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Game Analysis of the Equity Incentive Mechanism of Listed Company

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Abstract –Equity incentive mechanism is the main way of long-term incentives in modern enterprises. This mechanism has improved the economic efficiency and has reduced the cost of management, so it has been put into use in more and more companies. Through using the fundamentals of asymmetric information dynamic game to analyze the equity incentive mechanism plan of listed company's managers, it can be found that a principal-agent model of managerial risk and moral hazard will be very helpful to analyze the revenue function of corporate shareholders and managers and to discuss the relationship between the equity incentive levels, managerial risk and moral hazard, and at the same time, the paper has given reasonable proposals for equity incentives of listed companies in China. Therefore, listed companies can establish more explicit incentives mechanism to promote the long-term development itself.

Keywords – Listed company; Equity; Incentive mechanism; Game analysis; Principal-agent

1. Introduction

Listed company's equity incentive problem has always been a hot issue in the current human resource theory, Zhang Xin (2011) considers that the listed companies in China for implementing equity incentive exist some problems, including the unreasonable corporate governance structure, manager of market imperfections, not yet established effective tax policy and accounting policies, the assessment index system is not perfect, lack of capital market efficiency. And thus to improve the governance structure of listed companies, the establishment of a mature manager talent market, improve the accounting tax system, to establish a scientific assessment evaluation system, the perfect equity incentives to strengthen capital markets and the effectiveness of construction countermeasures is very important. Through discussing the problems from the perspective of China's listed companies in the market environment, reasonable proposals have been put forward. Pan Yongming (2009) makes use of game theory and information economics, the basic principles of equity incentives for enterprise managers to explore the relationship between the output and the manager's effort level, and introduces the oversight mechanisms of incentive stock options on the basis of information asymmetry, come to the best probability of the owner of supervision and the best probability of managers' efforts, and that the probability of the owner's supervision on the effective implementation of equity incentive mechanism is very significant. Han Ran (2010) utilizes the basic principle of asymmetric information and dynamic game analysis on equity incentives for company managers, the shareholders and managers in their respective income function and the number of equity incentive to shareholders to get the relationship of the supervision of the optimal monitoring efforts, as well as the effort level of managers and outside the uncertainties.

Listed companies in China facing the manager market imperfections and capital market efficiency and in the market where lots of unrealistic assumptions set up in theory, we need to make reasonable modifications to make the model more realistic to companies' decision-making for reference. Han Ran (2010) thinks that on condition that the assumption of the remuneration of the company manager is set up, if the manager is selected to manipulate the stock price behavior, shareholders of the company may gain in the short term, but in the long term that will damage shareholders interests a lot, so shareholders must be on the manager monitoring behavior to prevent it from speculative. Different from the processing of the probability of managers to manipulate stock prices of Han Ran (2010), this article which considers the efforts of managers manipulating stock prices may be completely reflecting the moral hazard of the company managers, then you can directly use one variable as a independent factor affecting the risk of moral hazard on the shares of listed companies. In practice, listed companies obviously cannot measure the probability of managers' efforts to manipulate stock price as a result of the imperfections of managers market in China,.

2. Solutions and analysis of the game model

The existing empirical research on incentive stock options focused primarily on the effect of incentive stock options. Implementation of incentive stock options as of September 1, 2011 is a total of 109, including 76 in 2011 and 2010, accounting for the implementation of stock options listed on the company's 69.72%, due to incentive stock options is a long-term incentive system , the incentive effect of stock options has not yet revealed.

Stock option incentive mechanism as a long-term

incentives method is aimed at promoting the company's managers and shareholders' equity consistent. When it comes to find impacts in analysis of stock option incentives for managers and companies, we need to establish a principal-agent model to identify the many factors of the company manager, and to analyze these factors in what place to maximize shareholders' equity.

Below we will use the basic principles in dynamic game of asymmetric information and the principal-agent theory of realistic companies' operating to put forward reasonable assumptions and make a brief analysis:

2.1. Basic concepts and assumptions

(1) The listed companies have their own shares in the capital markets, so it can be assumed that all income changes can reflect the company's market value volatility. And before the time when the contract between the manager and the company is reached, it can be assumed that exercisable price of the stock options is p_0, risk-free rate of return is r. After a time called t, the company's stock price is p, then the company's income changes can be expressed : $S = qe^{-rt}\max(p-\mathrm{p}_0,0)$, where q is a specific constant.

(2) Because the effort of managers is unobservable, it can be just defined as a variable to be a, and the set of efforts is A, moral hazard behavior is m, the moral hazard behavior of m collection is M, then all the actions of the manager is a collection of P = (a, m) ε A × M. You can assume that the marginal disutility of efforts of the manager $c(a)$ is equivalent to the secondary side of the effort level, that is $c(a)=\frac{1}{2}b_1a^2$, b in the formula is on behalf of the cost coefficient of managers' effort, and can also supervise the cost coefficient of managers' effort, the greater effort disutility is as a result of the greater of a. Similarly, you can assume that the marginal disutility of managers' moral hazard behavior is equivalent to the secondary side of moral hazard behavior, specifically, b_2 is on behalf of the cost coefficient of managers' moral hazard behavior, that is violation cost coefficient.

(3) Suppose that the income of the managers is mainly resulted by a fixed salary and a certain number of stock options on behalf of the companies' performance, that is $s(\pi)=\alpha+\beta\pi$, which gives the manager a fixed wage α for the company and a sharing ratio b for sharing the company's operating results.

(4) Assuming that the company's income is π_0, when it comes to not consider the manager's moral hazard, and the income is π when it is on the other way around.

(5) It can be assumed that the income of the managers becomes k, when considering moral hazard behavior of them.

2.2. Data processing of model

(1) According to the model assumptions in 2.1, you can come to the company's earnings $\pi_0 = qe^{-rt}\max(a+\theta_1-\mathrm{p}_0,0)$, which is the mean θ_1 =0, the variance σ_1^2 of normally distributed random variables, including the current macroeconomic situation, the confidence of investors and other exogenous factors on the stock price.

(2) The income created by the manager's when it comes to moral hazard behavior is: $k = qe^{-rt}\max(m+\theta_2-\mathrm{p}_0,0)$, which has a zero mean and variance σ_2^2 for normal distribution, including the moral hazard behavior of the exogenous uncertainties which bring managers additional revenue.

(3) The real earnings of company results is significantly reduced because of the manager's moral hazard behavior, then the company's actual results will become: ……..: $\pi = qe^{-rt}\max((a+\theta_1)-(m+\theta_2),0)$, where θ_1 and θ_2 are independent with each other.

(4) The shareholders of the company are risk neutral, then the expected utility of them is equivalent to the expected return. The expected return of the shareholders of the company as follows:

$$E[\pi - s(\pi)] = -\alpha + (1-\beta)\pi$$
$$= -\alpha + (1-\beta)qe^{-rt}\max((a-m),0)$$

(5) According to the assumptions, we can draw the manager's actual revenue function:

$$w = s(\pi) + k - c(a) - c(m)$$
$$= \alpha + qe^{-rt}\max(\beta(a+\theta_1)$$
$$+(m+\theta_2)(1-\beta)-\mathrm{p}_0,0)-\frac{b_1}{2}a^2-\frac{b_2}{2}m^2$$

Mangers are risk averse, you can set the managers' utility function is: $u=-e^{-\rho w}$, where ρ indicates the absolute coefficient of risk aversion $Arrow-Pratt$, and $\rho>0$. On one hand, an important feature of this function is used to measure managers' risk aversion on conditions of uncertainty, and on the other hand, the expected revenue is equal to the certainty equivalent income, so the manager's certainty equivalent income is:

$$W = Ew - \frac{1}{2}\rho\times Var(qe^{-rt}\beta\theta_1)$$
$$-\frac{1}{2}\rho\times Var[qe^{-rt}(1+\beta)\theta_1]$$
$$= \alpha + qe^{-rt}\max(\beta a+(1-\beta)m-\mathrm{p}_0,0)$$
$$-\frac{b_1}{2}a^2-\frac{b_2}{2}m^2-\frac{1}{2}\rho q^2e^{-2rt}\beta^2\sigma_1^2$$
$$-\frac{1}{2}\rho q^2e^{-2rt}(1-\beta)^2\sigma_2^2$$

2.3. Modeling and solving

(1)The structure of the model:

Let $\overline{w}$ be the manager's reservation utility level, the manager is obviously not to accept the contract when the

certainty equivalent income is less than $\overline{w}$. Shareholders observe less than the manager's effort level a in the case of asymmetric information, and similarly do not know moral hazard behavior of the manager, so at the same time as the shareholders of the company in pursuit of maximizing the interests of the company, it is necessary to take into account the manager's participation constraint IR, but also take into account the incentive compatibility constraint IC, therefore, the basic structure of the model can be expressed as follows:

$$\max_{\alpha,\beta}\left[-\alpha+(1-\beta)qe^{-rt}\max((a-m),0)\right]$$

$$s.t.$$

$$\alpha+qe^{-rt}\max(\beta a+(1-\beta)m-\mathrm{p}_0,0)-\frac{b_1}{2}a^2$$
$$-\frac{b_2}{2}m^2-\frac{1}{2}\rho q^2e^{-2rt}\beta^2\sigma_1^2$$
$$-\frac{1}{2}\rho q^2e^{-2rt}(1-\beta)^2\sigma_2^2\geq\overline{w}$$
$$.....(IR)$$

$$\max_{a,m}\left[\begin{array}{l}\alpha+qe^{-rt}\max(\beta a+(1-\beta)m-\mathrm{p}_0,0)\\ -\frac{b_1}{2}a^2-\frac{b_2}{2}m^2-\frac{1}{2}\rho q^2e^{-2rt}\beta^2\sigma_1^2\\ -\frac{1}{2}\rho q^2e^{-2rt}(1-\beta)^2\sigma_2^2\end{array}\right]$$
$$.....(IC)$$
$$\forall(a,m)\in A$$

(2) Solution of the model conditions

Stock options in the company's equity incentive grant managers the right to sign a contract with an stated price to buy a certain number of ordinary shares when the company reached a contract with the manager, then the manager reserves the right to sell these stocks after a certain period to get the spread between the stock price and exercise price, but in that contract period, the option is not transferable, and cannot get the dividend. In this case, the handling of stock option income change in formula $qe^{-rt}\max(a-m,0)$ of the principal-agent model in (1), obviously cannot be considered with the condition $a-m<0$. Because on this condition, analysis of the limit of equity incentives to managers of the company makes no sense.

(3) The solution of the model

Considering that the stock price in the future will rise due to the management of the company executives, managers will strike the option to get benefits when it comes to the rising of the stock price, and at this time shareholders of the company can also obtain a certain amount of revenue.

Given that (α,β), the maximum certainty equivalent income of the company is W as the result of manager's incentive compatibility constraint. That is to maximize the personal interests of conditions IC, we can get:

First-order conditions:

$$\frac{\partial W}{\partial a}=qe^{-rt}\beta-b_1a=0$$
$$\frac{\partial W}{\partial m}=qe^{-rt}(1-\beta)-b_2m=0$$

Then:

$$a=\frac{qe^{-rt}}{b_1}\beta\qquad m=\frac{qe^{-rt}}{b_2}(1-\beta)$$

After putting the conditions a,m and IR in the formula to maximize the interests of the company, we have:

$$\max_{\beta}\left\{q^2e^{-2rt}\left[\begin{array}{l}\frac{1-b_1\rho^2\sigma_1^2}{2b_1}\beta^2\\ +\frac{1-b_2\rho^2\sigma_2^2}{2b_2}(1-\beta)^2\end{array}\right]-\overline{w}\right\}$$

First-order conditions:

$$\frac{1-b_1\rho^2\sigma_1^2}{b_1}+\frac{1-b_2\rho^2\sigma_2^2}{b_2}(1-\beta)(-1)=0$$

Then:

$$\beta^*=\frac{b_1(1-b_2\rho^2\sigma_2^2)}{b_2(1-b_1\rho^2\sigma_1^2)+b_1(1-b_2\rho^2\sigma_2^2)}$$

With the same conditions, we have:

$$a^*=\frac{qe^{-rt}(1-b_2\rho^2\sigma_2^2)}{b_2(1-b_1\rho^2\sigma_1^2)+b_1(1-b_2\rho^2\sigma_2^2)}$$

$$m^*=\frac{qe^{-rt}(1-b_1\rho^2\sigma_1^2)}{b_2(1-b_1\rho^2\sigma_1^2)+b_1(1-b_2\rho^2\sigma_2^2)}$$

β^* is the optimal incentive coefficient of shareholders of the company when considering the moral hazard behavior of managers.

2.4 .Parameter analysis

2.4.1. The analysis of managers' efforts:

If $a=\frac{qe^{-rt}}{b_1}\beta$, then:

(1) $\frac{\partial a}{\partial\beta}>0$, this shows that the greater the proportion of the number of stock options given to managers, the greater the risk assumed by the company managers, the managers will manage the companies harder.

(2) $\frac{\partial a}{\partial b_1}<0$, this shows that the greater the disutility of efforts by the company managers when managing companies, the more reluctant they pay effort to the

management of the company.

2.4.2. The analysis of managers' moral hazard behavior

If $m = \frac{qe^{-rt}}{b_2}(1-\beta)$, then:

(1) $\frac{\partial m}{\partial \beta} < 0$,This shows that the smaller the proportion of stock options given to the mangers by the shareholders of the company, the smaller the risk taken by the company managers, and managers are more likely to achieve additional revenue through moral hazard behavior.

(2) $\frac{\partial m}{\partial b_2} < 0$,This shows that the larger the cost of achieving additional revenue through moral hazard, the less possible for managers to get extra income with moral hazard.

2.4.3.The analysis of the share ratio held by the managers

If $\beta^* = \frac{b_1(1-b_2\rho^2\sigma_2^2)}{b_2(1-b_1\rho^2\sigma_1^2)+b_1(1-b_2\rho^2\sigma_2^2)}$,

that is $\beta^* = \frac{b_1}{b_1 + b_2\frac{(1-b_1\rho^2\sigma_1^2)}{(1-b_2\rho^2\sigma_2^2)}}$,

then:

(1) $\frac{\partial \beta^*}{\partial \sigma_1^2} > 0$, This shows that shareholders of the company should reduce the manager's risk exposure level and the number of stock options given to the company managers when there is lots of uncertainties outside which affects the company's revenue.

(2) $\frac{\partial \beta^*}{\partial \sigma_2^2} < 0$, This shows that the company earnings mainly depends on the management of executives' business levels, shareholders should increase the manager's risk exposure level and increase the number of stock options given to managers when managers are more inclined to achieve revenue through moral hazard behavior or the possibilities of managers' moral hazard behavior.

(3) $\frac{\partial \beta^*}{\partial b_1} > 0$, This shows that the incentive stock options is positively related to the cost coefficient of managers' efforts, the greater the effort cost of the manager, the more reluctant for them to increase the level of effort. If shareholders want to raise the manager's effort level, they must increase the number of stock options given to managers.

(4) $\frac{\partial \beta^*}{\partial b_2} < 0$, This shows that the incentive stock options is negatively related to the cost coefficient of managers' moral hazard behavior, the greater the cost coefficient of manager's moral hazard, the lower possibility for managers to gain revenue through moral hazard behavior, so shareholders should reduce the stock options ratio held by the manager.

3. Recommendations and research results

3.1. Research results

(1) The principal-agent theory, information economics and the basic principles of equity incentives on the company's managers are analyzed to establish a principal-agent model including the manager's own effort and moral hazard behavior. This model is applied to use the revenue functions of the company's shareholders and the company managers to analyze the relationship between the the number of equity incentive given to the company manager, the manager's effort level, the managers' moral hazard behavior and various external uncertainties.

(2)The equity incentive mechanism makes the manager' revenue not exactly same as the shareholders' interests. The company's stock price is not necessarily completely consistent with the company long-term value, and the correlation depends on the effectiveness of the market, especially in our current development of capital market imperfections. Equity incentive, the manager's income is related to the changes in the value of the equity, but the changes in equity value depends not only on the manager's own efforts, but also by the current macroeconomic situation, the company's industry development and other factors.

3.2. Recommendations

(1) From 2.3 in the model parameters analysis, it shows the greater proportion of the number of stock options given to the company manager, the greater the risk assumed by the company managers, and managers will work harder to manage the company. But the smaller proportion of the number of stock options given to the company manager by shareholders of the company, the smaller the risk assumed by the company managers, and managers are more likely to achieve additional revenue through moral hazard. So a comprehensive assessment of managers' operating potential effort level and moral risk factor is needed when shareholders choose the best executive of their company.

(2) From the 2.3 model parameter analysis, it shows that the larger the cost of moral hazard for the company managers to achieve additional revenue, the less likely for them to get that extra income. While the greater the disutility of managers' efforts to manage the company, the more reluctant for them to pay efforts to the management. After the company signed a contract with the manager, shareholders of the company should increase the supervision of the manager and the costs of manager's moral hazard. At the same time, increasing the company's back-up support for the manager and reducing the effort disutility for the manager to the greatest will minimize the agency costs of managers' decision because

of deviating from the maximization of shareholders' wealth.

(3) The purpose of hunting for executives for the listed companies is in order to maximize the shareholders' equity, and in order to let the managers run the company more efficiently, lower incentive costs, taking a certain amount of stock options is needed. The paper discusses in detail the number of equity incentive for managers to operate companies, the main factors of the manager's effort level and managers' moral hazard behavior, and reveals the intrinsic links between the various factors parameters. Therefore these factors should be focused and efficient and reasonable assessment of the main parameters (fixed wages and long-term interests of the company equity ratio) of the contract is needed, when shareholders of the company sign a contract with s manager.

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