Journal of Investment and Management
2016; 5(6): 93-98
http://www.sciencepublishinggroup.com/j/jim
doi: 10.11648/j.jim.20160506.11
ISSN: 2328-7713 (Print); ISSN: 2328-7721 (Online)

Studying on the Relation Between Ability Structure and Incentive Structure Based on a Game Model

Zhang Chaoxiao

School of Management, Sichuan University of Science & Engineering, Zigong, China

Email address:
zhangchaoxiao@163.com

To cite this article:
Zhang Chaoxiao. Studying on the Relation Between Ability Structure and Incentive Structure Based on a Game Model. *Journal of Investment and Management.* Vol. 5, No. 6, 2016, pp. 93-98. doi: 10.11648/j.jim.20160506.11

Received: September 4, 2016; **Accepted**: September 22, 2016; **Published**: October 14, 2016

Abstract: A game model is designed to analyze the relation between employee's ability structure and enterprise's incentive structure. And some factors' impaction on incentive structure is analyzed, such as employee's ability, risk aversion, output error, and product price. The intrinsic mechanism of employee classification according to their ability level is also analyzed. The result reveals that under competitive working environment employee's ability level should be kept consistent, employee with different ability levels can't be classified by themselves, and piece rates should be kept direct ratio to employee's ability level and product's market trend. Although strict balanced incentive structure comprises of fixed wage and prize or promotion, balanced conditions can not usually be satisfied in real situation, so that fixed wage, piece rate wage, and prize or promotion should be combined to form a suitable proportion structure. Prize or promotion mechanism will strengthen the steepness degree of incentive structure, which will strengthen incentive effect under the condition of employee's participation restriction.

Keywords: Ability Structure, Incentive Structure, Game Model

1. Introduction

Nearly most companies attach much importance to employee incentive. Although many incentive measures are used to inspirit employees, the inner structure relation between these incentive measures has not been paid importance to, as in [1]. Some incentive measures have been so blindly used that under the law of marginal utility descending these incentive factors become health care factors. Modern organizations have three basic structures, which is governing structure, capital structure and incentive structure. Although many literatures have studied employee incentive from many aspects, only a few literatures mentioned the concept "incentive structure". Our past studies indicate that incentive structure has three levels meanings. First, it refers to the incentive measures' combination proportion relation. Second, incentive structure is the distribution law of incentive measure in the organization's members. Third, it refers to incentive changing law along with time. We can divide incentive methods into different types according to different study purposes, for instance, substance incentive and inspirit incentive. There exists complex structure relation between substance incentive and inspirit incentive. But there also exist complex structure relation between all kinds of substance incentives. Further all the incentive methods' structure relation is influenced by other factors in or out of organization, as discussed in [2] (Jed Devaro, 2006) and [3] (Peter Wright, Mark Kroll, Jeffrey A. Krug and Michael Pettus, 2007). Among these factors, employee's ability level and its structure influence incentive structure importantly.

Substance incentive structure is discussed in this paper. Substance incentive consists of fixed wage, piece rate wage, share, prize, promotion, stock option, etc. According to studying purpose, we divide substance incentives into three types, which is fixed wage, piece rate wage and prize or promotion. Lazear(1986)considered that piece rate wage and sharing is linear transformation of employee performance, while prize, promotion and stock income are nonlinear transformation of employee's performance, as in [4]. Lazear and Rosen's results demonstrates that the reason that why promotion incentive violently increase nonlinearly lies in that along with the position's ascending, an employee's further promotion room reduces, and the organization can only afford more rewards to achieve the same incentive effects,as in [5]. This demonstrates that promotion is a nonlinear

incentive which is different from fixed wage and piece rate wage. Usually fixed wage can not bestir an agent to work hard, but fixed wage provides insurance for employees. So for the risk-averse employees, fixed wage helps to satisfy their participation restriction. Piece rate wage can bestir risk-averse employees, but because of ratchet wheel effect, piece rate wage cannot become a credible long term contract, so piece rate wage may not substitute for fixed wage completely. However, promotion incentive is credible, because the principal and the agent can observe if a special ratio of employees are promoted to a certain higher position. Since a special ratio of employees must be promoted, the principal would like to promote the best employee. But the promotion or prize's problem lies in this characteristic of reward lagging which leads to the problem that an employee's current demand may not be satisfied. Commonly the three incentive methods supplement each other. By synthetically using the three incentive measures, an enterprise can reach the best incentive effect.

This paper is based on Lazear and Rosen's study in 1981. They first discussed wage structure's influence on employee's incentive in rank tournament. Their results demonstrate that the enterprise's incentive can not substitute for rank tournament promotion; employees who cannot be promoted should achieve a certain prize also. Malcomson (1984) designed a model and explained the rank wage, inner promotion, and position wage, as in [6], but they did not discuss optimal risk sharing and optimal piece rate. Holmstrom, et al (1986, 1987, and 1990) utilized principal-agency theory to analyze optimal risk sharing and agent's optimal action, as in [7], [8] and [9]. But they did not discuss rank tournament in their model, and the relation between risk sharing and other incentives. Lazear (2000) analyzed piece rate wage's role in promoting productivity through a demonstration study, as in [10]. Michael (2006) discussed the relation between optimal executive compensation andmanagerial power, as in [11]. Claudia and Beatrice (2006) analyzed competence-based and multidimensional operation, as in [12].

As analyzed in this paper, relative performance payoff has been researched by many researchers in recent years. Loch and Wu (2008) as in [13], Dreber, Fudenbergand Rand (2014) as in [14], Bowles and Polania-Reyes (2012) as in [15] andKoszegi (2014) as in [16] put forward an important point of view that pro-social behaviors is a key concept in interpreting relative incentive.Kidd, Nicholas and Rai (2013) as in [17], Erkal, Gangadha-ran, and Nikiforakis (2011) as in [18], Rey-Biel, Sheremeta, and Uler (2012) as in [19] and Riyanto andZhang (2013) as in [20] explored the effects of social preferences on productivity in the setting of relativeperformance incentives. In many circumstances social preferences or pro-social behaviors can be replaced by cooperation ((Dal Bó and Fréchette, 2011 as in [21], 2014 as in [22]; Fudenberg, Rand, and Dreber, 2012 as in [23]). Another important trend is that more and more experimental study are adopted to analyze the impaction of relative performance incentives on employees' pro-social actions or cooperation (Pablo, Dylan, Dana, 2015 as in [24]).

This paper's innovation point lies in that a game model is designed to analyze the relation between employee's ability structure and incentive structure and the principle of employee classification according as ability structure and work type.

2. Model Analyzation

Suppose that there has an enterprise which employs two employees. Each employee can be denoted as $i = j,k$. Employee i 's product function can be denoted as following

$$\pi_i = a_i + \theta_i + \varepsilon_i \tag{1}$$

In expression (1), a_i , θ_i and ε_i denotes employee i 's effort, ability, and output error. ε_i obeys normal distribution. The mean and deviation are 0 and σ^2 . The employee's wage comprises of three portions, fixed wage, piece rate wage and promotion or prize. Promotion is based on employee's relative output. The winner and loser separately achieve prize w_H and w_L ($w_H > w_L$). And wining probability and losing probability are p and $1-p$ respectively. The enterprise provide incentive contracts for the employee as following

$$s(\pi_i) = \alpha + \beta\pi_i + pw_H + (1-p)w_L \tag{2}$$

In equation (2), α is fixed wage, β is piece rate. α adjusts the employee's total income, which can screen the risk of piece rate wage's changing.

Suppose employee i 's utility function satisfies invariant absolute risk measurement. The formation is as following

$$u(s(\pi_i), c(a_i)) = -\exp(-\rho_i(s(\pi_i) - c(a_i))), i = j,k \tag{3}$$

ρ_i is i 's absolute risk aversion measurement. ρ_i can also depict employee i 's ability level, because employee of higher ability can better scatter risk. $c(a_i)$ is employee i 's effort a_i 's cost. And we suppose $c(a_i) = b_i a_i^2 / 2$, $b_i (> 0)$ is i 's marginal cost coefficient, which denotes employee's ability level. When level of ability is more higher, b_i is more less. That is to say if effort level is unchangeable, the higher ability employee's cost and marginal cost should become much less. p is i 's probability to win

$$\begin{aligned} p &= prob(\pi_i > \pi_{-i}) \\ &= prob(a_i + \theta_i + \varepsilon_i > a_{-i} + \theta_{-i} + \varepsilon_{-i}) \\ &= prob(a_i - a_{-i} + \theta_i - \theta_{-i} > \varepsilon_i + \varepsilon_{-i}) \\ &= prob(a_i - a_{-i} + \theta_i - \theta_{-i} > \xi) \\ &= G(a_i - a_{-i} + \theta_i - \theta_{-i} > \xi), i = j,k; -i = j,k, \\ &but - i \neq i \end{aligned} \tag{4}$$

$G(.)$ is $\xi's$ normal distribution function. Accordingly, $g(.)$ is $\xi's$ density function, $E(\xi)=0, E(\xi^2)=2\sigma^2$

From (1), (2) and (3), we can achieve employee's certain equal income function as following

$$CE_i=\alpha+\beta(a_i+\theta_i)+pw_H+(1-p)w_L-\frac{1}{2}b_ia_i^2-\frac{1}{2}\rho_i\beta^2\sigma^2 \quad (5)$$

Solve the first order condition for a_i in (5), we get

$$(w_H-w_L)g(a_i^*-a_{-i}+\theta_i-\theta_{-i})+\beta=b_ia_i^* \quad (6a)$$

(6a) denotes that employee's marginal income equals to marginal cost. The left of the formula is employee's marginal income, the right is employee's marginal cost. Employee's marginal income includes two parts. The first is the income of winning the competence, the second is piece rate. From (6a) we get the employee's reaction function

$$a_i^*=\frac{(w_H-w_L)g(a_i^*-a_{-i}+\theta_i-\theta_{-i})}{b_i}+\frac{\beta}{b_i} \quad (6b)$$

(6b) demonstrates that employee's effort can be divided into two parts: one is the effort to win rival, the other is to obtain piece rate wage. In Lazear's model (1981, 1986, as in [4] and [5]), employee's income consists only of the income to win rival. Suppose any employee don't know the other's effort level and ability level. Nevertheless all of them will speculate. When his or her ability level is better than the rival's, he or she can work less hard but will not influence his or her victory. Different from Lazear(1986, as in [5]), here an employee would not substitute effort level for ability level when the condition of participate restriction satisfies, because piece rates wage strengthens employee's incentive.

Suppose employee's reservation payment is $\overline{w}_i$, we can get employee's participate restriction

$$\alpha+\beta(a_i+\theta_i)+pw_H+(1-p)w_L-\frac{1}{2}b_ia_i^2-\frac{1}{2}\rho_i\beta^2\sigma^2>=\overline{w}_i \quad (7)$$

We can get employee's fixed wage from (7). Although (6b) denotes that fixed wage can bestir employee to work hard, the formula (7) denotes that for the risk-averse employee, he or she has risk cost, fixed wage has the advantageous roleof bestirring employee to participate contract.

The enterprise's expectant income function is as following

$$ER=v(\pi_j+\pi_k)-2\alpha-\beta(\pi_j+\pi_k)-w_H-w_L \quad (8)$$

v is product price which can denote environment factors' influence on incentive structure. According to economic law, price can synthetically reflect environment factors' influence. Let us suppose employees' ability levels equal, then in equilibrium, their effort levels equal, and their winning probability equal, $p=1/2$. From (6b), we can get

$$a_j^*=a_k^*=a^*=\frac{(w_H-w_L)g(0)}{b}+\frac{\beta}{b} \quad (9)$$

From (9), employee's optimal effort level increases along with prize disparity and piece rate, and decreases along with marginal cost coefficient. Formula (9) also demonstrates that when employees' ability equal, the competition is fiercest.

In equilibrium, equation (7) satisfies. We can get

$$\alpha=-\beta(a^*+\theta)-\frac{1}{2}(w_H+w_L)+\frac{1}{2}ba^{*2}+\frac{1}{2}\rho\beta^2\sigma^2+\overline{w} \quad (10)$$

Substitute (9) into (10), solve α, then substitute α into (8), we get

$$\beta^*=\frac{v-(w_H-w_L)g(0)}{1+\rho b\sigma^2} \quad (11)$$

From (11) we know that because of promotion, enterprise can reduce piece rate. So the piece rate in our model is less than that in Lazear's model in 1986. Equation (11) also demonstrates that the optimal piece rate decreases with absolute risk aversion, marginal cost coefficient and output variance. Another conclusion can be drawn from (11). That is when product price get higher, piece rate should get higheralso. It is can be so explained that during process of employee-capitalist negotiation, when employee find product market meliorates, he or she can request the enterprise to increase piece rate.

Substitute (11) into (9), we can get employee's optimal effort level as following

$$a^*=\frac{v+(w_H-w_L)\rho b\sigma^2g(0)}{b(1+\rho b\sigma^2)} \quad (12)$$

From (12) we can analyze how product price influence employee's optimal effort level. The price influences optimal effort level by influencing optimal piece rate. As if enterprise and employee signed a latent contract that when market turns valuable the enterprise will increase piece rate. At the same time, the employee will work harder to gain more piece rate wage.Then we will analyze optimal prize (w_H^* , w_L^*). Enterprise will select optimal prize to maximize its profit. Substitute (9) and (10) into (8), and solve the first order condition for w_H-w_L, then we get

$$w_H-w_L=\frac{v}{g(0)} \quad (13)$$

(13) denotes optimal prize disparity is in direct ratio to product price, and reaches the least value because g(.) reaches the largest value in equilibrium. Substitute (13) into (11) and (12), we get

$$\beta^*=0 \quad (14)$$

$$a^* = \frac{v}{b} \tag{15}$$

In equilibrium, it is not necessary to pay employee piece rate wage. Employee's optimal effort level is in direct ratio to product price and ability level. Since in equilibrium piece rate equals to 0, and prize disparity is only influenced by market price, then optimal effort level will only be influenced by market price. But in fact this incentive structure may not be feasible, because the prize is usually paid in the end; it may not satisfy employee's consumption restriction.

Let participating restriction (7) equation stands, then substitute (14) and (15) into (7), we get

$$w_H + w_L = -2\alpha + \frac{v^2}{b} + 2\bar{w} \tag{16}$$

From (16) and (13) we get

$$w_H^* = -\alpha + \frac{v^2}{2b} + \bar{w} + \frac{v}{2g(0)} \tag{17a}$$

$$w_L^* = -\alpha + \frac{v^2}{2b} + \bar{w} - \frac{v}{2g(0)} \tag{17b}$$

Compare (17a) and (17b), we find that the difference is their end term. This term can be interpreted as guarantee money which is deducted from employee's wage in advance. This term can also be interpreted as enterprise's debt belongs to employee. If any employee can not exceed his or her accompanier, he or she will not take back the guarantee money. By contrary, he or she may not only take back the guarantee money, but also obtain others' guarantee money. This can interpret the phenomena why wage rise along with working time.

3. The Mechanism of Work Classification

The analyses hereinbefore suppose employees' ability is equal. But if employees' ability is not equal, how would the enterprise do? There have three parameters in the model to depict an employee's ability, θ, ρ and b separately. The first parameter directly depicts ability. The second and the third indirectly depict ability. From product function, we know that ability can substitute effort. An employee of higher ability can work less hard to obtain a certain output. And an employee of lower ability must work harder to obtain the same output. We try to explain why it is invalid to let employees of different ability work together, and it is uncertain if each kind of employees would like to work together with other kind of workers.

Suppose there have two work teams A (high ability) and B (low ability), and the enterprise has established their optimal piece rate β_A^* and β_B^*. Suppose product price v, prize disparity $w_H - w_L$ and output variance σ^2 has be known. From (11), we know $\beta_A^* > \beta_B^*$, because $\rho_A < \rho_B$ and $b_A < b_B$. From (12), we get $a_A^* > a_B^*$, which means that employees of higher ability work more harder than employees of lower ability. As if this is inconsistent with the hypothesis that effort can substitute for ability. But it is noticeable that employees of kind A have no dominance over the same kind of employees. Only when they work with employees of B kind, have they dominance over B kind of employees. So when higher ability employees work with lower ability employees, they can slack off. Let's analyze what will happen if an employee of B kind interfuses into A kind of employees. Now three terms of the employee's certain equal income will change. First, his or her expectant promotion income will decrease because of the decreasing of promotion probability. Second, his or her piece rate will increase because $\beta_A^* > \beta_B^*$. Third, his or her risk cost will increase along with piece rate increase. So when an employee of B kind interfuses into A kind employees, if his or her certain equal income will increase depends on the value of the three terms. Only when the increment of piece rate wage becomes larger than the sum of loss of failing and risk cost, is it profitable to join A kind employees. In the same way, when an employee of kind A joins kind B, although the expectant promotion income will increase, and the risk cost will decrease, his or her opportunity cost will increase because of the decreasing of piece rate. In fact, if higher ability employee wants to join lower ability team (suppose it is profitable), the lower employees would not like to welcome them. On the same way, suppose it is profitable for an lower ability employee to join higher ability team, the higher ability team would not like to welcome them. So employees can not be classified automatically. It is effective to classify employees by their diplomas. In Lazear's model (1981 as in [4]), only lower ability employees would interfuses into higher ability team.

What would happen if we do not classify employees according to their ability? We know from reaction function (6b), suppose prize disparity and piece rate fixed, and suppose that employee of higher ability would work harder, and then $a_i + \theta_i - (a_{-i} + \theta_{-i}) \neq 0$, from the property of normal distribution function, we have $g(a_i + \theta_i - (a_{-i} + \theta_{-i})) < g(0)$, then

$$a_i^* = \frac{(w_H - w_L)g(a_i^* - a_{-i} + \theta_i - \theta_{-i})}{b_i} + \frac{\beta}{b_i} < \frac{(w_H - w_L)g(0)}{b_i} + \frac{\beta}{b_i}, i = j,k; -i \neq i \tag{18}$$

Expression (18) denotes that if we do not classify two kinds of employees, all their effort level will decrease. It can be easily understood. When an employee of higher ability will win an employee of lower employee certainly, why the former would like to work hard? On the same way, when the latter will lose certainly, why he or she would like to work hard?

4. Conclusions and Discussion

Enterprise's economic incentive can be divided into fixed wage, piece rate wage and promotion or prize. Usually, although fixed wage can not bestir employees to work additionally, it provides employees for insurance, which is profitable for employees to participate in work arrangement. Prize disparity increment and piece rate increment can motivate employees' hard work, but the optimal prize disparity is in direct ratio to employee's ability level. For the employees' of lower ability, prize disparity should be reduced. Optimal piece rate is in inverse ratio to prize disparity, employee's risk aversion, and output variance, and is in direct ratio to ability level. Enterprise should adjust optimal piece rate according to market situation.

But under ideal condition and in equilibrium, as long as an employee has enough credit or wealth, it need not pay employee piece rate wage, promotion based on relative performance can bestir employee effectively. The role of enterprise's pyramid-alike steep incentive structure lies in bestirring employees working hard to take back their guarantee money.

Employees would not classify automatically. Employees of higher ability or lower ability may all interfuse into the other team. But this situation can not happen at the same time. It is not profitable to mix all kinds of employees, which will reduce all kinds of employees' incentive effect. Enterprise should divide employees into different work teams according as their ability levels.

Different employees have different ability types. There may have mutual complementarities between different ability types. And different employees may help each other during working processing. These problems should be discussed further.

Acknowledgment

This work is supported by China Sichuan ProvinceScience and Technology Agency Soft Science Project "Studying on the human resource strategy of South Sichuan Province Economy Zone" under grant number 2015ZR0085, and supported by Sichuan Ideological and Political Studying Center "The ideological and political education's influence on undergraduates' character"under grant number CSZ14004, and by the Talent Recruitment Project of Sichuan University of Science & Engineering "Studying on the dynamic matching of the new generation employees' personality characteristics and organization management pattern"under the grant number 2014RC21.

References

[1] Edward P. Lazear (2000), "The Power of Incentives," The American Economic Review, 90, 410-414.

[2] Jed Devaro (2006),"Strategic Promotion Tournaments and Worker Performance,"Strategic Management Journal,27, 721-740.

[3] Peter Wright, Mark Kroll, Jeffrey A. Krug and Michael Pettus (2007), "Influences of Top Management Team Incentives on Firm Risk Taking," Strategic Management Journal, 28, 81-89.

[4] Edward P. Lazear, Sharwin Rosen (1981), "Rank-order Tournaments as Optimum Labor Contracts," Journal of Political Economy, 89, 841-864.

[5] Edward P. Lazear (1986), "Salaries and Piece Rates," The Journal of Business, 59, 405-432.

[6] Malcomson, James M. (1984), "Work Incentives, Hierarchy, and Internal Labor Markets," The Journal of Political Economy, 92, 486-507.

[7] Holmstrom,B., Ricard I Costa (1986), "Managerial Incentives and Capital Management," Quarterly Journal of Economics, 101, 403-460.

[8] Holmstrom, B., P. Milgrom (1987), "Aggregation and Linearity in the Provision of Intertemporal Incentives". Econometrica, 55, 303-328.

[9] Fudengerg, D.,B. Holmstrom,P. Milgrom (1990), "Short-term Contracts and Long-term Agency Relationship," Journal of Economic Theory, 51, 1-31.

[10] Eward P. Lazear (2000), "Performance Pay and Productivity," The American Economic Review, 90, 1346-1362.

[11] Claudia M. Van Der Heijde, Beatrice I. J. M. Van Der Heijden (2006), "A Competence-Based and Multidimensional Operationalization and Measurement of Employability," Human Resource Management, 45, 449–476.

[12] Michael S. Weisbach (2006), "Optimal Executive Compensation Vs. Managerial Power," NBER Working Paper.

[13] Loch, C. H., and Y. Wu (2008), "Social Preferences and Supply Chain Performance: An Experimental Study, Management Science, 54 (11), 1835-1849.

[14] Dreber, A., Fudenberg, D., and Rand, D. G. (2014), "Who Cooperates in Re-peated Games: The Role of Altruism, Inequity Aversion, and Demographics."Journal of Economic Behavior & Organization, 98, 41-55.

[15] Bowles, S., and S. Polania-Reyes (2012), "Economic Incentives and Social Preferences: Substitutes or Complements?", Journal of Economic Literature, 50 (2), 368-425.

[16] Koszegi, B.(2014), "Behavioral Contract Theory." Journal of Economic Literature, 52 (4), 1075-1118.

[17] Kidd, M., A. Nicholas and B. Rai (2013), "Tournament outcomes and pro-socialbehavior", Journal of Economic Psychology 39, 387.401.

[18] Erkal, N., L. Gangadharan, and N. Nikiforakis (2011), "Relative Earnings and Giving in a Real-Effort Experiment", American Economic Review, 101 (3), 3330-3348.

[19] Rey-Biel, P., R. Sheremeta and N. Uler (2012),"(Bad) Luck or (Lack of) Effort?Sharing Rules in the US and Europe", Working Paper.

[20] Riyanto, Y. and J. Zhang (2013), "The impact of social comparison of ability onpro-social behavior", The Journal of Socio-Economics, 47, 37-46.

[21] Dal Bó, P. and G. R. Fréchette (2011).“The Evolution of Cooperation in Infinitely Repeated Games: Experimental Evidence”, The American Economic Review, 101 (1), 411-429.

[22] Dal Bó, P. and G. R. Fréchette (2014), “On the Determinants of Cooperation inInfinitely Repeated Games: A Survey”, SSRN 2535963.

[23] Fudenberg, D., Rand, D. G., and A. Dreber (2012), “Slow to Anger and Fast toForgive: Cooperation in an Uncertain World”, American Economic Review, 102 (2), 720-49.

[24] Pablo Hernandez, Dylan Minor Dana Sisak (2015), “Do People Who Care About OthersCooperate More? ExperimentalEvidence from Relative Incentive Pay”, SSRN 2669665.