

Study on Incentive Mechanism of Military Representative

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Abstract: With the development of economy and transformation of the new military revolution, the problem that the current military representative system that adapts the traditional planned economical system is lack of incentive and constraint to military representative is getting worse. In this paper, we make military and military representative as both principal and agent; analyze the problems of goal divergent and information asymmetry between the two sides. Put the observable variables into the product quality and production schedule. The former is output, may reflect the level of effort. The latter is decided by the external random variables, may be related to the quality of military products reflecting the level of effort. This method is closer with reality. Based on moral hazard model, we mainly research two observable variables, the quality of military product and the production schedule, to set up the model and analyze this model under two different situations that the level of effort could be observed and unobserved. Finally, we propose a new mechanism of incentive and constraint for military representative. The theoretical method mentioned by this paper for optimizing the principal-agent relationship of the ordinary production also has some inspiration.

Keywords: Military Representative System; Contract; Model of Moral Hazard; Military Representative

1. Introduction

Military products are the commodities for the military activities or the use of military. The development and production of them must be controlled strictly by the state and army. The purchase contract of military equipments signed with the factory must rely on the military representative system to guarantee performance. Military representative generally lives in the factory that has tasks to product military products. The main duties and tasks of military representative are to make the supervision and approval of the quality of military products [1]. With the development of economy and transformation of the new military revolution, the problem that the current military representative system that adapts the traditional planned economical system is lack of incentive and constraint to military representative is getting worse. The wage of military representative is fixed. There is no specialized incentive mechanism, which makes military representative with full enthusiasm to work. The factors of their work effort and ability level in the line of military production play an important role for quality of military products and production schedule, but all of these can't be observed directly by military. Effective constraints also can't act on military representative.

The papers for the incentive of military representative are few, and most are qualitative research, the quantitative analysis are one of the few. Jin Dalong [2] made a comprehensive introduction to the military representative

system, established the mathematical model between military and military representative for utility equilibrium. The system design is mainly refer to the contract management of USA. Shuang Haijun [3] made that the output of military representative is determined by their own efforts, technical ability and frequency of inspection, at the same time by an uncontrollable external factors, but he didn't specify that the output could be observed. Put the observable variables into the product quality and production schedule. The former is output, may reflect the level of effort. The latter is decided by the external random variables, may be related to the quality of military products reflecting the level of effort. This method is closer with reality. This method is more close to the present system, so the follow-up system design is more operational.

2. The Model Establishment

The pursuit of military is good quality of products, fast military production schedule from the factories, expect to maximize the military effectiveness for the military training and exercises. So military hopes military representative to work conscientiously to product supervision and inspection and accomplish each task with the greatest efforts. In accordance to the hypothesis of national people, the objective of people maximizes their own interests. Military representative can't be excluded, because they are also easy to lower their own efforts and

requirements. Therefore, the targets of military and military representative are not completely consistent.

Military products are different from ordinary commodities. Their production, purchasing, using, repairing, scrapping are closed-loop processing and the quality could be obtained through the next stage. Production schedule could be calculated directly. Here, military and military representative could directly observe the military quality and production schedule. Military could directly observe the efforts of military representative, but only through the quality of military products and production schedule. The price of military products constitutes cost and fixed profit. In this paper, the price could be regarded as a fixed value.

In this paper, we make military and military representative as both principal and agent. Military is unable observe the efforts of military representative, but could observe the results of the action. It is not only determined by the agent's activity, but also depends on some external random variables.

2.1. The Basic Assumption

Military: for the maximum benefit of the military products quality as the goal, could directly observe the quality of military products and production schedule, but could directly observe the level of effort, only make some incentive mechanism to affect the positive of military representative.

Military representative: for maximizing their own interests as the goal; knows their behavior consequences; knows the reservation utility of their own and knows what kind of effort level to maximize the utility.

Representation of symbol:

a : The level of effort of military representative. It could determine the result of action. So use *a* to represent a specific action. It is could not be observed by military. Suppose *a* is a one-dimensional variable.

q : The external random variable. For example, the natural factors of external environment, policy and so on, it is not controlled by the principal and agent. Support its mean value is 0 and variance is σ^2 , following standard normal distribution.

p : The quality of military product. It is determined by the level of effort *a* and the external random variable *q*.

That is $p(a, q)$, that could be observed by the both.

p is a strictly increasing function of *a*. It is a strictly increasing function of *q*. Suppose the function is linear.

$$p = a + q . E p = E(a + q) = a \quad \text{var}(p) = \sigma^2 .$$

z : The production schedule. Suppose *z* is unrelated to *a*. It could be related to *q*, and unrelated to *p* (for example, *q* is the raw materials and spare parts supply shortage, or the change of the military, so military production schedule might be affected). It could be observed

by the both. Suppose its mean value is 0, and variance is σ_z^2 , following standard normal distribution.

p : The price of military product. It is a constant.

c : The effort cost of military representative. It is related with *a*. The marginal cost of effort is increasing. That is $c = c(a)$. Suppose $c(a) = ba^2/2$ and *b* is the cost coefficient. *b* is larger, negative effect for military representative is bigger.

s : The incentive contract for military representative. It is based on the quality of military products and production schedule that both could be observed. It is a function of military representative action results *p* and *z*. That is $s(p, z)$. Suppose $s(p, z)$ is linear, $s(p, z) = \alpha + \beta(p + \gamma z)$ where α is a fixed income of military representative (unrelated to *p*). β is the share of results to military representative. That means, *p* + γz increase one, the share of military representatives' increase β . $\beta = 0$ means that military representative does not bear any risk. $\beta = 1$ means that the military representative bears all risk. γ shows the relationship between the agent's income and *z*. $\gamma = 0$ means *z* is unrelated to the income of military representative.

v : The utility of military. It is the benefit from the quality of military products, minus the payment to military representative and the price of military products ($p - s - p$). Suppose military is risk neutral, that means the expected utility is equal to the expected revenue of military $E v[p - s(p, z) - p] = E[p - s(p, z) - p]$.

u : The utility of military representative. Military representative performs the contract to obtain payment *s*, cost *c* to supervise military products. Support the utility function of military representative has the constant absolute risk aversion. $u = -e^{-\rho[s(p, z) - c(a)]}$, ρ is the degree of absolute risk aversion.

2.2. The Model Construction

The expected income function of military could be expressed as:

$$E v[p - s(p, z) - p] = E[p - \alpha - \beta(p + \gamma z) - p] = -\alpha + (1 - \beta)a - p \quad (1)$$

The expected income function of military representative could be expressed as:

$$E u = -E e^{-\rho[s(p, z) - c(a)]} = -E \left[s(p, z) - c(a) \right] - \frac{1}{2} \rho^2 \beta^2 [\sigma^2 + \gamma^2 \sigma_z^2 + 2\gamma \alpha(p, z)] \quad (2)$$

$$= -\alpha + \beta a - \frac{b}{2} a^2 - \frac{1}{2} \rho^2 \beta^2 [\sigma^2 + \gamma^2 \sigma_z^2 + 2\gamma \alpha(p, z)]$$

Among them, $E[s(p, z) - c(a)]$ is the expected income of military representative.

$\frac{1}{2}\rho\beta^2[\sigma^2 + \gamma^2\sigma_z^2 + 2\gamma\text{cov}(p, z)]$ is the risk cost of military representative. When $\beta = 0$, the risk cost is 0.

Let \bar{w} as the reserved income of military representative. So the participation constraint of military representative (IR):

$$\alpha + \beta a - \frac{b}{2}a^2 - \frac{1}{2}\rho\beta^2[\sigma^2 + \gamma^2\sigma_z^2 + 2\gamma\text{cov}(p, z)] \geq \bar{w} \quad (3)$$

The incentive compatibility constraint (IC):

$$a \in \arg \text{Max}_{\hat{a}} \left\{ -Ee^{-\rho[s(p,z) - c(\hat{a})]} \right\} \quad (4)$$

IC could be solved through “the first-order approach”.

Get $a = \beta/b$

Therefore, the standard model expressions are as the following:

$$\max_{\alpha, \beta, \gamma} E v = -\alpha + (1 - \beta)a - p$$

$$\begin{cases} IR: \alpha + \beta a - \frac{b}{2}a^2 - \frac{1}{2}\rho\beta^2[\sigma^2 + \gamma^2\sigma_z^2 + 2\gamma\text{cov}(p, z)] \geq \bar{w} \\ IC: a = \frac{\beta}{b} \end{cases} \quad (5)$$

3. The Model Analysis

The standard model has been constructed. The following two cases will be analyzed.

3.1. Information Symmetry

We consider the optimal contract that military could directly observe the military representative's level of effort. According to the standard model (5), the incentive compatibility constraint (4) doesn't work. Any level of effort could meet the compulsory contract, just to consider the participation constraint (3). Therefore, the problem is the choice of contract (α, β) and a to solve the following optimal problem:

$$\max_{\alpha, \beta, a} E v = -\alpha + (1 - \beta)a - p$$

$$IR: \alpha + \beta a - \frac{b}{2}a^2 - \frac{1}{2}\rho\beta^2[\sigma^2 + \gamma^2\sigma_z^2 + 2\gamma\text{cov}(p, z)] \geq \bar{w}$$

Because in the optimization, the equation of the participation constraint (3) is set up (the client need not pay more to the agent). Put (3) into the objective function. Get the first-order derivative of the effort level a .

$$a^* = \frac{1}{b}; \beta^* = 0$$

Let the results into (3).

$$\alpha^* = \bar{w} + \frac{1}{2b}$$

This is Pareto optimal contract. Military representative doesn't bear any risk ($\beta^* = 0$). How much military pay to military representative is just equal to the reserved wage plus the effort cost of military representative, because military could observe the military representative's level of effort. As long as military representative select $a < a^*$, military would pay less than α^* . If military representative expects to get α^* , the he must choose the level of effort $a = 1/b$.

3.2. Information Asymmetry

We consider the optimal contract that military could not directly observe the military representative's level of effort. According to the standard model (5), Put (3) and (4) into the objective function.

$$\max_{\beta, \gamma} \frac{\beta}{b} - \frac{1}{2}\rho\beta^2[\sigma^2 + \gamma^2\sigma_z^2 + 2\gamma\text{cov}(p, z)] - \frac{1}{2b}\beta^2\bar{w} - p$$

Get the first-order derivative of β, γ .

$$\beta = \frac{1}{1 + b\rho(\sigma^2 - \text{cov}^2(p, z)/\sigma_z^2)} \quad \gamma = -\frac{\text{cov}(p, z)}{\sigma_z^2}$$

Because $\sigma^2\sigma_z^2 \geq \text{cov}^2(p, z)$, $0 < \beta < 1$. That means military representative must bear some risk. β is a decreasing function of b, ρ, q or σ^2 . If military representative doesn't want to work hard or higher degree of risk aversion, or smaller fluctuations in external uncertain factors, the risk should be bearded smaller, namely, the share is smaller. For a given β , if ρ or σ^2 is larger, b will be smaller. Means for the unchanged share of military representative, the higher degree of risk aversion or larger fluctuation of external uncertain factors, military representative doesn't want to work hard.

If p isn't related with z , and p is a sufficient statistic, and z does not provide any information about a , $\gamma = 0$.

z is not written into the contract. Namely, the quality of military products is not related to the production schedule; the military representative's effort level doesn't affect the production schedule, so the production schedule need not reflected in the contract.

If p is related with z , $\text{cov}(p, z) \neq 0$.

$$\beta = \frac{1}{1 + b\rho(\sigma^2 - \text{cov}^2(p, z)/\sigma_z^2)} > \frac{1}{1 + b\rho\sigma^2}$$

From this formula, if the production schedule is written into the contract, the agent can improve the share. If the

quality of military products is related to production schedule, production schedule should be included in the incentive contract. In the quality of military products and production schedule unchanged, the share of military representative should be with the with the external environment changes. If p and z are positive, $cov(p, z) > 0, \gamma < 0$.

When $z > 0$, the quality of military products rise and the production schedule shorten. In a poor external environment, such as the shortage of raw material supply or the stress of international environment, it more reflects a higher level of effort. When $z < 0$, the quality of military products decline and the production schedule prolong. In a good external environment, it more reflects a lower level of effort. In the first case, the pay of military representative should be increased, and in the latter case, the pay should be reduced.

4. Mechanism Design

With the reality of our work of military representative, we propose a new incentive and constraint mechanism of military representative.

4.1. Establish a Clear Incentive Mechanism of Military Representative

In order to avoid the moral hazard of military representative, we should put the "economic man" motive of military representative into the incentive mechanism; convert the pursuit of individual utility maximization to the quality supervision of military products. When military representative supervises and inspects the quality of military products, the higher authorities could not suppress the benefits of military representative, but guide this pursuit into beneficial to system operation and military efficiency. We could try to establish approach formed fixed salary and bonus. The premise is a comprehensive assessment of military representative system. After full argument, it is necessary to design a set of standard system. For example, quality incentive standards and production schedule incentive standards. The precondition of quality incentive standards is that the higher authorities should analyze the usage of military products; establish relationship between the quality of military products and the incentive for military representative. Develop appropriate incentive standards according to the quality of military products. The precondition of production schedule incentive standards is that the higher authorities should master the external military factors that affect production sche-

dule; analyze the level of effort of military representative combined with the quality of military products. According to the level of efforts, we can determine the incentive proportion of production schedule.

4.2. Establish a Strict Constraint Mechanism of Military Representative

Getting the behavior information of military representative reducing the information asymmetry is the key to design the optimal constraint mechanism. We should gradually improve the use of products report system in the forces. For example, staffing, adding, fault and so on. The higher authorities could grasp duly the use of military products, and military representative could also be supervised by the forces. We should strengthen the constraint of economic interests; consider establishing a unified, transparent accounting standard in the army. We should standardize the various budget, regularly submit various information, including quality control, production schedule, payment, information feedback and so on. In addition, we should also strengthen the cooperation with the audit department. Our aim is to carry out the effective combinations of supervision units, internal management and external audit.

Conclusion

The incentive and constraint go hand in hand. This paper is based on the moral risk model. According to the present situation of military representative system, we analyze the moral hazard problem of military and military representative, and mainly study two observable variables, quality of military products and production schedule, to set up the model, and analyze this model under two different situations that the level of effort could be observed and unobserved. Finally, we propose a new incentive and constraint mechanism of military representative to provide some useful points for the reform and management of our military representative system.

References

- [1] Chen Dedi, Dictionary of national defense economy [M]. Beijing, Military Science Press, 2001, 348.
- [2] Jin Dalong, Research on the innovation of military representative system of our country, National University of Defense Technology, Changsha, Hunan, China, 2005, 19-20.
- [3] Shuang Haijun, A study on supervision and incentive mechanism in weapon equipment procurement, Chongqing University, Chongqing, China, 2010, 49-60.