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AN ANALYSIS OF THE DECISION-MAKING BEHAVIOR OF THREE INTERESTED PARTIES IN THE PROCESS OF PRIVATE UNIVERSITY EDUCATION REFORM

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Abstract. *In response to the current situation in which an imbalance in educational redistribution has led to an inefficient and slow educational environment in the long-term, difficulty in satisfying the interests of subjects, and a lack of effective targeting of school policy measures, an SD evolutionary game model targeting educational reform, with schools, administrative institutions, and professors as the three parties, was established. Based on expected utility theory and Lyapunov's first law, a feedback regulation simulation study was conducted on subjects' decision-making behavior. The research results show that: the evolutionary trajectory of the subjects in the game is affected by the redistribution of education funding benefits, but the evolution of the final system is in a state of stable equilibrium (push, reform, reform); the decision-making behavior of the pushing party plays a decisive role in the stability of the system, and if the education subsidies of university professors and the income from the value of research results are greater than the education subsidies before the education reform, evolution over time is conducive to prompting the professor group to prefer the education reform strategy, while the effect of school push on the stability of the educational reform system is significant in schools with lower returns on the value of research funding.*

Keywords: *education reform; simulation study; decision-making behavior; reform strategy.*

Reikšminiai žodžiai: *švietimo reforma; simuliacinis tyrimas; elgesys priimant sprendimus; reformų strategija.*

Introduction

As the social environment and times change, the conceptual framework and connotations of education have undergone a process of constant evolution and change. The concept of innovation in education has risen to the national policy level (Law and Pan 2009). Deepening innovation in colleges and universities is an important initiative to advance the comprehensive reform of higher education and promote higher-quality entrepreneurship and employment for college graduates (Zhang and Yao 2020).

Deepening reform on innovation in education requires good institutional design as well as a complete policy system as a guarantee; otherwise, defects in the system and policies will become the main factors that restrict the subjects of reform and keep them trapped in their work (Azam et al. 2017). From the perspective of deepening education reform, although the corresponding policy system at the national level is complete and rich in content, concrete implementation in different colleges and universities – subject to the latter's regional differences in geographical location, resource endowment, economic foundation, cultural tradition, etc. – creates a differing sense of urgent regarding the policy barriers to be broken in supporting or promoting deepening education reform (Laengle et al. 2017). For example, from 2001 to 2016, Guangdong Province issued 24 policy documents related to innovation reform, involving various aspects such as entrepreneurship training, incubator construction, innovation talent introduction program, fund management, etc. In contrast, Yunnan Province issued only 11 related policies from 2008 to 2016. In terms of geographical factors, policy responses in developed provinces and poor regions are not timely. Some regions still have difficulties in implementing national policies despite their inclinations in the direction of education reform (Mantovi and Schianchi 2019).

This experiment mainly demonstrates the feasibility of education reform, using the tripartite game system theory (professor-administration-school) to discuss the internal factors related to education reform (Ormerod and Ulrich 2013). It also analyzes the demand for education reform, clarifies the responsibility list and task list of each relevant functional department and faculty, and builds a collaborative joint implementation mechanism and a mutually beneficial incentive mechanism for multiple subjects (Abdel-Moneim 2020).

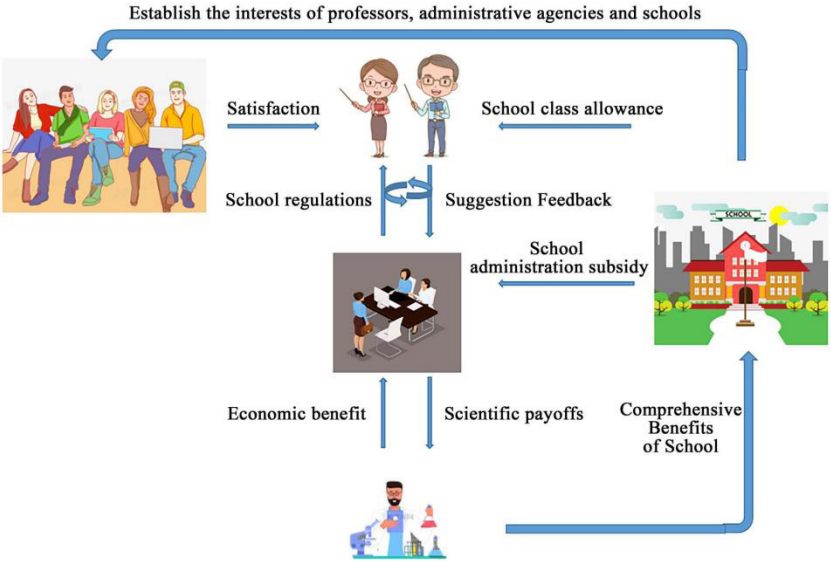

Figure 1. *The logical relationships within the game model between professors, administrative bodies and schools*

Game model assumptions

In the context of the General Office of the State Council of China issuing the Notice of Carrying Out National Education System Reform, it is clearly proposed to comprehensively improve the service capacity of education and provide strong support for building the talents needed for China's modernization (Bellani et al. 2022). Scientific and technological achievements are encouraged to create economic benefits for society. This study focuses on the logical strategy of the game among teachers, administrative agencies and schools adopted by local universities to participate in the education system reform, and makes the following assumptions with reference to a large amount of literature (Casini and Garulli 2022).

Hypothesis 1 (game subject assumption): In this paper, the school, the administration and the professor are the three game subjects, and it is assumed that all three parties are finite and rational. The administration and professors seek to maximize the benefits they receive, and the school seeks to maximize the comprehensive benefits of the school (Huang et al. 2022).

Hypothesis 2 (game strategy hypothesis): The state protects the right of university student groups to pursue quality education and promotes student groups in giving feedback on the improvement of professors' lectures while following the university's rules and regulations. At the same time, the university must also respect the professor's wishes

in the process of referring to the feedback from the university student body. Schools have two behavioral choices: to promote educational quality reform or not to promote teaching quality reform in order to improve the school's research, with a strategy set of {push, not push}. The administration has two decision-making behaviors in promoting educational quality reform based on the game conditions, in which the educational quality reform outcomes are related to the school's administrative subsidies: to promote education quality reform or not to promote teaching quality reform, where the set of strategies is {push, not push}. Similarly, professors can choose to promote education quality reform or not to promote teaching quality reform in the game process, where the set of strategies is {push, not push}.

Hypothesis 3 (strategic probability assumption): Supposing that the probability of the university promoting teaching quality reform is g, then the probability of not promoting is 1–g. If the probability of the university administration choosing to promote teaching reform is m, then the probability of not promoting teaching reform is 1–m. Finally, if the probability of the professor choosing to promote teaching quality reform is f, then the probability of not promoting teaching quality for reform is 1–f.

Hypothesis 4 (assumptions on the parameters of the university-related game): The subsidy given to professors' hours according to the university policy is θ, and the subsidy given to the education administration is $\boldsymbol{\mu}_{\mathbf{m}}$. The cost invested by the university to promote the reform of teaching quality in order to encourage professors and the administration to accept the educational reform is C_g^s, including: the cost of the negotiation process of the leadership organization, C_g^{s1}; the subsidy required by the administration to develop improved regulations, C_g^{s2}; and the additional subsidy received by the university professors for accepting the improved regulations, μ_f. The comprehensive benefits of the university generated by the university to promote the educational reform are represented as P_g^s (economic benefits generated by the university's research results and the university's reputation, and the security for student recruitment and employment provided by the improvement of the ranking)

Hypothesis 5 (assumptions about the parameters of the game related to the administration): The cost of the negotiation process between the administration and the university professors themselves is represented as C_m. The period of the educational reform process is n years, and the range of disciplines involved in the educational reform is Q. The cost of educating university students is P_l. The number of research results per year is Y_m, the cost of the required labware materials is C^i, the value of the research results is α_i, and the discount on the consumable labware purchased in bulk is η. The university's professors and administration are engaged in spontaneous negotiation and educational quality improvement, and the overall benefits of the university through improved research and higher student employment rates are P_m^s.

Hypothesis 6 (assumptions about the parameters of the game related to professors): The cost of spontaneous negotiations between professors and the administration for the improvement of school regulations (educational reform) is C_f, the annual income of professors after the educational reform is P_f^i, the cost of readjusting professors to the new regulations after the completion of the educational reform is λ. If no educational reform

is carried out, the number of research results per year is 1 and the overall benefit to the school is generated as P_g^f.

Table 1. *The two-sided game payment matrix for universities to promote education reform*

		Pro $\sum_{i=1}^{n} P_g^s - C_g^s$ form (f)	No reform $\sum_{i=1}^{n} P_f^s - C_g^{s1} - \sum_{i=1}^{n} Q\theta$
Administrative department	Reform (m)	$\sum_{i=1}^{n} Q\left[\mu_m + C_g^{s2} + \alpha_i Y_m - P_i - C^i + \eta\right]$	
			$\sum_{i=1}^{n} \hat{Q}\left(\alpha_i Y_f - C^i + \theta\right)$
		$\sum_{i=1}^{n} P_f^s - C_g^{s1} - \sum_{i=1}^{n} Q\theta$	$\sum_{i=1}^{n} P_f^s - C_g^{s1} - \sum_{i=1}^{n} Q\theta$
	No reform (1-m)		
		0	$\sum_{i=1}^{n} Q\left(\alpha_i Y_f - C^i + \theta\right)$
		$\sum_{i=1}^{n} Q\left(\alpha_i Y_f - C^i + \theta\right)$	

		Professor Reform (f)	No reform (1-f)
Administrative department	Reform (m)	$\sum_{i=1}^{n} P_m^s - Q\mu_m$	$\sum_{i=1}^{n} P_f^s - \sum_{i=1}^{n} Q\theta$
		$\sum_{i=1}^{n} Q\left[\mu_m + \alpha_i Y_m - C^i - P_i + \eta\right] - C_m$	$-C_m$
		$\sum_{i=1}^{n} \left[Q\left(P_i - \alpha_i Y_f + C^i - \theta\right) + P_f^i\right] - \lambda Q - C_f$	$\sum_{i=1}^{n} Q\left(\alpha_i Y_f - C^i + \theta\right)$
	No reform (1-m)	$\sum_{i=1}^{n} P_f^s - \sum_{i=1}^{n} Q\theta$	$\sum_{i=1}^{n} P_f^s - \sum_{i=1}^{n} Q\theta$
		0	0
		$\sum_{i=1}^{n} Q\left(\alpha_i Y_f - C^i + \theta\right) - C_f$	$\sum_{i=1}^{n} Q\left(\alpha_i Y_f - C^i + \theta\right)$

Constructing the payoff expectation function

As shown in Table 1, the two-sided game payment matrix for universities to promote education reform is $P_f^p = \sum_{i=1}^{n} Q\left(\alpha_i Y_f - C^i + \theta\right)$, $p_m^p = \sum_{i=1}^{n} Q\left(\alpha_i Y_m - C^i + \eta - p_l + \mu_m\right)$. As shown in Table 1, the benefits of education reform are shown for each side in n years. The expected benefits for schools choosing the "push" and "no push" education reform strategies are E_g^1 and E_g^2, respectively, and the average expected benefits are $\bar{E}_g$ $E_g^1 = n\left[\left(1-fm\right)\left(P_f^s - \theta Q\right) + fmn\left[P_g^s - Q\left(C_g^s + \mu_f\right)\right]\right] - C_g^{s1}$ (1), $E_g^2 = n\left[\left(1-fm\right)P_f^s + fmP_m^s - Q\left(\theta - fm\theta + fm\mu_m\right)\right]$ (2), and $\bar{E}_g = g\,E_g^1 + \left(1-g\right)E_g^2$ (3).

The expected benefits of the administration's "reform" and "no reform" education reform strategies are E_m^1 and E_g^2, respectively, and the average expected benefit is E_g.

$E_m^1 = gfn C_g^{S2} + \left(g-1\right)C_m + fP_m^p$ (4), $E_m^2 = 0$ (5), $\bar{E}_m = m\,E_m^1 + \left(1-m\right)E_m^2$ (6).

The expected benefits of the "reform" and "no reform" education strategies are E_f^1 and E_f^2, and the average expected benefit is $\bar{E}_f$, respectively.

$E_f^1 = \left(g-1\right)C_f + \left(1-2m\right)P_f^p + m\left[\sum_{i=1}^{n} P_f^i + Q\left(nP_l - \lambda + g\eta\mu_f\right)\right]$ (7), $E_f^2 = P_f^p$ (8), $\bar{E}_f = f\,E_f^1 + \left(1-f\right)E_f^2$ (9).

Stability analysis of the strategy of the three game subjects, stability analysis of school gaming strategies, and dynamic equation analysis based on school stability

$F\left(g\right) = dg/dt = g\left(1-g\right)\left\{fmn\left[P_g^s - P_m^s + Q\left(\mu_m - C_g^{s2} - \mu_f\right)\right] - C_g^{s1}\right\}$ (10),

$F'\left(g\right) = dF\left(g\right)/dg = \left(1-2g\right)\left\{fmn\left[P_g^s - P_m^s + Q\left(\mu_m - C_g^{s2} - \mu_f\right)\right] - C_g^{s1}\right\}$ (11).

The following equation enables the analysis of the evolutionary stability of school game decision behavior, where F(g)=0:

$fmn\left[P_g^s - P_m^s + Q\left(\mu_m - C_g^{s2} - \mu_f\right)\right] - C_g^{s1} = 0$, $f_0 = C_g^{s1} \Big/ \left\{mn\left[P_g^s - P_m^s + Q\left(\mu_m - C_g^{s2} - \mu_f\right)\right]\right\}$

That is, at that time $f = f_0$, $F(g) = 0$, when the school game strategy is stable in the system regardless of the value of g.

(a) $f > f_0$, $H\left(f\right) > 0$, $F'\left(g\right)_{g=1} < 0$, $F'\left(g\right)_{g=0} > 0$ At this point, $g = 1$ represents a steady state of the school's game evolution, and therefore the school's game strategy tends to choose to promote educational reform.

(b) $f<f_0$, $H(f)<0$, $F'(g)_{g=1}>0$, $F'(g)_{g=0}<0$ At this point, $g = 0$ represents a stable state of the school's game evolution, so the school's game strategy tends to choose not to push for educational reform.

(c) $f>f_0$, $H(f)<0$, $F'(g)_{g=1}>0$, $F'(g)_{g=0}<0$ At this point, $g = 0$ represents a steady state of the school's game evolution, so the school's game strategy tends to choose not to push for educational reform.

(d) $f<f_0$, $H(f)>0$, $F'(g)_{g=1}<0$, $F'(g)_{g=0}>0$ At this point, $g = 1$ represents a stable state of the school's game evolution, so the school's game strategy tends to choose to push for educational reform.

Stability analysis of administrative agencies' gaming strategies and game replication dynamic equation analysis based on administrative agencies

According to equations (4) to (6), the replication dynamic equation of the administration in the educational reform game system is obtained as:

$$F(m)=dm/dt=m(1-m)\left[fgnC_g^{s2}+(g-1)C_m+fP_m^p\right] \quad (12),$$

$$F(m)=dF(m)/dm=(1-2m)\left[fgnC_g^{s2}+(g-1)C_m+fP_m^p\right] \quad (13),$$

$$fgnC_g^{s2}+(g-1)C_m+fP_m^p,\ \partial K(f)/\partial f=gnC_g^{s2}+P_m^p$$

Therefore, $K(f)$ is an increasing function with respect to f.

(a) When $f>f_1$, $K(f)>0$, then $F'(m)_{m=1}<0$, and $F'(m)_{m=0}>0$, so $m=1$ is the stable state point of the game for the administration, and the administration's game strategy prefers to "push" the education reform

(b) When $f<f_1$, $K(f)<0$, $F'(m)_{m=1}>0$, and $F'(m)_{m=0}<0$, then $m=0$ is the stable state point of the game for the administration; therefore, the administration's game strategy tends to "not push" the education reform (Han and Fu 2022).

Stability analysis of professor selection strategy and analysis based on the replication dynamic equations of professors

According to equations (7) to (9), the replication dynamic equation of professors in the educational reform game system is obtained as:

$$F(f)=df/dt=f(1-f)\left[(g-1)C_f+2mP_f^p+mQ\left(\sum_{i=1}^{n}P_f^i-\lambda+nP_l+gn\mu_f\right)\right]$$

$$F'(f)=dF(f)/dt=(1-2f)\left[(g-1)C_f-2mP_f^p+mQ\left(\sum_{i=1}^{n}P_f^i-\lambda+nP_l+gn\mu_f\right)\right]$$

If the evolutionary stability of the professor's decision-making behavior in the game of educational reform is analyzed such that $F(f) = 0$, then:

$$mQ\left(\sum_{i=1}^{n} P_f^i - \lambda + nP_l + gn\mu_f\right) + (g-1)C_f - 2mP_f^p = 0$$

(a) When $g > g_0$, then $L(g) > 0$, $F'(f)_{f=1} < 0$, $F'(f)_{f=0} > 0$. At this time, the professor in the game of educational reform tends to choose "reform."

(b) When $g < g_0$, $L(g) < 0$, $F'(f)_{f=1} > 0$, and $F'(f)_{f=0} < 0$. At this time $f = 0$, hence the professor in the game of the evolution of the state educational reform tends to choose "do not promote educational reform".

Stability analysis of the combined strategy of the gaming system

By associating equations (10), (12) and (14), a replicated dynamic system of equations for the game of the three subjects in educational reform is obtained, as shown in equation (16):

$$\begin{aligned}
F(g) &= g(1-g)\left\{fmn\left[P_g^s - P_m^s + Q\left(\mu_m - C_g^{s2} - \mu_f\right)\right] - C_g^{s1}\right\} \\
F(m) &= m(1-m)\left[fgnC_g^{s2} + (g-1)C_m + fP_m^p\right] \\
F(f) &= f(1-f)\left[\left[(g-1)C_f - 2mP_f^p + mQ\left(nP_l + gn\mu_f - \lambda\right) + m\sum_{i=1}^{n} P_f^i\right]\right]
\end{aligned}$$

According to equation (16), the Jacobian matrix of the decision-making behavior system of the three stakeholders in the process of education reform in private colleges and universities is obtained:

$$J = \begin{bmatrix} \frac{\partial F(g)}{\partial g} & \frac{\partial F(g)}{\partial m} & \frac{\partial F(g)}{\partial f} \\ \frac{\partial F(m)}{\partial g} & \frac{\partial F(m)}{\partial m} & \frac{\partial F(m)}{\partial f} \\ \frac{\partial F(f)}{\partial g} & \frac{\partial F(f)}{\partial m} & \frac{\partial F(f)}{\partial f} \end{bmatrix} = \left\{ \begin{array}{l} \frac{\partial F(g)}{\partial g} = (1-2g)\left\{fmn\left[P_g^s - P_m^s + Q(\mu_m - C_g^{s2} - \mu_f)\right] - C_g^{s1}\right\}, \frac{\partial F(g)}{\partial m} = fgn(1-g)\left[P_g^s - P_m^s + Q(\mu_m - C_g^{s2} - \mu f)\right], \frac{\partial F(g)}{\partial f} = 0, \\ \frac{\partial F(m)}{\partial g} = m(1-m)fnC_g^{s2} + m(1-m)C_m, \frac{\partial F(m)}{\partial m} = (1-2m)\left[fgnC_g^{s2} + (g-1)C_m + fP_m^p\right], \frac{\partial F(m)}{\partial f} = m(1-m)gnC_g^{s2} + m(1-m)P_m^p, \\ \frac{\partial F(f)}{\partial g} = f(1-f)C_f + f(1-f)mn\mu_f Q, \frac{\partial F(f)}{\partial m} = f(1-f)(nP_l + gn\mu_f - \lambda)Q - 2P_f^p f(1-f) + f(1-f)\sum_{i=1}^{n} P_f^i \\ \frac{\partial F(f)}{\partial f} = (1-2f)\left[(g-1)C_f + mQ(nP_l + gn\mu_f - \lambda) + m\left(\sum_{i=1}^{n} P_f^i - 2P_f^p\right)\right]. \end{array} \right\}$$

Reinhard pointed out that the stable solution in a multi-group evolutionary game is a strict Nash equilibrium, which must be a pure strategy. Therefore, there are eight combinations of pure strategies in the three-subject evolutionary game system. The stability of the strategy combinations of the game system can be judged according to Lyapuno's first law, which stipulates that: if the Jacobian matrix eigenvalues are all negative real parts,

then the equilibrium point is asymptotically stable; if the Jacobian matrix eigenvalues have at least one positive real part, then the equilibrium point is unstable; and if the Jacobian matrix eigenvalues have eigenvalues with real parts of 0 except for the remainder of the eigenvalues, then the equilibrium point is in a critical state where the Jacobian matrix eigenvalues have at least one positive real part. In the replicated dynamic system (16), let F(g)= F(m)= F(f)=0. The 8 combinations of pure strategy equilibrium points are found to be $E_1(0,0,0)$, $E_2(1,0,0)$, $E_3(0,1,0)$, $E_4(0,0,1)$, $E_5(1,1,0)$, $E_6(1,0,1)$, $E_7(0,1,1)$, $E_8(1,1,1)$. Jacobian matrix (see Appendix A1) eigenvalues of the replicated dynamic equations are further obtained, and the stability of the equilibrium point of the gaming system is analyzed by the Jacobian matrix eigenvalues, as shown in Table 2, which shows that there are three possible stable equilibrium points of the system: (0,0,0), (0,1,1) and (1,1,1).

Table 2. *System equilibrium points, corresponding Jacobian matrix eigenvalues and asymptotic stability analysis*

Equantequation	Eigenvalue			Sign symbol	Meet the conditions	Stability
	λ_1	λ_2	λ_3			
$E_1(0,0,0)$	$-C_g^{s1}$	$-C_m$	$-C_f$	$(-,-,-)$	\	ESS
$E_2(1,0,0)$	C_g^{s1}	0	0	$(+,0,0)$	\	Point of instability
$E_3(0,1,0)$	$-C_g^{s1}$	C_m	$-C_f-2P_f^p+Q(nP_l-\lambda)+\sum_{i=1}^{n}P_f^i$	$(-,+,N)$	\	Point of instability
$E_4(0,0,1)$	$-C_g^{s1}$	$P_m^p-C_m$	C_f	$(-,+,+)$	\	Point of instability
$E_5(1,1,0)$	C_g^{s1}	0	$-2P_f^p+Q(nP_l+n\mu_f-\lambda)+\sum_{i=1}^{n}P_f^i$	$(+,0,N)$	\	Point of instability
$E_6(1,0,1)$	C_g^{s1}	$nC_g^{s2}+P_m^p$	0	$(+,+,0)$	\	Point of instability
$E_7(0,1,1)$	$n\left[P_g^s-P_m^s+Q(\mu_m-C_g^{s2}-\mu_f)\right]-C_g^{s1}$	$C_m-P_m^p$	$C_f+2P_f^p-Q(nP_l-\lambda)-\sum_{i=1}^{n}P_f^i$	$(-,-,-)$	①	ESS
$E_8(1,1,1)$	$C_g^{s1}-n\left[P_g^s-P_m^s+Q(\mu_m-C_g^{s2}-\mu_f)\right]$	$-nC_g^{s2}-P_m^p$	$2P_f^p-Q(nP_l+n\mu_f-\lambda)-\sum_{i=1}^{n}P_f^i$	$(-,-,-)$	②	ESS

Simulation

In the game stability analyses concerning Heilongjiang Province, Jiangxi Province and Henan Province colleges and universities as the objects of study, cases were mainly selected from Qiqihar Engineering College, Henan Engineering College and Jiangxi Vocational College. The data were mainly obtained from online consultation, the Ministry of Education information network and academic literature. In addition, it was assumed that: all three schools had five identical majors and 50 professors adapted to the education reform; the cycle of education reform was 3 years; the growth rate of scientific research achievements was 3%; and the initial value of the willingness of professors and administration to push forward the education reform was 0.5, i.e., $g = m = f = 0.5$. The initial values of the simulation parameters are shown in Table 3.

Table 3. *Initial values of case simulation parameters*

parameter	i	Q	α_1	C_w^1	C_r^1	θ	μ_m	C_g^{s1}	C_g^{s2}	μ_f	P_g^s	P_m^s	C_m	P_l	η	Y_m	C_f	P_f^s	Y_f	λ	a
value	Qiqihar College of Engineering	3	500	1.25	570	800	210	100	5000	0	100	150000	150000	4000	500	225	1950	2000	2000000	1700	50	50
	Henan College of Engineering	3	500	1.25	570	710	215	100	1200	200	0	150000	150000	1000	700	225	2100	500	3810000	1800	50	50
	Jiangxi Vocational College	3	500	1.25	570	710	215	100	5000	0	160	150000	150000	4000	900	225	2400	2000	3740000	2100	50	50

Simulation analysis of three private university initialization programs

The three-party evolutionary game simulation model is established through Vensim software, and the data in Table 3 are input into the simulation model to produce the initial results of the simulation of colleges and universities. This paper uses Matlab software to carry out the simulation, and the simulation results of the initialization scenario of the three schools are shown in Figure 2. From the overall view of Figure 2, different regions have different schooling systems, infrastructures, and policy environments, which affect the evolution path of the game between the three stakeholders, but the evolution of the system is finally stabilized at the equilibrium point (1,1,1).

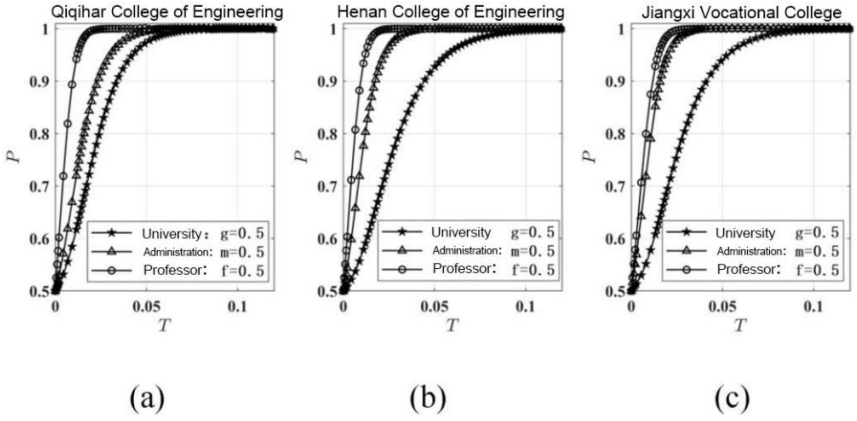

Figure 2. *Evolutionary path results for different case scenarios*

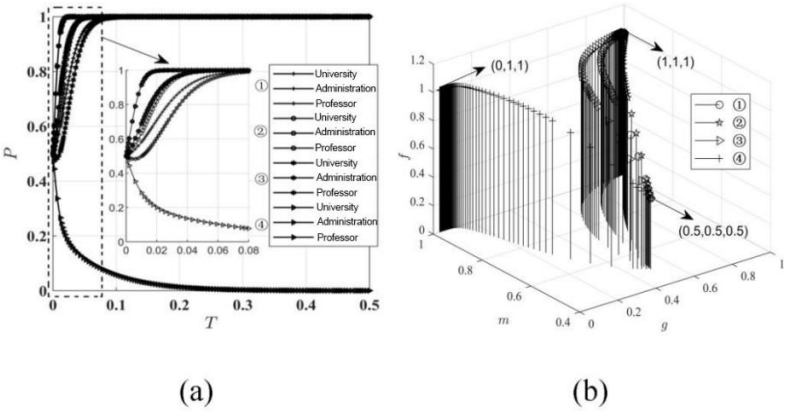

Figure 3. *Results of the impact of changes in* C_g^{s1} *and* P_g^s *on school decision-making behavior and the game system*

However, as can be seen from Figure 2(a), schools and administrations reach the steady evolutionary state the fastest in the gaming system compared to the other two schools with poorer experimental facilities and regulations. For schools, vocational education for university students is beneficial to local employment, professionalism, and the building of a modernized country, thus generating higher overall school benefits. Therefore, schools are more willing to push forward with pedagogical reforms (Doumpos et al. 2023).

Analysis of the influence of key exogenous variables on the evolutionary process and the outcome of the subject's game decisions

Taking Qiqihar Engineering School as the background, $\{C_g^{s1}, P_g^s\}$ = ①{5000 ,400000}, ②{50000 600000}, ③{600000 600000}, ④{1500000 600000}, the simulation results are shown in Figure 3. The higher the cost of promoting education reform in schools, the lower the willingness of schools to promote. When the cost of promoting education is much greater than the comprehensive benefits of education, schools are not willing to invest in promoting education reform, and their strategy converges towards "no-push." The more that the P_g^s cost is greater than the C_g^{s1} cost, the faster the evolution of the educational game converges towards the "no-push" strategy (Elango and Talluri 2023).

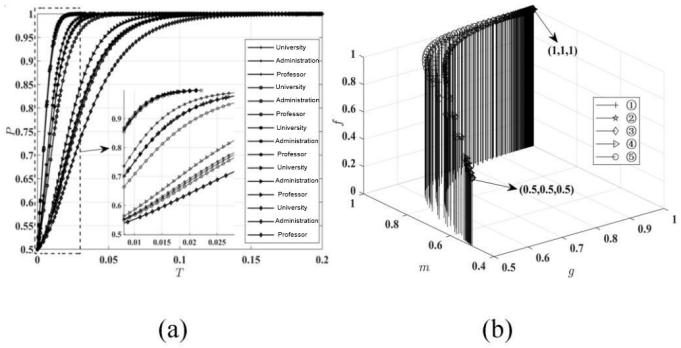

Figure 4. *The results of the impact of changes in* P_m^p *and* C_g^{s2} *on the decision-making behavior of administration X and the game system*

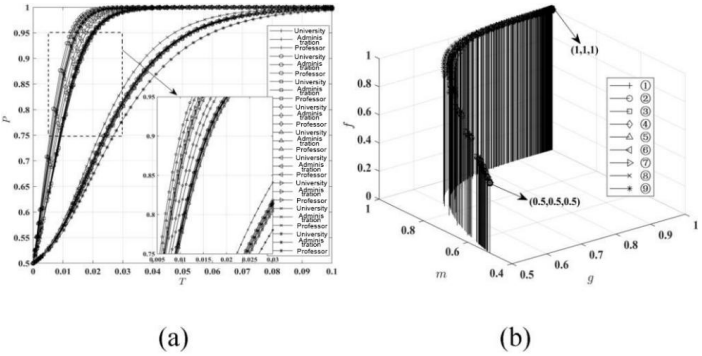

Figure 5. p_f^p p_f^i p_l *and* μ_f *changes in the professor's decision-making behavior and the outcome of the game system*

Taking Jiangxi Vocational College, it is assumed that ① {1513500 200} ② {1200000 200} ③ {1800000 300} ④ {1513500 100}, ⑤ {1513500 300}, and the simulation results are shown in Figure 4. The game evolution trajectory of the administrative agency in the education reform process is less influenced by the administrative agency subsidy C_g^{s2} and more significantly influenced by the combined research and school revenue P_m^p. In contrast, after the reform of eastern teachers' education, the comprehensive school revenue is high, and the administrative agency C_g^{s2} revenue

is higher compared to the meager school subsidy, so the school administrative agency subsidy has less influence on the administrative agency's game decision (Schuelka 2023).

The educational infrastructure of Jiangxi Vocational College is closer to perfect, so the educational reform recommendation is faster and the comprehensive output gain of the school is higher. While the cost of student education is also relatively high, administrative agencies are not highly motivated to promote educational reform. Taking Jiangxi Vocational College as the background, assuming that $\{p_f^p, p_f^i, p_l, \mu_f\}$ = ① {2550000 6425000 900 160} ② {2200000 6425000 900 160} ③ {2800000 6425000 900 160} ④ {2550000 6025000 900 160} ⑤ {2550000 6825000 900 160} ⑥ {2550000 6425000 800 160} ⑦ {2550000 6425000 1000 160} ⑧ {2550000 6425000 900 100} ⑨ {2550000 6425000 900 220}, the simulation results are shown in Figure 5. The motivation for educational reform increases when university professors receive an increased additional subsidy μ_f from improved regulations.

Conclusion

This paper takes the premise of the finite rationality of game parties, combines game theory and system dynamics methods, and applies them to the study of the decision-making behavior of multiple stakeholders in education reform. It also establishes an SD evolution game model of education reform with professors, administrative agencies and schools as the three game subjects. Then, through the stability analysis of game strategies and feedback regulation simulation, it draws the following main conclusions.

From the overall results of the feedback regulation simulation, the heterogeneity of educational infrastructure conditions and educational implementation measures affects the game evolution trajectories of professors, administrative agencies and schools, and the state of educational infrastructure and educational reform policies are the root causes that influence professors' and administrative agencies' willingness, and thus lead to different educational reform processes. The redistribution of the benefits of reform among three schools in three different geographical scenarios has an impact on the evolutionary trajectory of the subject's game, but ultimately the system evolves in an ideal equilibrium (push, push, reform), i.e., schools choose to reform and administrative agencies and professors choose to reform, realizing a win-win situation and highlighting the trend of educational reform.

Changes in the willingness of professors or administrative agencies to reform education have an impact on the other players. The evolutionary trajectory of the decision-making behavior of the other two parties also has a significant impact. Since the satisfaction of the interests of the three game subjects depends on the value of the research results, professors and research institutions are the direct educational reform decision makers; therefore, the reform willingness of both of them significantly affects the evolutionary trajectory of the decision-making behaviors of the other two parties.

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TRIJŲ SUINTERESUOTŲJŲ ŠALIŲ SPRENDIMŲ PRIĖMIMO ELGESIO ANALIZĖ PRIVATAUS UNIVERSITETO UGDYMO REFORMOS PROCESE

Anotacija. *Šis tyrimas buvo atliktas reaguojant į susiklosčiusią situaciją, kai švietimo perskirstymo neatitiktis lemia ilgalaikę neveiksmingą ir lėtą ugdymo aplinką, mokomųjų dalykų lūkesčių tenkinimo sunkumus, veiksmingo švietimo politikos priemonių tikslinimo trūkumą. Remiantis numatoma naudingumo teorija ir pirmuoju Lyapunovo dėsniu, buvo atlikta tiriamųjų elgsenos priimant sprendimus grįžtamojo ryšio reguliavimo modeliavimo analizė. Tyrimo rezultatai atskleidė, kad mokomojo dalyko raidą veikia švietimo finansavimo išmokų perskirstymas, tačiau galutinė sistemos raida yra stabili. Tačiau trijų sprendimų įgyvendintojų, kurie visokeriopai siekia realizuoti reformą, elgesys yra lemiamas norint užtikrinti sistemos stabilumą. Todėl didesnės subsidijos švietimui, nei buvusios iki reformos, ilgainiui sudaro palankias sąlygas paskatinti ypač mokslininkų grupes pirmenybę teikti švietimo reformos strategijai, taip pat leidžia kontroliuoti reformos finansavimo garantijas.*

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