned}$$

Let $F(x)=0$, when $y=y^{\star}=\frac{C_1}{R_1z-S_2z+R_2-R_1+S_2}$, $F(x)$ is always 0. However, if $y\neq\frac{C_1}{R_1z-S_2z+R_2-R_1+S_2}$, we obtain that $x=0$ and $x=1$ are two possible equilibrium points for $F(x)$. According to the stability theorem of the replicated dynamic equation, When $F'(x)<0$, this point is the stable strategy point of the evolutionary game. Take the derivative of F of x, $F'(x)=(1-2x)[C_1+(R_1-R_2-S_2)y+(S_2-R_1)yz]$. When $0<y<\frac{C_1}{R_1z-S_2z+R_2-R_1+S_2}$, $F'(x)|_{x=0}<0$, $F'(x)|_{x=1}>0$, in this case, $x=0$ is the stable strategy point of the evolutionary game. The government tends not to build a cordial and clean relationship between government and business. When $\frac{C_1}{R_1z-S_2z+R_2-R_1+S_2}<y<1$, $F'(x)|_{x=0}>0$, $F'(x)|_{x=1}<0$, in this case, $x=1$ is the stable strategy point of the evolutionary game. The government tends to build a cordial and clean relationship between government and business.

3.1.2 Industry associations

(i) Expected returns from implementing "strong regulation" y

$$\begin{aligned}EY_1 &= xz(B_2+S_1+T_1-S_3-C_2)+x(1-z)\\&\quad\times(B_2+S_1+T_1-T_2-C_2)\\&\quad+(1-x)z(B_2+S_1+T_1-T_2-S_3-C_2)+(1-x)(1-z)\\&\quad\times(B_2+S_1-T_2-C_2)\\&=(T_2-T_1)xz+T_1x+(T_1-S_3)z+B_2+S_1-T_2-C_2\end{aligned}$$

(ii) Expected benefits of implementing "weak regulation" $1-y$

$$\begin{aligned}EY_2 &= xz(B_2+T_1-S_3-C_3)+x(1-z)(B_2+T_1-T_2-C_3)\\&\quad+(1-x)z(B_2+S_1+T_1-T_2-S_3-C_3)+(1-x)(1-z)\\&\quad\times(B_2-T_2-C_3)\\&=(T_2-T_1-S_1)xz+T_1x+(S_1-S_3+T_1)z+B_2+S_1-T_2\\&\quad-C_3\end{aligned}$$

(iii) Average expected return

$$\begin{aligned}EY &= yEY_1+(1-y)EY_2\\&=S_1xyz+(T_2-T_1-S_1)xz-S_1yz+T_1x+(S_1+C_3-C_2)y\\&\quad+(S_1-S_3+T_1)z+B_2-T_2-C_3\end{aligned}$$

(iv) Government replicates dynamic equations: $F(y)=\frac{dy}{dt}=y(EY_1-EY)$

$$\begin{aligned}F(y) &= y(EY_1-EY)\\&=y(1-y)(EY_1-EY_2)\\&=y(1-y)(-S_1z+S_1-C_2+C_3+S_1xz)\end{aligned}$$

let $F(y)=0$, when $z=z^{\star}=\frac{C_3+S_1-C_2}{S_1-S_1X}$, $F(y)$ is always 0. However, if $z\neq\frac{C_3+S_1-C_2}{S_1-S_1X}$, we obtain that $y=0$ and $y=1$ are two possible equilibrium points for $F(x)$. According to the stability theorem of the replicated dynamic equation, when $F'(y)<0$, this point is the stable strategy point of the evolutionary game. Take the derivative of F of y, $F'(y)=(1-2y)(-S_1z+S_1-C_2+C_3+S_1xz)$. When $0<x<\frac{T_4y-B_3-S_2+C_4-T_4}{S_2y+T_4y-S_2}$, $F'(z)|_{z=0}<0$, $F'(z)|_{z=1}>0$, $z=0$ is the stable strategy point of the evolutionary game. That is, firms tend to act positively. When $0<z<\frac{C_3+S_1-C_2}{S_1-S_1X}$, $F'(y)|_{y=0}>0$, $F'(y)|_{y=1}<0$, $y=1$ is the stable strategy point of the evolutionary game. That is, trade associations favor strong regulation. When $\frac{C_3+S_1-C_2}{S_1-S_1X}<z<1$, $F'(y)|_{y=0}<0$, $F'(y)|_{y=1}>0$, $y=0$ is the stable strategy point of the evolutionary game. That is, trade associations favor weak regulation.

3.1.3 Enterprises

(i) The expected benefits of implementing "positive" z

$$\begin{aligned}EZ_1 &= xy(B_3+T_3+S_2-C_4)+x(1-y)(B_3+T_3-C_4)\\&\quad+(1-x)y(B_3+T_3+S_2-C_4-T_4)+(1-x)(1-y)\\&\quad\times(B_3+S_2-C_4)\\&=(S_2+T_4-T_3)xy+(T_3-S_2)x+(T_3-T_4)y+B_3+S_2-C_4\end{aligned}$$

(ii) Expected returns from implementing "negative" $1-z$

$$\begin{aligned}EZ_2 &= xy(T_3-T_4)+x(1-y)(T_3-T_4)\\&\quad+(1-x)y(T_3-T_4)+(1-x)(1-y)(-T_4)\\&=-T_3xy+T_3x+T_3y-T_4\end{aligned}$$

(iii) Average expected return

$$\begin{aligned}EZ &= zEZ_1+(1-z)EZ_2\\&=(S_2+T_4)xyz-T_3xy-S_2xz-T_4yz+T_3x+T_3y\\&\quad+(B_3+S_2-C_4+T_4)z-T_4\end{aligned}$$

(iv) Government replicates dynamic equations: $F(z)=\frac{dz}{dt}=z(EZ_1-EZ)$

$$\begin{aligned}F(z) &= z(EZ_1-EZ)\\&=z(1-z)(EZ_1-EZ_2)\\&=z(1-z)\left[(S_2+T_4)xy-S_2x-T_4y+B_3+S_2-C_4+T_4\right]\end{aligned}$$

let $F(z)=0$, when $x=x^{\star}=\frac{T_4y-B_3-S_2+C_4-T_4}{S_2y+T_4y-S_2}$, $F(z)$ is always 0. While $x\neq\frac{T_4y-B_3-S_2+C_4-T_4}{S_2y+T_4y-S_2}$, we obtain that $z=0$ and $z=1$ are two possible equilibrium points for $F(z)$. According to the stability theorem of the replicated dynamic equation, when $F'(z)<0$, this point is the stable strategy point of the evolutionary game. Take the derivative of F of z, $F'(z)=(1-2z)[(S_2+T_4)xy-S_2x-T_4y+B_3+S_2-C_4+T_4]$. When $0<x<\frac{T_4y-B_3-S_2+C_4-T_4}{S_2y+T_4y-S_2}$, $F'(z)|_{z=0}<0$, $F'(z)|_{z=1}>0$, $z=0$ is the stable strategy point of the evolutionary game. That is, firms tend to act positively. When $\frac{T_4y-B_3-S_2+C_4-T_4}{S_2y+T_4y-S_2}<x<1$, $F'(z)|_{z=0}>0$, $F'(z)|_{z=1}<0$, in this case, $z=1$ is the stable strategy point of the evolutionary game. That is, trade associations tend to behave negatively.

TABLE 2 Stability analysis of pure strategy equilibrium points.

Equalization point	λ_1	λ_2	λ_3	Stability condition
(0,0,0)	$-C_1$	$C_3 - C_2 + S_1$	$B_3 - C_4 + S_2 + T_4$	$C_3 < C_2 - S_1$, $B_3 < C_4 - S_2 - T_4$
(1,0,0)	C_1	$C_3 - C_2 + S_1$	$B_3 - C_4 + T_4$	Unstable point
(0,1,0)	$R_2 - R_1 - C_1 + S_2$	$C_2 - C_3 - S_1$	$B_3 - C_4 + S_2$	$R_2 < R_1 + C_1 - S_2$, $C_3 > C_2 - S_1$, $B_3 < C_4 - S_2$
(0,0,1)	$-C_1$	$C_3 - C_2$	$C_4 - B_3 - S_2 - T_4$	$C3 < C2$, $B_3 > C_4 - S_2 - T_4$
(1,1,0)	$C_1 + R_1 - R_2 - S_2$	$C_2 - C_3 - S_1$	$B_3 - C_4 + S_2 + T_4$	$C_1 < R_2 - R_1 + S_2$, $C_3 > C_2 - S_1$, $B_3 < C_4 - S_2 - T_4$
(1,0,1)	C_1	$C_3 - C_2 + S_1$	$C_4 - B_3 - T_4$	Unstable point
(0,1,1)	$R_2 - C_1$	$C_2 - C_3$	$C_4 - B_3 - S_2$	$C_1 > R_2$, $C_2 < C_3$, $C_4 < B_3 + S_2$
(1,1,1)	$C_1 - R_2$	$C_2 - C_3 - S_1$	$C_4 - B_3 - S_2 - T_4$	$C_1 < R_2$, $C_2 < C_3 + S_1$, $B_3 > C_4 - S_2 - T_4$

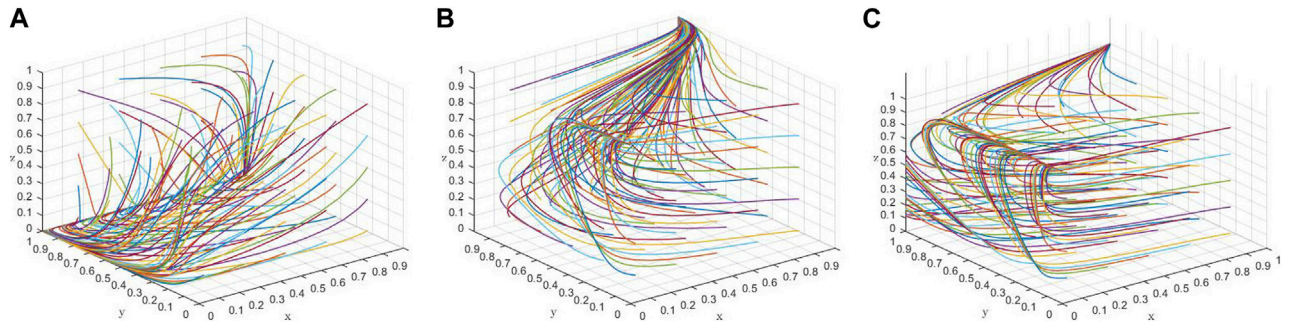

FIGURE 2
(A) System evolution path in the initial stage. **(B)** System evolution path during development stages. **(C)** System evolution path in the mature stage.

3.2 Strategy analysis

$$\begin{cases} F_x(x,y,z) = x(x-1)[C_1 + (R_1 - R_2 - S_2)y + (S_2 - R_1)yz] \\ F_y(x,y,z) = y(1-y)(-S_1z + S_1 - C_2 + C_3 + S_1xz) \\ F_z(x,y,z) = z(1-z)[(S_2 + T_4)xy - S_2x - T_4y + B_3 + S_2 - C_4 + T_4] \end{cases}$$

The Jacobian matrix of the system:

$$A = \begin{vmatrix} \frac{\partial F_x(x,y,z)}{\partial x} & \frac{\partial F_x(x,y,z)}{\partial y} & \frac{\partial F_x(x,y,z)}{\partial z} \\ \frac{\partial F_y(x,y,z)}{\partial x} & \frac{\partial F_y(x,y,z)}{\partial y} & \frac{\partial F_y(x,y,z)}{\partial z} \\ \frac{\partial F_z(x,y,z)}{\partial x} & \frac{\partial F_z(x,y,z)}{\partial y} & \frac{\partial F_z(x,y,z)}{\partial z} \end{vmatrix}$$

$$= \begin{vmatrix} x(C_1 + R_1y - R_2y - S_2y - R_1yz + S_2yz) \\ +(x-1)(C_1 + R_1y - R_2y - S_2y \\ -R_1yz + S_2yz) & x(1-x)(R_2 - R_1 + S_2 + R_1z - S_2z) & x(1-x)(R_1y - S_2y) \\ S_1yz(1-y) & -y(C_3 - C_2 + S_1 - S_1z + S_1xz) \\ & -(y-1)(C_3 - C_2 + S_1 - S_1z + S_1xz) & y(y-1)(S_1 - S_1x) \\ z(1-z)(S_2y - S_2 + T_4y) & z(1-z)(S_2x - T_4 + T_4x) & -z(B_3 - C_4 + S_2 + T_4 \\ & & -S_2x - T_4y + S_2xy + T_4xy) \\ & & -(z-1)(B_3 - C_4 + S_2 + T_4 \\ & & -S_2x - T_4y + S_2xy + T_4xy) \end{vmatrix}$$

In this study, a total of thirteen equilibrium points have been derived. The stability of eight of these points, which represent pure strategy equilibria within the evolutionary system, is extensively analyzed. The difference between benefits and costs determines the choice of three subjects. It is more important to maintain the relationship between government and business. According to the time sequence of the cordial and clean relationship between government and business, the evolution process is divided into three stages: the initial stage, the development stage and the mature stage which is shown in Table 2.

Initial stage (Figure 2A): The economic base determines the superstructure, and a good relationship between government and business plays an important role in promoting government, industry and enterprise [10]. In the early stage of the establishment of the cordial and clean relationship between government and business, most government departments lack the grasp of the policy and do not advocate the establishment of cordial and clean relationship between government and business; Industry associations do not have the case support to promote the success of government-entrepreneur cooperation, so they lack the consciousness to build a good relationship between government and business, and tend to choose the "weak regulation" strategy; Because enterprises fail to understand and grasp the essence of the new government-business relationship promptly and lack understanding of relevant policy publicity, they take negative actions. Therefore, this stage corresponds to the equilibrium point $A_1(0, 0, 0)$, We know from the table that it must be satisfied ① $C_2 < C_3 + S_1$: The cost of weak regulation is less than that of strong regulation; ② $B_3 < C_4 - S_2 - T_4$: The stable point is when the enterprise actively takes the condition that the profit is lower than the cost.

TABLE 3 The initial value of the parameter.

B_1	C_1	S_1	S_2	R_1	R_2	B_2	C_2	C_3	T_1	T_2	S_3	B_3	C_4	T_3	T_4
4	1.4	0.5	0.5	2	3	2	1.2	1.1	0.6	0.5	0.8	2	2.5	0.8	0.5

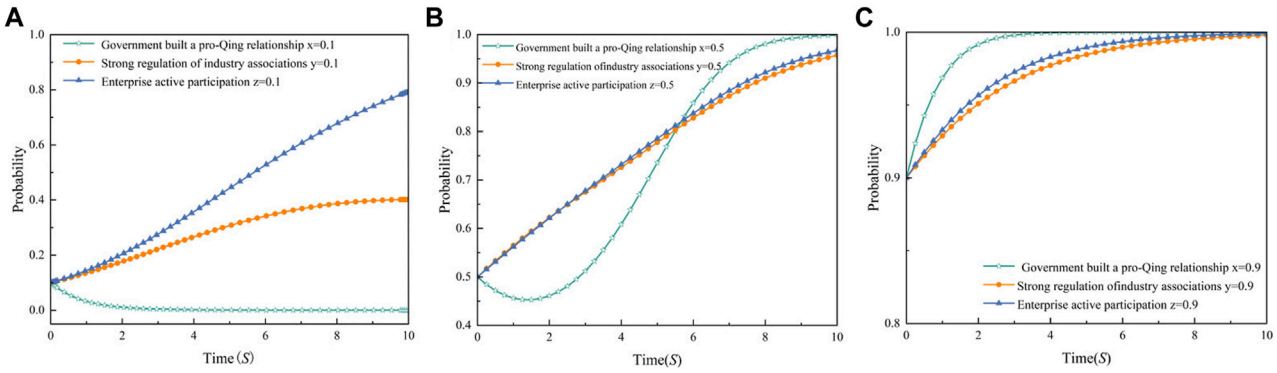

FIGURE 3
The impact of strategy proportion on system evolution results. **(A)** The initial choice probability of the three parties is 0.1 **(B)** The initial choice probability of the three parties is 0.5 **(C)** The initial choice probability of the three parties is 0.9.

Development stage (Figure 2B): The government is inclined to actively build a new type of government-business relationship of "affinity, Qing and unity" and allocate more resources to enterprises and associations [11]. Industry associations began to improve the sound regulatory channels, motivated by government subsidies, keen to promote the connection between the government and entrepreneurs, and inclined to a "strong regulation" strategy; Entrepreneurs are gradually affected by the government's propaganda role, irregularly participate in the discussion, but the effect is still lower than expected, so they take negative actions. Therefore, this stage corresponds to the equilibrium point $A_5(1, 1, 0)$, We know from the table that it must be satisfied ① $C_1 < R_2 - R_1 + S_2$: The cost of government's construction of cordial and clean relationship between government and business is lower than the benefit of government's strong supervision of industry associations; ② $C_2 < C_3 + S_1$: The cost of strong supervision is greater than that of weak supervision; ③ $C_4 < B_3 + S_2 + T_4$: The stable point is when the enterprise actively takes the condition that the profit is lower than the cost. Because the evolution of the relationship between government and business has a historical stage, the traditional relationship between government and business is restricted by the social system in the development stage, which easily leads to the absence of government and market failure. The implementation of the policy of cordial and clean relationship between government and business through deepening the transformation of government functions, rationalizing the market order, so that the decisive role of the "invisible hand" and the strategic role of the "visible hand" are coordinated, laying the foundation for the return of healthy development of government-business relations. The government is highly motivated to build good relations and is willing to invest more energy and resources to build relations.

Maturity stage (Figure 2C): To realize the stable development of society, the government vigorously promotes the establishment of "pro-clean" government-business relationship [12]; Influenced by government policy welfare and entrepreneur donation behavior, industry associations can improve their own supervision and management ability, and tend to "strong supervision" strategy; Entrepreneurs are governed by relevant policies and profit maximization goals, and are willing to take positive actions. Therefore, this stage corresponds to the equilibrium point $A_8(1, 1, 1)$, We know from the table that it must be satisfied ① $C_1 < R_2$: The cost of constructing a cordial and clean relationship between government and business is lower than the benefit of strong supervision; ② $C_2 < C_3 + S_1$: The cost of strong supervision is less than that of weak supervision; ③ $C_4 < B_3 + S_2 + T_4$: The stable point is when the enterprise actively takes the condition that the profit is higher than the cost. The government pays more attention to sticking to the original intention. Take the initiative to be close to entrepreneurs in thought and emotion, have better platforms and support from industry associations, and actively guide entrepreneurs to communicate and exchange, so that they can get more sense of gain from the benign interaction with the government. In the mature stage, the market environment for fair competition is more optimized. The system and mechanism to prevent conflicts of interest will be more complete, and the norms of behavior for government and business exchanges are more perfect, so that the government can spend less energy to gain more trust.

3.3 Initial strategy simulation analysis

The influence of the initial strategy ratio on system evolution outcomes, given the initial parameter values, is explored in this research, as depicted in Table 3; Figure 3. The initial strategy selection ratios of the government, industry associations, and enterprises significantly affect the system's convergence speed [13]. A proximity between the initial strategy selection ratio and

the equilibrium point accelerates system convergence, highlighting the criticality of the initial strategy ratio in enabling the tripartite stakeholders to align in the direction of construction, robust supervision, and positivity. This suggests that industry associations should stimulate both the government and enterprises to actively engage in establishing a favorable pro-clean relationship. Concurrently, they should enhance their supervisory role through cooperative alliances, thus fostering a virtuous cycle within the system.

4 Discussion

Upon solving the game's equilibrium solution, it becomes evident that the realization of a "cordial" and "clean" government-business relationship necessitates policy guidance and interest balance between the government, industry associations, and enterprises. The following points elucidate this conclusion: 1. The extent of enterprise proactivity is directly proportional to the financial subsidies provided by the government to incentivize industry associations' supervision [14]. However, the costs incurred by enterprises due to active action, equipment transformation, and technological innovation exceed the opportunity loss from inaction. 2. Industry associations need to provide robust support and subsidies to enterprises to counterbalance profit reduction and cost increase [15]. Yet, they should avoid excessive investment in local enterprises to maintain a balanced relationship. 3. Enterprises require strong governmental support in response to profit reduction [16]. The government must grant sufficient subsidies to industry associations to overcome resistance and encourage policy compliance. Consequently, the government's macro-decisions guide industry associations, affecting the implementation of policies and subsequent enterprise behavior [17]. 4. Government governance should promote a rule of law, service orientation, and efficiency, providing high-quality public services [18]. The government's positive role in market system construction can be realized through strict power supervision and innovative service methods [19]. 5. Trade associations, based on market and enterprise, play a crucial role in market mechanism operation and industry interest realization [20]. Legal norms are necessary to ensure their healthy development, clarifying their legal status, power, responsibility, governance structure, and operation mechanism. Efficient undertaking of government service projects reflects the rule of law, specialization, and socialization of industry association governance [21].

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

MW: Conceptualization, Methodology, Writing–original draft, Writing–review and editing. YZ: Conceptualization, Methodology, Writing–original draft, Writing–review and editing. TY: Formal analysis, Writing—review & editing. YX: Conceptualization, Methodology, Writing–original draft, Writing–review and editing.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. General project of National Social Science Foundation of China: "Research on the influence mechanism of Differentiated Leadership in Family Firms on the Deviant innovation Behavior of the New Generation of Employees and governance Countermeasures" (19BGL127). National Natural Science Foundation of China (NSFC): Research on Differential Leadership, Employee Competition Behavior and Organizational Innovation Performance of Family Firms from the Perspective of Organizational Embeddedness (72072076); National Natural Science Foundation of China: Research on De-Familial Governance, Innovation Resilience and Organizational Innovation Performance of Family Firms (72372106).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

1. Ferasso M, Beliaeva T, Kraus S, Clauss T, Ribeiro-Soriano D. Circular economy business models: the state of research and avenues ahead. *Business Strategy Environ* (2020) 29:3006–24. doi:10.1002/bse.2554

2. Maisigova LA, Niyazbekova SU, Isayeva BK, Dzholdosheva TY. Features of relations between government authorities, business, and civil society in the digital economy. In: *Socio-economic systems: paradigms for the future*. Berlin, Germany: Springer (2021). p. 1385–91.

3. Keynes JM. *The general theory of employment, interest and money*. United Kingdom: Palgrave Macmillan (1936).

4. Moringiello JM. Dispossessing resident voice: municipal receiverships and the public trust. *U Mich JL Reform* (2019) 53:733. doi:10.36646/mjlr.53.4.dispossessing.moringiello

5. Locke J. *Two treatises of government*. United Kingdom: Awnsham Churchill (1689).

6. Yuxi H, Ahmad A, Talib ZM. The relationship between urban community collaborative governance and building resilience cities in zhengzhou city, henan province, China. *Int J Prof Business Rev* (2023) 8:e03561. doi:10.26668/businessreview/2023.v8i9.3561

7. Buchanan JM. The pricing of highway services. *Natl Tax J* (1952) 5:97–106. doi:10.1086/ntj41789931

8. Chen L, Tian Z. Current situation and prospect of the research on the relationship between government and business in the context of China. *Soft Sci* (2022) 36:125–31. doi:10.13956/j.ss.1001-8409.2022.04.17

9. Marques JC, Eberlein B. Grounding transnational business governance: a political-strategic perspective on government responses in the global south. *Regul governance* (2021) 15:1209–29. doi:10.1111/rego.12356

10. Zhao X, Yi C. Can the intervention of state-owned assets restrain the real enterprises from real to virtual? – on the regulating effect of pro-qing government business relationship. *Econ Manag* (2021) 43:61–74. doi:10.19616/j.cnki.bmj.2021.07.004

11. Jiang C, Jiang C, Zhen D. Can new political-business ties break the political resource curse of corporate innovation? *Soft Sci* (2021) 35:52–7. doi:10.13956/j.ss.1001-8409.2021.06.08

12. Liu N. Century-old construction of the relationship between government and enterprise under the leadership of the communist party of China: thought, practice and experience. *Financial Res* (2021) 47:4–18. doi:10.16538/j.cnki.jfe.20211016.201

13. Wei J, Zhao Q, Liu Y. New government-business relationship and robustness of corporate performance: evidence from listed companies. *J Manag Eng* (2021) 35:1–13. doi:10.13587/j.cnki.jieem.2021.04.001

14. Chen Y, Peng Z, Peng C, Xu W. Impact of new government–business relations on urban digital economy: empirical evidence from China. *Finance Res Lett* (2023) 58:104325. doi:10.1016/j.frl.2023.104325

15. Nugent JB. A new institutional perspective on business associations: filling a gap between firms and states in the dynamic analysis of richard day. *J Econ Behav Organ* (2023) 211:49–59. doi:10.1016/j.jebo.2023.04.015

16. Zhou J, Wang M. The role of government-industry-academia partnership in business incubation: evidence from new r&d institutions in China. *Tech Soc* (2023) 72:102194. doi:10.1016/j.techsoc.2022.102194

17. Wenqi D, Khurshid A, Rauf A, Calin AC. Government subsidies' influence on corporate social responsibility of private firms in a competitive environment. *J Innovation Knowledge* (2022) 7:100189. doi:10.1016/j.jik.2022.100189

18. Yu Y, Yin S, Zhang A. Clean energy-based rural low carbon transformation considering the supply and demand of new energy under government participation: a three-participators game model. *Energ Rep* (2022) 8:12011–25. doi:10.1016/j.egyr.2022.09.037

19. Mas JM, Gómez A. Social partners in the digital ecosystem: will business organizations, trade unions and government organizations survive the digital revolution? *Technol Forecast Soc Change* (2021) 162:120349. doi:10.1016/j.techfore.2020.120349

20. Tian Y, Wang Y, Xie X, Jiao J, Jiao H. The impact of business-government relations on firms' innovation: evidence from Chinese manufacturing industry. *Technol Forecast Soc Change* (2019) 143:1–8. doi:10.1016/j.techfore.2019.02.007

21. An H, Chen Y, Luo D, Zhang T. Political uncertainty and corporate investment: evidence from China. *J Corporate Finance* (2016) 36:174–89. doi:10.1016/j.jcorpfin.2015.11.003