Proceedings of the 2nd International Conference on Management Research and Economic Development
DOI: 10.54254/2754-1169/91/20240978

Analysis of Labor Relations in Private Enterprises

-- A Three-party Game Based on Overtime Work

Ruiyang Chen[1], Ruiqi Liu[2,a,*]

[1]*School of Applied Mathematics, Nanjing University Of Finance and Economics, Nanjing, China*
[2]*School of Mathematics, South China Normal University, Guangzhou, China*
a. 20212221150@m.scnu.edu.cn
**corresponding author*

Abstract: At present, China has successively introduced multiple laws and regulations to prevent employees from being forced to work overtime. However, this situation is still serious in private enterprises, which has led to gradually tense labor relations. Starting from the issue of overtime, this article constructs a game model between government regulatory departments, enterprises, and employees, explores the impact of government regulation on the labor management relationship of private enterprises, and uses evolutionary games to analyze the stability of the strategies of the three parties. The result shows that there is a stable equilibrium solution in the tripartite game: private enterprises arrange employees to work overtime normally, employees take the initiative to work overtime, and the government's project management department strictly supervises them. Among them, strict supervision by labor supervision agencies plays an important role in balancing labor management relations, therefore, certain incentive measures should be given to labor supervision agencies to ensure their strict supervision; Private enterprises should strictly abide by market order, proactively reduce the burden on employees, and avoid forcing employees to work overtime excessively; Employees should maintain a good work attitude and promote the development of common interests with private enterprises.

Keywords: Private enterprise, industrial relations, tripartite evolutionary game, simulation

1. Introduction

Based on the sound and perfect socialist market economy system in China, the vitality provided by different entities in the market also stimulates the development of the national economy to varying degrees. Among them, the non-public economy represented by private enterprises plays an important role in China's economy. Private enterprises have refined social division of labor, enriched social resources, and provided a large number of positions to alleviate social employment pressure. However, the lack of market control and the fiercely competitive demand for industrial productivity have further amplified the inherent contradictions in labor capital relations in private enterprises. Some enterprises excessively exploit the surplus value of workers in pursuit of high production efficiency, and workers often swallow their pride due to a lack of legal awareness and channel choices. This ultimately leads to more acute labor capital conflicts, which will have an undeniable negative impact on market order and social harmony. As an important part of the market, the issue of labor capital contradiction in

DOI: 10.54254/2754-1169/91/20240978

private enterprises is related to the healthy operation of the socialist market economy and the harmonious development of socialism. It is urgent to analyze the causes of labor capital relations, identify the location of labor capital contradictions, and seek ways to resolve conflicts.There are some precedents for studying labor capital relations through game theory.

Tan Kun considered the possibility of repeated games in his study of the impact of worker communication on labor capital relations [1]. Ning Fangkai constructed a second-order game matrix and used the "prisoner's dilemma" game to analyze the strategy combination between labor and capital in different specific scenarios [2]. On the basis of the previous research, Zhang Bian and Xu Qingqing pointed out that studying labor capital relations through the "prisoner's dilemma" and repeated game theory has certain limitations, revealing the current situation of unequal labor capital relations in China [3]. A more comprehensive game model has been derived from this. Chen Hua characterized the function of harmonious labor capital relations (whether labor capital relations are harmonious or not), pointed out the problems behind the disharmony of labor capital relations, such as supply and demand imbalance, low awareness of labor rights protection, inadequate government supervision and trade union constraints, and constructed second-order game matrices for enterprises and workers, as well as enterprises and governments, introducing the costs and benefits of labor rights protection, the benefits obtained by enterprises infringing on workers, and the losses incurred by enterprises in the face of rights protection, and the government's impact on enterprises. The profit and loss of whether a company complies with regulations and takes active intervention or not ultimately determine the degree of compliance of private enterprises with discipline, largely determined by the government's attitude towards control under the premise of "strong capital and weak labor" [4].There are also relevant studies in China that attempt to apply the method of evolutionary game to the tripartite game. Cao Ming, Zhang Chengke, and Zhu Huainian combined the idea of evolutionary game to study the coordination mechanism of labor and capital interests, constructed a matrix of the tripartite game between workers, enterprises, and government, set profit cost sharing coefficients, government control costs, and benefits, and endowed labor capital relationship game research with more realistic rationality, ensuring that the results of evolutionary game analysis are in line with reality [5]. In terms of the influencing factors and means of tripartite decision-making, existing research has also explored the optimization of game solutions from different perspectives: Shang Ke and Xing Ni analyzed the mechanism of excessive labor formation, differentiated mandatory and induced overwork, and added two strategies for enterprises to increase employment and incentive measures in labor issues from the perspectives of government enterprise game and labor capital game. A mixed strategy was used to find an equilibrium solution, and it was concluded that the government should impose stricter punishment and establish a more reasonable wage protection mechanism to balance the inequality between labor and capital relations [6]. Cheng Xiangbin et al. combined hedonic wage theory to differentiate different types of workers with different risk preferences, and used labor supply and demand utility curves to differentiate the types of workers with different risk preferences. Depicting the equilibrium process and explaining the rationality of individual choices by workers regarding overtime issues [7]. Li Qingqing and Zhang Xingming explore the consistent and conflicting interests between enterprises and workers, citing Carroll's idea that enterprises have social responsibility towards employees, pointing out the consistency of employee interests in enterprises, and dialectically analyzing that private enterprises have to sacrifice humanized management to maintain market competitiveness, Sorting out the choices between short-term and long-term benefits, realizing benefits and preventing risks, and taking a developmental perspective on the long-term benefits that enterprises actively take responsibility for their employees and enterprises [8]. The above research focuses on different aspects, combining with the current development of the socialist market economy, constructing a game model between the government, enterprises, and employees, continuously differentiating the types of research objects, refining the influencing factors on the

DOI: 10.54254/2754-1169/91/20240978

research objects, and deepening the thinking and decision-making on the social status quo behind the relationship between the research objects.

This article aims to focus on the phenomenon of "overtime" based on existing models and research methods, further concretize the game between the government, private enterprises, and employees, refine the influencing factors in the decision-making process of each game subject, combine evolutionary game theory to construct a model of mutual checks and balances among the three, find equilibrium, and find a better solution to the problem of "overtime" in the game process, thereby analyzing the handling of labor management relations. Based on the theoretical foundation of game theory, this article provides a new analytical approach for studying the labor management relationship in private enterprises: by introducing the government, enterprises, and employees, focusing on overtime issues, and considering the labor management relationship game among them. By analyzing the game matrix, the influencing and restraining factors of the tripartite game can be specifically revealed; Join the evolutionary game and further analyze and optimize the government's control measures.

2. Model Assumptions and Establishment

2.1. Model Assumptions

For the game between private enterprises (P), employees (S), and labor supervision agencies (G), private enterprise strategy S1={excessive overtime, normal overtime}, employee strategy S2={proactive overtime, forced overtime}, and labor supervision agency strategy S3={strict supervision, loose supervision}. The three constitute a strategic combination of 2×2×2. Among them, for private enterprises and employees, (excessive overtime, proactive overtime) indicates that private enterprises seriously exploit employees to obtain high profits, and employees face physical health problems while receiving high returns; (Overtime, passive overtime) is reflected in the dual pressure faced by employees under the mandatory arrangement of private enterprises, which in turn will have a certain impact on the efficiency of private enterprises; (Normal overtime, proactive overtime) means that private enterprises require overtime to receive normal benefits, and employees receive normal rewards for normal overtime; (Normal overtime, forced overtime) reflects the impact of overtime on the work efficiency of employees with lower work enthusiasm. For labor supervision agencies, the strictness of supervision determines the level of management costs, as well as the severity of punishment for disciplinary violations in private enterprises and the extent to which they can benefit together with their employees. The probability of excessive overtime in private enterprises is x, the probability of normal overtime is 1-x, the probability of employees actively working overtime is y, the probability of passive overtime is 1-y, the probability of strict supervision by labor supervision agencies is z, and the probability of loose supervision is 1-z. The specific settings are as follows:

C: The management cost of strict supervision by labor supervision agencies

C_1: Punishment for private enterprises directly investigated and punished by supervisory departments

C_2: Impairment of physical health of employees due to excessive overtime

C_3: Decreased psychological utility of employees due to excessive overtime (dissatisfaction)

E_0: Income earned by private enterprises from normal overtime work

E: Benefits earned by employees from normal overtime

E_1: Private enterprises that work overtime excessively earn profits

E_2: Benefits earned by employees from private enterprises that work excessively overtime

a: Regarding the distribution coefficient of benefits between employees and supervisory departments, a represents the share occupied by employees, $0<a<1$

DOI: 10.54254/2754-1169/91/20240978

m: The coefficient of the impact of health loss on efficiency, $0 < m < 1$, mC_2 represents the indirect transformation of employee health loss into a reduction in efficiency for private enterprises

n: The coefficient of the impact of dissatisfaction on efficiency, $0<n<1$, nC_3 represents the indirect transformation of employee dissatisfaction

L: The coefficient for the degree of dissatisfaction, $0<L<1$, LC_3 represents the psychological utility loss of employees who work overtime normally (but do not want to)

k: Regarding the coefficient of the strictness of supervision by the labor supervision department, $0 \leq k < 1$, kC represents the management cost invested by the labor supervision department that is not strictly supervised, and kC1 represents the reduction in benefits punished by the supervision department

2.2. Model Establishment

Based on the above assumptions, a tripartite game matrix can be formulated:

Table 1: Game Matrix.

<table>
<tr><td colspan="6">Labor Supervision Department</td></tr>
<tr><td colspan="3">Strict regulation z</td><td colspan="3">Loose regulation 1-z</td></tr>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Staff</td><td colspan="2" rowspan="2"></td><td colspan="2">Staff</td></tr>
<tr><td>Proactively working overtime y</td><td>Forced to work overtime 1-y</td><td>Proactively working overtime y</td><td>Forced to work overtime 1-y</td></tr>
<tr><td rowspan="2">Private enterprise</td><td>Excessive overtime x</td><td>$E_1 - C_1 - mC_2 + aC_1 - C_2(1 - a)C_1 - C$</td><td>$E_1 - C_1 - mC_2 - nC_3E_2 + aC_1 - C_2 - C_3(1 - a)C_1 - C$</td><td rowspan="2">Private enterprise</td><td>Excessive overtime x</td><td>$E_1 - kC_1 - mC_2E_2 + akC_1 - C_2(1 - a)kC_1 - kC$</td><td>$E_1 - kC_1 - mC_2 - nC_3E_2 + akC_1 - C_2 - C_3(1 - a)kC_1 - kC$</td></tr>
<tr><td>Normal overtime 1-x</td><td>$E_0E - C$</td><td>$E_0E - LC_3 - C$</td><td>Normal overtime 1-x</td><td>$E_0E - kC$</td><td>$E_0E - LC_3 - kC$</td></tr>
</table>

Table 1 shows 8 strategic combinations formed by the two strategic choices of private enterprises, employees, and labor supervision departments.

DOI: 10.54254/2754-1169/91/20240978

3. Model Analysis

Let E_1 (P) and E_2 (P) be the expected returns of private enterprises during excessive and normal overtime, respectively, and E (P) be the average expected return.

$$E_1(P) = z[y(E_1 - C_1 - mC_2) + (1-y)(E_1 - C_1 - mC_2 - nC_2)] + (1-z)[y(E_1 - kC_1 - mC_2) + (1-y)(E_1 - kC_1 - mC_2 - nC_3)] \quad (1)$$

$$E_2(P) = z[yE_0 + (1-y)E_0] + (1-z)[yE_0 + (1-y)E_0] \quad (2)$$

$$E(P) = xE_1(P) + (1-x)E_2(P) \quad (3)$$

Let E_1 (S) and E_2 (S) represent the expected benefits for employees who actively work overtime or are forced to work overtime, respectively, and E (S) be the average expected benefits.

$$E_1(S) = z[x(E_2 + aC_1 - C_2) + (1-x)E] + (1-z)[x(E_2 + akC_1 - C_2) + (1-x)E] \quad (4)$$

$$E_2(S) = z[x(E_2 + aC_1 - C_2 - C_3) + (1-x)(E - LC_3)] + (1-z)[x(E_2 + akC_1 - C_2 - C_3) + (1-x)(E - LC_3)] \quad (5)$$

$$E(S) = yE_1(S) + (1-y)E_2(S) \quad (6)$$

Let E1 (G) and E2 (G) be the expected returns of strict and relaxed supervision by labor supervision agencies, respectively, and E (G) be the average expected return.

$$E_1(G) = x[y(C_1 - aC_1 - C) + (1-y)(C_1 - aC_1 - C)] + (1-x)[yE + (1-y)(E - LC_3)] \quad (7)$$

$$E_2(G) = x[y(kC_1 - akC_1 - kC) + (1-y)(kC_1 - akC_1 - kC)] - (1-x)[ykC + (1-y)kC] \quad (8)$$

$$E(G) = zE_1(G) + (1-z)E_2(G) \quad (9)$$

In the process of strategy selection, for participants, if the average return of a specific strategy is higher than the average return of a mixed strategy, they are more inclined to choose that specific strategy. Assuming that the relative adjustment speed of the frequency of participants using this strategy is directly proportional to the extent to which their profits exceed the average income, using the change speed of x, y, and z in private enterprises, employees, and labor supervision agencies, a dynamic replication system can be obtained:

$$\frac{dx}{dt} = \dot{x} = x(E_1(P) - E(P)) = x(1-x)(E_1(P) - E_2(P)) = x(x-1)(E_0 - E_1 + kC_1 + mC_2 + nC_3 + zC_1 - kzC_1 - nyC_3 + nzC_2 - nzC_3 - nyzC_2 + nyzC_3) \quad (10)$$

$$\frac{dy}{dt} = \dot{y} = y(E_1(S) - E(S)) = y(1-y)(E_1(S) - E_2(S)) = y(1-y)[xC_3 + (1-x)LC_3] \quad (11)$$

$$\frac{dz}{dt} = \dot{z} = z(E_1(G) - E(G)) = z(1-z)(E_1(G) - E_2(G)) = z(1-z)[x(1-k)(C_1 - aC_1 - C) + (1-x)(E - LC_3 + kC + yLC_3)] \quad (12)$$

labor supervision agencies. The dynamic adjustment process reflects the formation mechanism of individual behavior transitioning to collective behavior.

DOI: 10.54254/2754-1169/91/20240978

When $F(x)=\frac{dx}{dt}=0, F(y)=\frac{dy}{dt}=0, F(z)=\frac{dz}{dt}=0$, The rate of change of the system strategy is 0, and the system is in a stable state. Using Matlab operations, the equilibrium point of the three-dimensional system is obtained. If and only if the strategy combination is strictly Nash equilibrium, the strategy combination is stable in the dynamic replication system of evolutionary games. And strict Nash equilibrium is a pure strategy Nash equilibrium, so only the asymptotic stability of the eight equilibrium points E1 (0,0,1), E2 (1,0,0), E3 (0,1,0), E4 (1,1,0), E5 (1,0,1), E6 (0,1,1), E7 (1,1,1), and E8 (0,0,0) needs to be discussed.

According to Friedman's method, the stability of the equilibrium point of a population dynamics described by a differential equation system is obtained by analyzing the local stability of the Jacobi matrix obtained by the system. The Jacobi matrix obtained from the dynamic replication system is table 2:

Table 2: Jacobi matrix

$(2x-1)(E0-E1+kC1+mC2+nC3+zC1-kzC1-nyC3+C2nz-nzC3-nyzC2+nyzC3)$	$x(x-1)(-nC3-nzC2+nzC3)$	$x(x-1)(C1-kC1+nC2-nC3-nyC2+nyC3)$
$C3y(1-y)(1-L)$	$C3(1-2y)(L+x-Lx)$	0
$z(z-1)(C-C1+E-LC3+aC1-2kC-kC1+LyC3-akC1+2kyC)$	$z(z-1)(-LC3-2kC+LC3x+2kCx)$	$(2z-1)(kC-E+Cx-C1x+Ex+LC3-LxC3-LyC3+axC1-2kxC+kxC1-2kyC+LxyC3-akxC1+2kxyC)$

For dynamic replication systems with many parameters and relatively complex expressions, direct analysis is not convenient. Data simulation can provide a clearer analysis of the evolution trend. Take E1 (0,0,1), E2 (1,0,0), E3 (0,1,0), E4 (1,1,0), E5 (1,0,1), E6 (0,1,1), E7 (1,1,1), and E8 (0,0,0) into matrix J and calculate their eigenvalues separately.

According to the theory of dynamical systems, the stability problem of the solution of any linear system can be reduced to the stability problem of the zero solution of the corresponding linear homogeneous system. For linear homogeneous constant coefficient systems, the necessary and sufficient condition for the zero solution to be locally stable is that all eigenvalues of the n x n constant matrix (i.e. the Jacobian matrix mentioned above) as coefficients are negative real parts. From this, the stability analysis results can obtained table 3:

DOI: 10.54254/2754-1169/91/20240978

Table 3: Stability analysis results

Equilibrium point Ei	Characteristic root J_i		Characteristic root symbol	Local stability
E1(0,0,1)	$\lambda 1 = -(E - E_1 + mC_2 + C_1)$	Indefinite	Having positive characteristic roots	Unstable fixed point
	$\lambda 2 = LC_3$	>0		
	$\lambda_3 = LC_3 + kc - E$	Indefinite		
E2(1,0,0)	$\lambda 1 = E_0 - E + kC_1 + mC_2 + nC_3$	>0	Having positive characteristic roots	Unstable fixed point
	$\lambda_2 = C_3$	>0		
	$\lambda_3 = (1 - k)(C_1 - aC_1 - C)$	>0		
E3(0,1,0)	$\lambda_1 = -(E_0 - E_1 + kC_1 + mC_2)$	Indefinite	Having positive characteristic roots	Unstable fixed point
	$\lambda_2 = -LC_3$	<0		
	$\lambda_3 = E + kc$	>0		
E4(1,1,0)	$\lambda_1 = E_0 - E_1 + kC_1 + mC_2 - nC_3$	Indefinite	If $E_0 - E_1 + kC_1 + mC_2 - nC_3 < 0$, $C_1 - aC_1 - C < 0$	Asymptotic stable point
	$\lambda_2 = -C_3$	<0		
	$\lambda_3 = (1 - k)(C_1 - aC_1 - C)$	Indefinite		
E5(1,0,1)	$\lambda_1 = E_0 + mC_2 + nC_2 + C_1$	Indefinite	Having positive characteristic roots	Unstable fixed point
	$\lambda_2 = C_3$	>0		
	$\lambda_3 = (k - 1)(C_1 - aC_1 - C)$	Indefinite		
E6(0,1,1)	$\lambda_1 = -(E_0 - E_1 + mC_2 + C_1)$	Indefinite	If $E_0 - E_1 + mC_2 + C_1 > 0$	Asymptotic stable point
	$\lambda_2 = -LC_3$	<0		

DOI: 10.54254/2754-1169/91/20240978

Table 3: (continued).

	$\lambda_3 = -E - kc$	<0		
E7(1,1,1)	$\lambda_1 = E_0 - E_1 + mC_2 + C_1 - kC_1$	Indefinite	If $E_0 - E_1 + mC_2 + C_1 - kC_1 < 0$, $aC_1 - C_1 + C < 0$时	Asymptotic stable point
	$\lambda_2 = -C_3$	<0		
	$\lambda_3 = (1-k)(aC_1 - C_1 + C)$	Indefinite		
E8(0,0,0)	$\lambda_1 = -(E_0 - E_1 + kC_1 + mC_2 + nC_3$	Indefinite	Having positive characteristic roots	Unstable fixed point
	$\lambda_2 = LC_3$	>0		
	$\lambda_3 = E - LC_3 - kc$	Indefinite		

Table 3 shows the eigenvalues obtained by incorporating 8 possible equilibrium points into the matrix and the analysis of their stability.

Identify the three possible stable points E4 (1,1,0), E6 (0,1,1), and E7 (1,1,1), and assign values to each parameter under the following constraints:

Table 4: Parameter assignment

Parameter assignment	Data One(1,1,0)	Data Two(0,1,1)	Data Three(1,1,1)
C	2	2	2
C1	4	4	4
C2	1	1	1
C3	1	1	1
E0	5	5	5
E	3	3	3
E1	10	8	10
E2	5	5	5
a	0.8	0.6	0.3
m	0.5	0.5	0.5
n	0.5	0.5	0.5
L	0.2	0.2	0.2
k	0	1	1

Table 4 represents the assignment of existing parameters after maximizing data variability under given constraints.

Using Matlab to simulate a replicated dynamic system, data one, two, and three correspond to the curves of K values 1, 2, and 3 in the graph.

DOI: 10.54254/2754-1169/91/20240978

Data one is satisfied. The system starts from different initial values, undergoes different trends of change, and after a period of game, ultimately converges towards (1,1,0). That is, the stable strategy combination of private enterprises, employees, and labor supervision agencies is {excessive overtime, proactive overtime, and loose supervision}. The choice of private enterprises to allow employees to work overtime excessively indicates that the value of exploitation from their employees is higher than the loss of benefits caused by the supervision of labor supervision agencies and the decline in employee efficiency. If employees choose to work overtime voluntarily, it indicates that they believe that the benefits they can obtain from overtime and labor supervision agencies are greater than the physical and mental losses caused by overtime. Labor supervision agencies consider their own regulatory costs and choose to relax supervision. In this case, the revenue of private enterprises is 9.5, the revenue of employees is 4, the revenue of labor supervision agencies is 0, and the total revenue of the three parties is 13.5.

Data explanation: In the process of assigning values to parameters, by appropriately adjusting the size of some parameters, it can be obtained that when private enterprises have a larger profit difference between excessive overtime and normal overtime, the punishment intensity of labor supervision organs is smaller (regulatory intensity k is smaller or punishment C1 is smaller), the efficiency loss caused by employee health problems is smaller, the profit of labor supervision organs is smaller (punishment effect is worse or profit sharing coefficient a is larger), and the supervision cost is higher, a possible equilibrium point can be determined, that is, private enterprises have excessive overtime, employees actively work overtime, and labor supervision organs relax supervision.

Data two meets the requirements. Starting from different initial values and experiencing different trends of change, the borrowing system eventually converges towards (0,1,1) after a period of game, that is, the stable strategy combination of private enterprises, employees, and labor supervision agencies is {normal overtime, proactive overtime, and strict supervision}. Private enterprises allow employees to work overtime normally, and employees actively work overtime without any loss of efficiency or physical and mental health. Labor supervision agencies strictly supervise. In this case, the revenue of private enterprises is 5, the revenue of employees is 3, the revenue of labor supervision agencies is -2, and the total revenue of the three parties is 6.

Data explanation: In the process of assigning values to parameters, by appropriately adjusting the size of some parameters, it can be determined that when the profit difference between excessive overtime and normal overtime in private enterprises is smaller, the punishment intensity of labor supervision organs is greater (i.e. the income from labor supervision organs and employee investigations is greater), and the efficiency loss caused by employee health problems is greater. A possible equilibrium point can be determined, which is that private enterprises work overtime normally, employees work overtime voluntarily, and labor supervision organs strictly supervise.

Data three meets the requirements. The system starts from different initial values, undergoes different trends of change, and after a period of game, ultimately converges towards (1,1,1), that is, the stable strategy combination of private enterprises, employees, and labor supervision agencies is {excessive overtime, proactive overtime, and strict supervision}. The benefits that private enterprises receive from their employees outweigh the losses caused by punishment and reduced employee efficiency. Employees choose to follow the overtime arrangements of private enterprises, while labor supervision agencies strictly supervise them. In this case, the revenue of private enterprises is 5.5, the revenue of employees is 5.2, the revenue of labor supervision agencies is 0.8, and the total revenue of the three parties is 11.5.

Data explanation: In the process of assigning values to parameters, by appropriately adjusting the size of some parameters, it can be obtained that the larger the profit difference between excessive overtime and normal overtime in private enterprises, the stricter the supervision of labor supervision

DOI: 10.54254/2754-1169/91/20240978

organs, the smaller the punishment intensity, the smaller the efficiency loss caused by employee health problems, the greater the profit of labor supervision organs (the punishment effect is good or the profit sharing coefficient is small), the lower the supervision cost, and a possible equilibrium point can be determined, that is, when private enterprises excessively work overtime, employees actively work overtime, and labor supervision organs strictly supervise.

Comprehensive explanation: The changes in parameters play a decisive role in controlling the formation of the final stable point. Due to the employees adopting a proactive overtime strategy in the obtained equilibrium points, the coefficients L, C3, and n related to psychology do not affect the stable results.

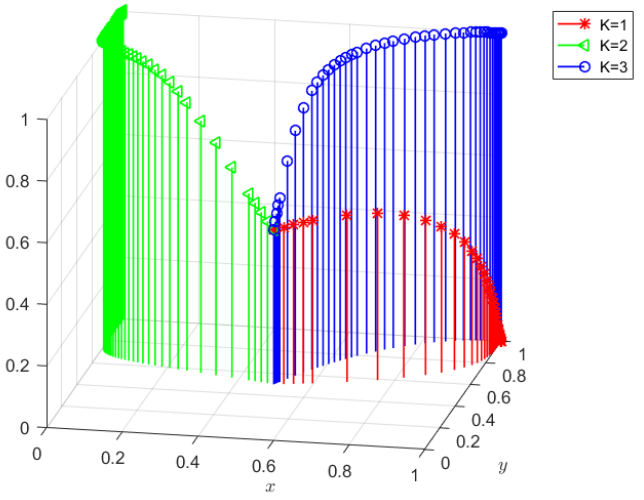

Figure 1: Results of cluster analysis

In figure 1, clusters of red, blue, and green indicate that the strategy combination results remain stable at three points: (1,1,0), (0,1,1), and (1,1,1) after significantly differentiated assignment under different constraint conditions.

4. Conclusion

Among the three equilibrium points mentioned above, considering the total revenue of the three parties, it can be seen that in the case of (1,1,0), the combination of private enterprises, employees, and labor supervision agencies {excessive overtime, proactive overtime, and loose supervision} has the highest total revenue. In the early stage of market development in our country, relying solely on the spontaneous operation mechanism of the market cannot guarantee the implementation of humanized management by private enterprises and assume certain social responsibilities for employees. The imperfect and lax governance methods of supervisory organs are also a major cause of vicious market competition. Therefore, the introduction of strict supervision by labor supervision agencies includes (1,1,1) and (0,1,1), namely, private enterprises, employees, labor supervision agencies {excessive overtime, proactive overtime, strict supervision} and {normal overtime, proactive overtime, strict supervision}. In these two combinations, (the difference between the benefits obtained by private enterprises from excessive overtime and the punishment imposed by labor supervision agencies plus the reduction of employee benefits) determines the strategic choice of private enterprises. With the increase of market supervision intensity (k value increases, C1 increases) and the improvement of production technology level (the marginal excess profit brought about by excessive overtime decreases), (1,1,1) will ultimately lean towards the solution of (0,1,1).

DOI: 10.54254/2754-1169/91/20240978

From the above analysis, it can be seen that strict supervision by labor supervision agencies plays an important role in balancing the imbalance between labor and capital. Strengthening the review and inspection of labor supervision agencies and the punishment of illegal private enterprises can effectively promote the social responsibility of private enterprises towards employees, promote mutual understanding between labor and capital, actively cooperate to create stable and long-term value. At the same time, certain incentive measures should also be implemented for labor supervision agencies to ensure their strict supervision; Private enterprises should strictly abide by market order and proactively reduce the burden on employees; Employees should maintain a good work attitude and promote the development of common interests with private enterprises.

Authors Contribution

All the authors contributed equally and their names were listed in alphabetical order.

References

[1] *Tan, K. (2011) Take the principle of repeated game to demonstrate the necessity of effective communication between workers -- Take Foxconn as an example. Enterprise economy, (08),65-68.*

[2] *Ning, F.K. (2013) A Master's thesis on the coordination of labor relations from the perspective of game theory. Shandong University.*

[3] *Zhang, X., Xu, Q.Q. (2015) Labor relations study based on the asymmetric game model -- concurrently discusses the limitations of the "prisoner's dilemma". Research on financial issues, (05),124-128.*

[4] *Chen, H. (2017) Construction of harmonious labor relations in private enterprises from the perspective of game. Yanshan University.*

[5] *Cao, M., Zhang, C.K., Zhu, H.N. (2016) Analysis of labor relations based on the evolutionary game. Journal of Systems Sciences, (04),111-116.*

[6] *Shang, K., Xing, N. (2019) Game analysis of the formation mechanism of overwork. Journal of China Institute of Labor Relations, (04),39-44.*

[7] *Chen, X.B., Zhang, H.C., Cui, X.J., Liang, D.D., Tang, Q.L. (2024) Theoretical analysis of the statistical life value of workers from the perspective of labor game. Chinese collective economy, (05),123-126.*

[8] *Li, Q.Q., Zhang, X.M. (2023) "overtime culture" -- based on the analysis of the phenomenon of high-intensity work. Guide to Economic Research, (04),24-27.*