

Nash Equilibrium in the Game of Compensation and Promotion between Enterprises and Employees

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Abstract. Employee motivation is an important human resource management measure for enterprises to promote the realization of enterprise goals by improving employee motivation. The salary increase and promotion are the most commonly used incentive means. If properly used, they can achieve twice the result with half the effort, which is conducive to the enterprise to build a high-quality, reasonable structure of the staff. This paper analyses the game behavior of enterprises and employees under different strategies of salary increase and promotion, and suggests that enterprises should maintain the average level of wage growth in the market, increase salary increase moderately in the stage of rapid economic growth, and attach importance to the needs of high-competent employees and key positions, so as to provide some reference for human resources management of enterprises.

Keywords: Incentive; Increase in salary; Promotion; Game; Nash Equilibrium.

1. Introduction

Motivation theory is a theory that studies people's needs and motivations. It explains how to drive and strengthen people's behavior through external stimulation. Famous incentive theories, such as Maslow's hierarchy of needs theory, Herzberg's two-factor theory, McClellan's achievement needs theory and Fromm's expectation theory, have studied human's demand motivation from different levels and angles. Reasonable use of incentive theory in enterprises can effectively guide employees' behavior and make it consistent with the strategic direction of enterprises as far as possible, which is conducive to promoting the realization of enterprise goals. Enterprises' incentive measures to employees mainly include competitive income, granting necessary power, arranging satisfactory work content, creating a harmonious working atmosphere, giving corresponding personal honors, ensuring the safety and comfort of working environment, and formulating scientific and reasonable management system. Among them, the former two are traditional "salary increase and promotion", which are the most commonly used incentive means for enterprises. If properly used, they can effectively improve the enthusiasm and initiative of employees and benefit enterprises. However, in reality, the application of these two incentive policies is not the same. Some enterprises are open-minded and tend to enhance employee loyalty through positive incentives, while others are more conservative and accustomed to controlling the intensity and frequency of employee incentives from the perspective of cost savings. Others are good at adjusting specific strategies according to the actual situation of employees. How to achieve the maximum benefits of enterprises and the ultimate goal of employee incentive is one of the important contents of human resource management. This paper studies the game between enterprises and employees under different salary increase and promotion strategies, in order to provide some reference for enterprises in the formulation of incentive policies.

2. Game Analysis of Enterprises and Employees

2.1 Hypothesis

Assuming that both enterprises and employees are economic people, the purpose of pursuing is to maximize profits, that is, enterprises pursue maximization of profits and employees pursue maximization of personal utility.

The average market wage level available to employees will continue to increase with the accumulation of their work experience.

Employees are divided into two categories: low-competence and high-competence. Low-competence employees can be competent for general jobs, and high-competence employees can be competent for higher positions. Only those who show high-competence in general positions can be adjusted to higher Position.

The game between enterprises and employees is a dynamic game of perfect information, that is, the actions of enterprises and employees do not occur at the same time, the latter actors can accurately understand the strategies and benefits of the former actors, and the two sides can accurately observe the occurrence of exogenous events.

3. Game Analysis of Pay Increase

The dynamic game between enterprises and employees for salary increase can be divided into three stages.

In the first stage, the salary of employees entering the enterprise is the market average level of W_1 . At this time, employees have two kinds of action strategies, one is not to work hard, the other is to work hard.

In the second stage, after employees have worked in the enterprise for a period of time, the enterprise will take the next step. First, according to the market conditions, employees will increase their wages to W_2 at least. At this time, employees will stay in the enterprise to work, and second, they will not increase their wages.

In the third stage, if the enterprise does not increase wages, employees have two kinds of action strategies, namely, not job-hopping, and second, job-hopping to other enterprises whose wage level reaches W_2 . Assuming that the employee's choice of whether to work hard or not remains unchanged after job-hopping, while the enterprise needs to re-recruit employees, assuming that the probability of new recruits working hard and not working hard is equal, the recruited new employees' salary is still W_1 .

Through the analysis, we can see that there are six kinds of action strategy combinations between employees and enterprises, including employees do not work hard, the normal salary increase of enterprises; employees do not work hard, enterprises do not raise salaries, employees change jobs; employees do not work hard, enterprises do not raise salaries, employees do not change jobs; employees work hard, enterprises raise salaries; employees work hard, enterprises do not raise salaries; employees work hard, enterprises do not raise salaries, employees Job-hopping; Employees work hard, enterprises do not raise salaries, employees do not change jobs. Therefore, the perfect dynamic information game model of employees and enterprises can be constructed, as shown in the game tree in Figure 1. According to the hypothesis, both employees and enterprises are rational, and the sub-game refined Nash equilibrium is the best strategy choice.

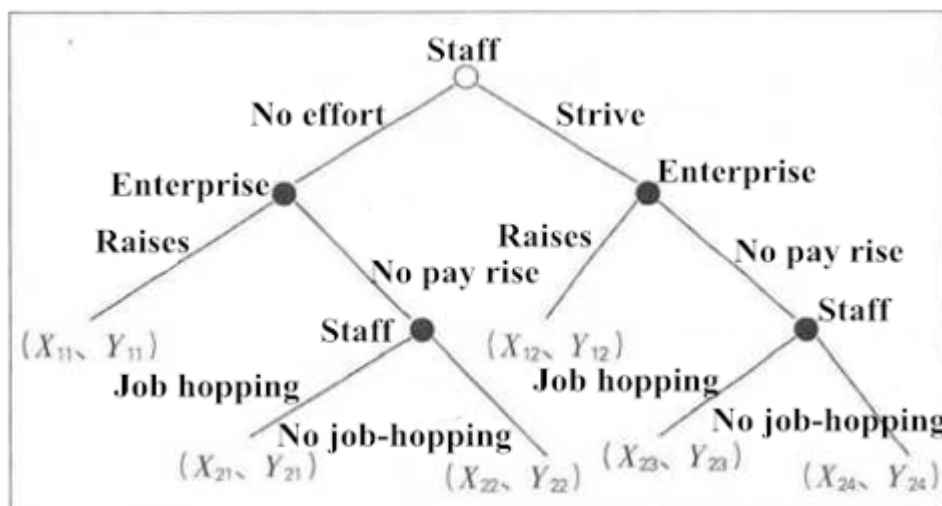


Fig 1. Game Tree of Compensation between Enterprises and Employees

The profits of both sides in each stage are as follows:

$$\begin{aligned}
 X_{11} &= W_2 - C_1, Y_{11} = B_1 - W_2, X_{12} = W_2 - C_2, Y_{12} = B_2 - W_2 \\
 X_{21} &= W_2 - C_2 - H_1, Y_{21} = 0.5(B_1 + B_2)W_1 - P, X_{22} = W_1 - C_1, Y_{22} = B_1 - W_1 \\
 X_{23} &= W_2 - C_1 - H_2, Y_{23} = 0.5(B_1 + B_2)W_1 - P, X_{24} = W_1 - C_2, Y_{24} = B_2 - W_1
 \end{aligned}$$

Among them, C_1 and C_2 are the costs that employees pay for not working hard, such as time and energy; B_1 and B_2 are the benefits that employees create for enterprises when they do not work hard.

H_1 and H_2 are the cost of job-hopping for employees who do not work hard, while P is the cost of recruitment and training for employees who are re-recruited by enterprises $C_1 < C_2$, $B_1 < B_2$, $W_1 < W_2$, $C_1 < W_1 < B_1$, $C_2 < W_2 < B_2$, $H_1 < H_2$.

H_1 , H_2 and P are actually categories of natural selection, but they are used as criteria for analysis. According to the reverse induction method, we can get the refined Nash equilibrium of H_1 , H_2 and P in different situations. Because the calculation and judgment process are complex, this paper only gives the conclusion (Table 1).

Table 1. Combination of Game Strategies for Pay Increase between Enterprises and Employees.

P	H₁ and H₂	Employees	Enterprises	Employees	Game result
$P > dW + 0.5 dB$	—	No effort	Raises	—	$W_2 - C_1, B_1 - W_2$
$P > dW - 0.5 dB$ $P < dW + 0.5 dB$	$H_1 > dW > dC$	Strive	Raises	—	$W_2 - C_2, B_2 - W_2$
	$H_1 > dW, dW < dC$	No effort	No pay rise	No job hopping	$W_1 - C_1, B_1 - W_1$
	$dW > H_1 > dC$	Strive	Raises	—	$W_2 - C_2, B_2 - W_2$
	$dW > H_1, dC > H_1$	No effort	No pay rise	Job hopping	$W_2 - C_1 - H_1$ $0.5(B_1 + B_2) - W_1 - P$
$P < dW - 0.5 dB$	$H_2 < dW < H_1$ $H_2 < dW - dC$	Strive	No pay rise	Job hopping	$W_2 - C_2 - H_2$ $0.5(B_1 + B_2) - W_1 - P$
	$dW - dC < H_2 < dW < H_1$	No effort	No pay rise	No job hopping	$W_1 - C_1, B_1 - W_1$
	$H_1 < dW, H_1 - H_2 < dC$	Strive	No pay rise	Job hopping	$W_2 - C_2 - H_2$ $0.5(B_1 + B_2) - W_1 - P$
	$H_1 < dW, H_1 - H_2 < dC$	No effort	No pay rise	Job hopping	$W_2 - C_1 - H_1$ $0.5(B_1 + B_2) - W_1 - P$

Note: DW denotes $W_1 - W_2$, dB denotes $B_2 - B_1$, dC denotes $C_2 - C_1$.

3.1 Game Analysis of Promotion

After employees have worked in the enterprise for a certain period of time, both the enterprise and the employees themselves have learned about their ability information. For low-competent employees, enterprises only need to provide market-oriented wage levels, in this case, low-competent employees will not take the exit strategy. For highly competent employees, the dynamic game between enterprises and employees can be divided into two stages.

3.1.1 In the First Stage, There are Two Strategies for Enterprises.

One is not to be promoted. According to the results of the game in the salary increase stage, the salary of highly competent employees may be either W_1 or W_2 , which is expressed in W_0 . The second is promotion, which arranges more difficult positions for highly competent employees, assuming that the income is W_3 .

3.1.2 In the Second Stage, Employees Also have Two Strategies, One is to Stay in the Enterprise and the Other is to Change Jobs.

It is assumed that employees change jobs to obtain different positions from those arranged by the enterprise, and the enterprise needs to re-recruit and train employees for this position.

According to the analysis, there are four kinds of action strategies for employees and enterprises, including reluctance to promote employees and job-hopping; reluctance to promote employees and employees do not change jobs; promotion for employees and job-hopping for employees; and promotion for employees and job-hopping for employees. Construct a perfect dynamic information game model for employees and enterprises (as shown in Figure 2).

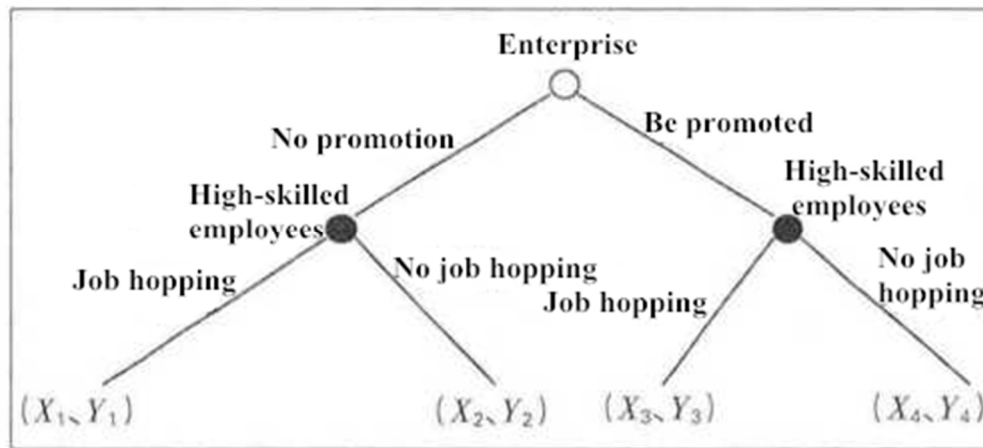


Fig 2. Game Tree of Promotion between Enterprises and Employees

The earnings of both parties at each level are as follows:

$$X_1=W_3-C_3-H_3, Y_1=B_0-W_0-P_0, X_2=W_0-C_0, Y_2=B_0-W_0$$

$$X_3=W_0-C_0-H_0, Y_3=B_3-W_3-P_3, X_4=W_3-C_3, Y_4=B_3-W_3$$

Among them, C_0 and C_3 are the costs of employees' non-promotion and promotion, such as time and energy; B_0 and B_3 are the benefits created by employees' non-promotion and promotion; H_0 and H_3 are the cost of job-hopping for employees seeking the original position and higher position; P_0 and P_3 are the cost of recruiting and training new employees for the original position and higher position respectively. Existence $C_0 < C_3, B_0 < B_3, W_0 < W_3, C_0 < W_0 < B_0, C_3 < W_3 < B_3, H_3 > H_0, P_3 > P_0$.

In order to facilitate the analysis, natural selection factors such as H_0, H_3 and P_0 are still used as judgement conditions for analysis. The conclusions are shown in Table 2.

Table 2. Combination of Game Strategies for Promotion between Enterprises and Employees

H_0 and H_3	P_0 and P_3	Enterprise	Staff	Game result
$H_0 < dC - dW$ and $H_3 > dW - dC$	$P_3 > dB - dW$	No promotion	No job hopping	$W_0 - C_0, B_0 - W_0$
	$P_3 < dB - dW$	Be promoted	Job hopping	$W_0 - C_0 - H_0, B_3 - W_3 - P_3$
$H_0 > dC - dW$ and $H_3 < dW - dC$	$P_0 < dW - dB$	No promotion	Job hopping	$W_3 - C_3 - H_3, B_0 - W_0 - P_0$
	$P_0 > dW - dB$	Be promoted	No job hopping	$W_3 - C_3, B_3 - W_3$
$H_0 > dC - dW$ and $H_3 > dW - dC$	$dW > dB$	No promotion	Job hopping	$W_3 - C_3 - H_3, B_0 - W_0 - P_0$
	$dW < dB$	Be promoted	No job hopping	$W_3 - C_3, B_3 - W_3$

4. Conclusions and Suggestions

As shown in the analysis, we can see that the comparison between enterprises' cost and employees' cost (P and $dW - 0.5dB$, $dC - dW$ and H) decides the equilibrium of the games of pay increase and promotion. When enterprises' cost is low, neither pay rise nor promotion occurs. However, when employees' cost is low, they will not choose job hopping unless the enterprises do not give them pay rise. Therefore, it is clear that the enterprises holds a stronger and more active position in the negotiation between these two parties.

One implication of this model is that regulators should help employees to obtain a better position in such negotiations, in order to introduce more competition to the labor market. This is not only good for the employees, but also for the enterprises since they will have more free employees to choose from. On the other hand, in economic growth, enterprises should give pay rises more often, or they face the risk of losing high-level employees.

In reality, it is difficult to accurately calculate the income B , the recruitment and training cost P and the job-hopping cost H of employees for enterprises. The different utility functions of employees also determine the cost of their work varies from person to person. In addition, the flexibility of enterprise wage policy, the nature of work in different industries, the voice of trade unions in enterprises, the external policy environment and the economic cycle will all have an impact on the behavior of both sides. Therefore, the game model between enterprises and employees is not a simple perfect information dynamic game. However, the above game model still has some guiding significance for human resource management of enterprises.

Employees' competency information is not completely transparent in recruitment, but through the design of effective recruitment topics, they can still have a certain degree of understanding. Enterprises should not be too rigid when recruiting. They should consider the matching degree between the employee and the nature of the post, and use different recruitment strategies. It is difficult for enterprises to retain talents if they blindly hope to recruit employees with strong comprehensive abilities without considering the actual positions that can be arranged.

Enterprises cannot fundamentally save expenditure by limiting employee wage growth, because it is easy to make employees flow to higher-income enterprises, while the original enterprises will pay additional recruitment costs and training costs, but also bear the hidden costs of product or service quality fluctuations caused by the unstable workforce, as well as the loss of corporate reputation. It may even affect the implementation of enterprise development strategy.

Establishing a scientific and reasonable incentive and restraint mechanism is one of the most effective measures for enterprises to mobilize the enthusiasm of employees. By differentiating between hard-working and hard-working employees in terms of income, incentive policies can be brought into full play so that both enterprises and employees can get the greatest benefits, thus realizing Pareto optimum. If it can be promoted in all enterprises, it can significantly improve social productivity, but also make the job-hopping strategy of a few employees who do not work hard invalid, which is more conducive to the stability of the staff.

According to the traditional incentive theory, employees will have higher-level needs after their salaries meet their living needs, such as hope that their abilities will be recognized by others, hope to control more resources and challenge more difficult work. Therefore, it is another effective incentive for enterprises to arrange promotion for high-competent employees at the right time. It can achieve more scientific resource allocation, further enhance the satisfaction and belonging of employees, and enterprises will often get higher returns. In enterprises where promotion opportunities are scarce, employees are generally lack of vitality because they can not see the channels of promotion, and highly competent employees are more likely to be lost.

Job-hopping costs of employees and recruitment and training costs of enterprises are important factors affecting the decision-making of both sides. When the economic growth rate is faster and the demand for labor is greater than the supply, the cost of job-hopping is lower. At this time, enterprises should keep wage growth slightly faster than the average level of the market to reduce the rate of employee turnover. For key positions with certain technical or experience barriers, the cost of

recruitment and training is high. Therefore, we should make full use of all kinds of incentives to stabilize the work of these employees.

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