Keio Business School

Incentive Provision and Risk Bearing: The Applicability of Contract Theory Reconsidered I

Questions

1. For the first-best contract described in Section 2, find the wage rates (the solution for Problem (2)) and state its feature in terms of risk bearing.
2. Does the pair of wage rates in the first-best contract (found in Question 1) satisfy all the constraints of the expected cost minimization problem (Problem (1)) for the second-best contract? Discuss the results in terms of incentive provision and risk bearing.
3. What conditions or environments in employment practices in Japanese companies do you think is diffcult to maintain in implementing the second-best contract described in Section 2. Consider those conditions and environments, referring to traditional employment practices and work styles in Japanese companies (performance evaluation, human resource development, external labor market, etc.).

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The aim of this case

Japanese companies once tried introducing performance-based reward system but could not make it work well, and many of those companies eventually abolished it. Someones pointed out that performance-based reward system was not compatible with employment practices and corporate culture of Japanese companies. Many Japanese companies are, however, currently faced with a management problem of combined use of job-based employment and membership-based employment. This case material gives a numerical example of a simple employment contract for clarifying the tradeoff between incentive provision by a firm and risk bearing by a worker in a situation where moral hazard occurs. The aim of this material is to illustrate a solid formulation based on the theory of contract in order to seek for precise conditions under which an incentive contract for employment works. The mathematical knowledge that the discussion in this case material requires of the readers is the derivative of the function $y = x^2$. The readers who can find the minimum value of a quadratic function may read through the text without knowing the derivative.

1 Preface to the Discussion

Moral hazard, along with adverse selection, is a concept that was proposed in the 1950s by actuaries, with whom joint research by economists led to the formulation of a clear mathematical form of expression; it attributes the cause of inefficiencies in transactions to **hidden actions**. While in the near future it may become technically possible for insurance companies to fully monitor the standard of precaution observed on the part of an insured person, this will nevertheless remain unfeasible in terms of the cost of implementation. As such, it is difficult to design insurance contracts that rely on the standard of precaution on the part of the insured.[1] In this case, when the insured party is also the beneficiary of the insurance claim, the insured party may be less cautious due to the alleviation of the risk burden as a result of the insurance contract, potentially inviting accidents that could have been avoided had there been no insurance. This reduction in the standard of precaution caused by the alleviation of the risk burden is known as **moral hazard**.

If a breach in the duty of caution corresponding to the moral hazard actually takes place and the standard of precaution cannot be fully monitored, such that the evidence necessary to prove the action in court will be insufficient, then insurers who have not provided contracts giving due consideration to carelessness on the part of the insured may incur unexpected losses due to claims

[1] For example, in the case of automobile insurance (a so-called "discretionary insurance," in which enrollment is not mandatory under the terms of the Act on Securing Compensation for Automobile Accidents), insurance premiums are often set higher for drivers in inverse proportion to how many years it has been since they obtained their driver's license. This is based on a recognition that drivers with less experience driving an automobile are more likely to cause accidents, and not because the drivers' standard of precaution is being directly monitored by the insurance company or a third party.

payments. This is why the design of contracts that include provisions for dealing with moral hazard has come to be an important object of consideration for insurance companies. In many contexts of a variety of transactions other than that of insurance contracts, we can observe phenomena similar to the inefficiency of transactions arising due to the “hidden actions” of the insured who cannot be fully monitored by insurers.[2]

In this case material, through numerical examples of a simple employment contract in situations where moral hazard occurs, we show the structure of the underlying tradeoff, commonly held by such phenomena, between incentive provision and risk bearing. In order to prioritize analytical simplicity, rather than a transaction mediated through the market, the consideration undertaken here is focused on a configuration that is likened to the contract entered into between a **principal** of a job and its **agent**. Typically, when analyzing a transaction by likening it to the contract entered into between a principal and its agent, the object of consideration thus formulated is called a **principal-agent problem** and the specific area of microeconomics that considers this type of problems is called **contract theory**.

The next section demonstrates how to derive **second-best contracts**. Consider a situation where an agent can obtain benefit by taking some action which cannot be observed by the principal. We consider the maximization of the expected profit that the principal can earn. This type of contracts are called the second-best contracts. The principal will sacrifice part of the benefit that he or she might have obtained in the case that there is no hidden action of the agents, in attempting to control the agent’s action. As opposed to those second-best contracts, the contracts that maximize the principal’s expected profits (or payoffs) in case of no hidden actions of agents are called **first-best contracts**

2 Situation for Consideration

A firm hires a worker. If the worker accepts this contract, then he or she decides to exert effort ($e = 1$) or not ($e = 0$). The worker is risk-averse, and thus his or her utility is represented by $\sqrt{w^2} - 6e$, given that a wage rate w^2 is paid to him or her and the cost of effort is measured as $6e$ on a monetary scale.[3]

When $e = 1$ is chosen, the firm obtains $x_h (> 0)$ (good result) as its revenue with probability 0.7 and nothing (bad result) with probability 0.3, whereas when $e = 0$ is chosen, the firm obtains nothing

[2] The 1970s, when the theoretical analysis of these phenomena in the field of microeconomics was coming into the mainstream, was coincidentally a period when the detailed examination of reasons why market institutions did not lead to efficient resource allocation was deemed necessary. The research results around that period became the basis for the design of contracts under situations in which moral hazard occur. The Nobel Prize in Economics 2016 was awarded to a founder of this theory, Bengt Holmström. During the initial stages of theorizing the design of second-best contracts for situations in which moral hazard arises, a significant contribution was made by Mirrlees (1975) after the formulation of the problem by Ross (1973).

[3] When a decision maker is risk-averse, his or her utility function $u(y)$ satisfies $u'(y) > 0$ and $u''(y)$, where y represents his or her income. The decision maker prefers smaller fluctuations in income. Note that $\sqrt{w^2} - 6e$ satisfies both conditions.

with probability 0.9 and x_h with probability 0.1. The firm cannot observe the effort level of the worker, but wishes to induce the worker to exert effort. Thus, this firm offers a contract that it pays w_H^2 if a good results occurs and w_L^2 otherwise. If the worker rejects this contract, then he or she obtains 9 and the firm's profit is zero. In order to minimize the expected payment, what value should this firm set the pair of w_H^2 and w_L^2 ? Note that the value of x_h is fixed, and thus this cost minimization problem implies the profit maximization problem.[4]

The (expected) cost minimization problem for the above situation is formulated as follows.

$$\begin{aligned} \min_{w_H, w_L} \quad & C = 0.7w_H^2 + 0.3w_L^2 \\ \text{s.t.} \quad & 0.7\sqrt{w_H^2} + 0.3\sqrt{w_L^2} - 6 \geq 9 \\ & 0.7\sqrt{w_H^2} + 0.3\sqrt{w_L^2} - 6 \geq 0.1\sqrt{w_H^2} + 0.9\sqrt{w_L^2}. \end{aligned} \tag{1}$$

The first constraint in Problem (1) guarantees that the worker will accept this employment contract, and it is called **participation constraint**. The second constraint is called **incentive compatibility constraint**, which requires the worker to voluntarily select $e = 1$ under this employment contract; namely, the expected utility with $e = 1$ is greater than the expected utility with $e = 0$, and thus workers should choose $e = 1$.[5]

In Problem (1), under these constraints, the pair of wage rates that minimizes the expected cost $C = 0.7w_H^2 + 0.3w_L^2$. These constraints are rearranged as $7w_H + 3w_L \geq 150$ and $w_H - w_L \geq 10$, respectively. If the equality holds for each constraint, then $w_H = 18$ and $w_L = 8$. This is the wage rates in the second-best contract. Why does the equality holds in each constraint?

The first-best contract is derived as the solution of the following cost minimization problem.

$$\begin{aligned} \min_{w_H, w_L} \quad & C = 0.7w_H^2 + 0.3w_L^2 \\ \text{s.t.} \quad & 0.7w_H + 0.3w_L - 6 \geq 9. \end{aligned} \tag{2}$$

In the first-best contract, by definition, there is no private information about the effort level of the worker. The firm can fully monitor the effort level of the worker without any cost. At this time, if it is possible to force the workers to the level of effort desired for the firm, the first-best contract can be obtained by minimizing the expected cost C of the firm only under the participation constraint.

In the first-best contract, if the constraint in Problem (2) holds with strict inequality, by reducing w_H or w_L within the range that satisfies $0.7w_H + 0.3w_L - 6 > 9$, the expected cost C can

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[4] When the effort level is a continuous variable, the incentive compatibility condition of problem (1) is replaced with the first-order condition that dfferentiates the expected utility of the worker by the effort level. This solution is called the **first order approach**, and Holmstr¨omom (1979) and Shavell (1979) began the rigorous analysis.

[5] This two-step method was first studied by Grossman and Hart (1983). Oliver Hart, along with Bengt Holmström, won the Nobel Prize in Economics 2016 for his contribution to contract theory. The content covered in this case material corresponds to the theory of complete contracts, but there is another field in contract theory, which is called the theory of incomplete contracts. The contributions of Hart were greatly acknowledged also in the theory of incomplete contracts, and the contents are discussed in other case materials, "Hold-Up Problem: Underinvestment in Parts Transactions (KBS Case 91-19-3216) and "Allocation of Control Rights: An Application to Corporate Finance (KBS case 91-19-3217).

be lowered. This means that the cost is not minimized, so that it cannot be the first-best contract. Therefore, in the first-best contract, the participation constraint in Problem (2) hold with equality. Substituting $0.7w_H + 0.3w_L - 6 = 9$ into C, we have

$$\min_{w_L} \quad C = 0.7\left(\frac{150 - 3w_L}{7}\right)^2 + 0.3w_L^2.$$

Problem (2) is simplified to the problem for finding the minimum value of the quadratic function. ($w_H \geq 0$ and $w_L \geq 0$ are implicitly imposed as constraint expressions.) The solution is $W_H = W_L = 15$, which means that the firm provides full insurance with the worker in terms of wage fluctuation.

References

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