信息经济学

第二讲 道德风险（上）

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一、不对称信息模型分类

- 生活中一些看似违背经济理论的行为，很可能是因为信息不对称，而不是非理性。比如价格战，本质上是一种不完全信息动态博弈。
- 我们将分析五种不对称信息博弈：
  - 道德风险（moral hazard）
  - 逆向选择（adverse selection）
  - 信息甄别（screening）
  - 信号发射（signalling）
  - 敲竹杠（holdup）

一、不对称信息模型分类

- 分析框架：委托人-代理人模型（**principal-agent model**）
- 定义（*尽管并不准确*）

The **principal** *(or* **uninformed player***) is the player who has the coarser information partition.*

The **agent** *(or* **informed player***) is the player who has the finer information partition.*

一、不对称信息模型分类

- 委托人-代理人举例

Table 1: Applications of the Principal-Agent Model

	Principal	Agent	Effort or type and signal
Moral hazard with hidden actions	Insurance company	Policyholder	Care to avoid theft
	Insurance company	Policyholder	Drinking and smoking
	Plantation owner	Sharecropper	Farming effort
	Bondholders	Stockholders	Riskiness of corporate projects
	Tenant	Landlord	Upkeep of the building
	Landlord	Tenant	Upkeep of the building
	Society	Criminal	Number of robberies
Moral hazard with hidden knowledge	Shareholders	Company president	Investment decision
	FDIC	Bank	Safety of loans
Adverse selection	Insurance company	Policyholder	Infection with HIV virus
	Employer	Worker	Skill
Signalling and screening	Employer	Worker	Skill and education
	Buyer	Seller	Durability and warranty
	Investor	Stock issuer	Stock value and percentage retained

二、生产博弈I

- 委托人——经理；代理人——工人

The Production Game

Players
The principal and the agent.

The order of play
1 The principal offers the agent a wage w.
2 The agent decides whether to accept or reject the contract.
3 If the agent accepts, he exerts effort e.
4 Output equals $q(e)$, where $q' > 0$.

Payoffs
If the agent rejects the contract, then $\pi_{agent} = \bar{U}$ and $\pi_{principal} = 0$.
If the agent accepts the contract, then $\pi_{agent} = U(e, w)$ and $\pi_{principal} = V(q - w)$.

二、生产博弈I

- 生产博弈I：对称信息，委托人为了代理人竞争。委托人的问题是，设计一个满足代理人参与约束的契约，以达到期望的努力水平和产出。

The agent must be paid some amount $\tilde{w}(e)$ to exert effort e, where $\tilde{w}(e)$ is defined to be the w that solves the participation constraint

$$U(e, w(e)) = \overline{U}. \tag{1}$$

Thus, the principal's problem is

$$\underset{e}{Maximize} \quad V(q(e) - \tilde{w}(e)) \tag{2}$$

二、生产博弈I

求解过程

The first-order condition for this problem is

$$V'(q(e) - \tilde{w}(e))\left(\frac{\partial q}{\partial e} - \frac{\partial \tilde{w}}{\partial e}\right) = 0, \tag{3}$$

which implies that

$$\frac{\partial q}{\partial e} = \frac{\partial \tilde{w}}{\partial e}. \tag{4}$$

From the implicit function theorem (see section 13.4) and the participation constraint,

$$\frac{\partial \tilde{w}}{\partial e} = -\left(\frac{\frac{\partial U}{\partial e}}{\frac{\partial U}{\partial \tilde{w}}}\right). \tag{5}$$

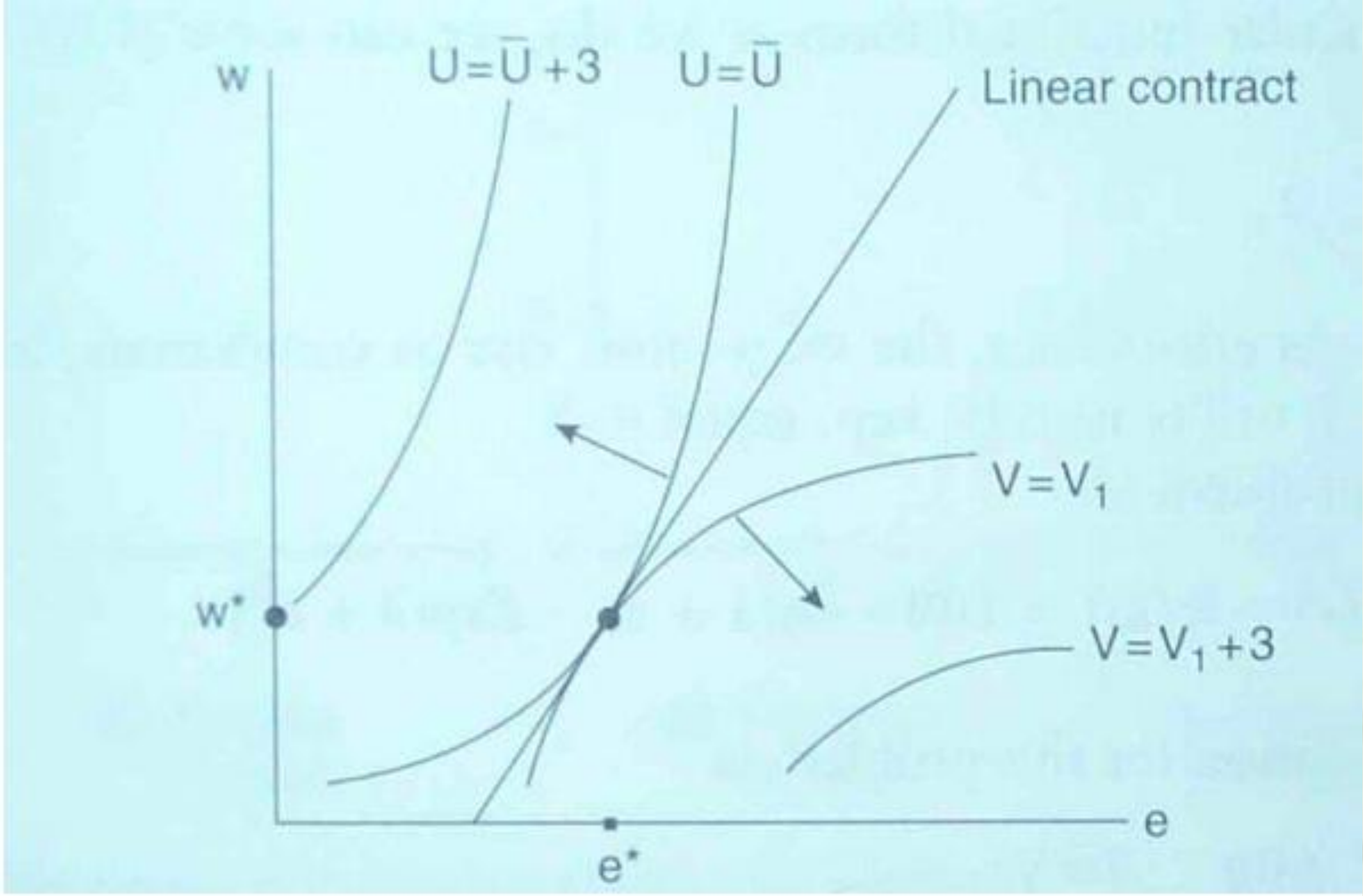
Combining equations (4) and (5) yields

$$\frac{\partial U}{\partial \tilde{w}}\frac{\partial q}{\partial e} = -\frac{\partial U}{\partial e}. \tag{6}$$

- 结果：代理人努力的**MR=MC**。

二、生产博弈I

- 图示



二、生产博弈I

■ 最优契约实现方式

1 The **forcing contract** sets $w(e^*) = w^*$ and $w(e \neq e^*) = 0$. This is certainly a strong incentive for the agent to choose exactly $e = e^*$.

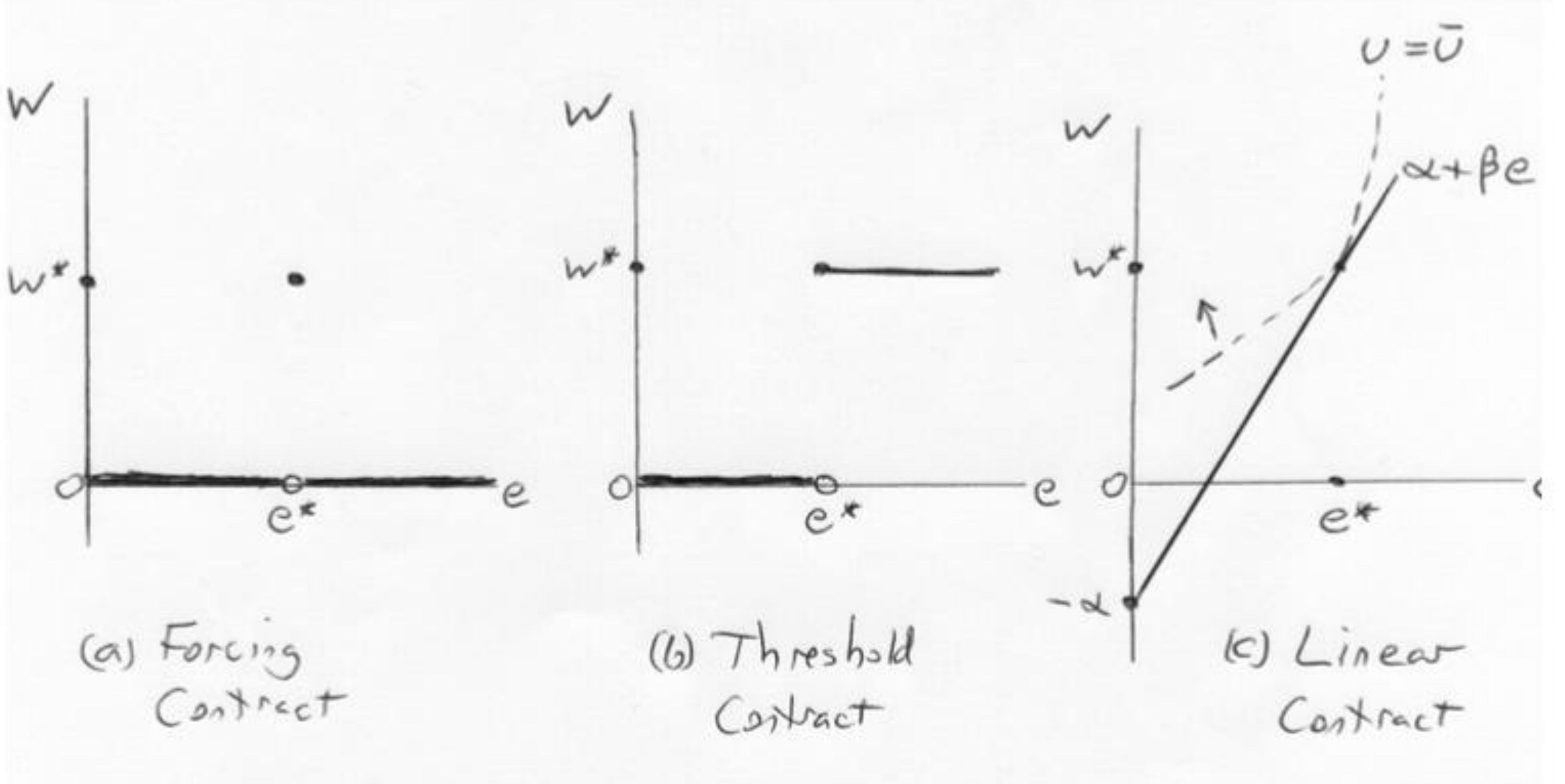
2 The **threshold contract** sets $w(e \geq e^*) = w^*$ and $w(e < e^*) = 0$. This can be viewed as a flat wage for low effort levels, equal to 0 in this contract, plus a bonus if effort reaches e^*. Since the agent dislikes effort, the agent will choose exactly $e = e^*$.

3 The **linear contract** shown in Figure 2 sets $w(e) = \alpha + \beta e$, where α and β are chosen so that $w^* = \alpha + \beta e^*$ and the contract line is tangent to the indifference curve $U = \bar{U}$ at e^*. The most northwesterly of the agent's indifference curves that touch this contract line touches it at e^*.

二、生产博弈I

- 图示

Figure 3: Three contracts that induce effort e^* for wage w^*



二、生产博弈I

- 数值例子

Let's now fit out Production Game I with specific functional forms. Suppose the agent exerts effort $e \in [0, \infty]$, and output equals $q(e) = 100 * log(1+e)$. If the agent rejects the contract, let $\pi_{agent} = \bar{U} = 3$ and $\pi_{principal} = 0$, whereas if the agent accepts the contract, let $\pi_{agent} = U(e, w) = log(w) - e^2$ and $\pi_{principal} = q(e) - w(e)$.

二、生产博弈I

■ 代理人的优化问题

The agent must be paid some amount $\tilde{w}(e)$ to exert effort e, where $\tilde{w}(e)$ is defined to solve the participation constraint,

$$U(e, w(e)) = \overline{U}, \quad so \;\; log(\tilde{w}(e)) - e^2 = 3. \tag{8}$$

Knowing the particular functional form as we do, we can solve (8) for the wage function:

$$\tilde{w}(e) = Exp(3 + e^2). \tag{9}$$

This makes sense. As effort rises, the wage must rise to compensate, and rise more than exponentially if utility is to be kept equal to 3.

二、生产博弈I

■ 委托人的优化问题

The principal's problem is

$$\underset{e}{Maximize} \quad V(q(e) - \tilde{w}(e)) = 100 * log(1+e) - Exp(3+e^2) \tag{10}$$

The first order condition for this problem is

$$V'(q(e) - \tilde{w}(e)) \left(\frac{\partial q}{\partial e} - \frac{\partial \tilde{w}}{\partial e} \right) = 0, \tag{11}$$

or, for our problem, since the firm is risk-neutral and $V' = 1$,

$$\frac{100}{1+e} - 2e(Exp(3+e^2)) = 0, \tag{12}$$

We can simplify the first order condition a little to get

$$(2e + 2e^2)Exp(3+e^2) = 100, \tag{13}$$

but this cannot be solved analytically. Using the computer program Mathematica, I found that $e^* \approx .77$, from which, using the formulas above, we get $q^* \approx 100 * log(1+.77) \approx 57.26$ and $w^* \approx 36.50$.

二、生产博弈I

■ 最优契约的三种形式

1 The **forcing contract** sets $w(e^*) = w^*$ and $w(e \neq .77) = 0$. Here, $w(.77) = 37$ (rounding up) and $w(e \neq e^*) = 0$.

2 The **threshold contract** sets $w(e \geq e^*) = w^*$ and $w(e < e^*) = 0$. Here, $w(e \geq .77) = 37$ and $w(e < .77) = 0$.

3 The **linear contract** sets $w(e) = \alpha + \beta e$, where α and β are chosen so that $w^* = \alpha + \beta e^*$ and the contract line is tangent to the indifference curve $U = \bar{U}$ at e^*. The slope of that indifference curve is the derivative of the $\tilde{w}(e)$ function, which is

$$\frac{\partial \tilde{w}(e)}{\partial e} = 2e * Exp(3 + e^2). \tag{14}$$

At $e^* = .77$, this takes the value 56. That is the β for the linear contract. The α must solve $w(e^*) = 37 = \alpha + 56(.77)$, so $\alpha = -7$.

二、生产博弈II

- 博弈时序

In this version, every move is common knowledge and the contract is a function $w(e)$. The order of play, however, is now as follows

The order of play

1 The agent offers the principal a contract $w(e)$.
2 The principal decides whether to accept or reject the contract.
3 If the principal accepts, the agent exerts effort e.
4 Output equals $q(e)$, where $q' > 0$.

- *与生产博弈I的差异在哪里呢？*

二、生产博弈II

- 分析思路

In this game, the agent has all the bargaining power, not the principal. The participation constraint is now that the principal must earn zero profits, so $q(e) - w(e) \geq 0$. The agent will maximize his own payoff by driving the principal to exactly zero profits, so $w(e) = q(e)$. Substituting $q(e)$ for $w(e)$ to account for the participation constraint, the maximization problem for the agent in proposing an effort level e at a wage $w(e)$ can therefore be written as

$$\underset{e}{Maximize} \quad U(e, q(e)) \tag{15}$$

二、生产博弈II

- 求解过程和结果

The first-order condition is

$$\frac{\partial U}{\partial e} + \left(\frac{\partial U}{\partial q}\right)\left(\frac{\partial q}{\partial e}\right) = 0. \tag{16}$$

Since $\frac{\partial U}{\partial q} = \frac{\partial U}{\partial w}$ when the wages equals output, equation (16) implies that

$$\frac{\partial U}{\partial w}\frac{\partial q}{\partial e} = -\frac{\partial U}{\partial e}. \tag{17}$$

Comparing this with equation (6), the equation when the principal had the bargaining power, it is clear that e^* is identical in Production Games I and II. It does not matter who has the bargaining power; the efficient effort level stays the same.

- 启示：哪一方拥有谈判能力与最优努力水平无关，这是科斯定理（**Coase，1960**）的体现，也意味着建模者可以自由假定谈判力的分布。

二、生产博弈III

- 确定性下的固定工资（**flat wage under certainty**）契约
- 委托人既不能观察到努力，也不能观察到产出，此时是不对称信息，或者努力和产出“**is not contractible (the court will not enforce a contract) or verifiable (the court cannot observe output)**”。
- 举例：保安工资、教师工资、公务员晋升
- 解决方案：固定工资
- 证明思路：排除法
- 启示：固定工资并不总是最差的，当然它是有代价的。

二、生产博弈IV

- 确定性下基于产出的工资
- 委托人不能观察到努力，但可以观察到产出，因此工资契约为**w(q)**。

Now the principal picks not a number w but a function $w(q)$. His problem is not quite so straightforward as in Production Game I, where he picked the function $w(e)$, but here, too, it is possible to achieve the efficient effort level e^* despite the unobservability of effort. The principal starts by finding the optimal effort level e^*, as in Production Game I. That effort yields the efficient output level $q^* = q(e^*)$. To give the agent the proper incentives, the contract must reward him when output is q^*. Again, a variety of contracts could be used. The forcing contract, for example, would be any wage function such that $U(e^*, w(q^*)) = \bar{U}$ and $U(e, w(q)) < \bar{U}$ for $e \neq e^*$.

- 例子：按件计酬
- 启示：不是所有信息不对称都有成本

二、生产博弈V

- 不确定性下基于产出的工资
- 委托人不能观察到努力，但可以观察到有噪音的产出，**q(e, *θ*)**。
- 博弈顺序：代理人行动后，自然再行动，然后产出实现。
- 如果代理人知道自然状态后再行动，就变成了隐藏知识的道德风险问题。
- 难题在于，委托人不能根据**q=q***推断**e=e***。
- 那么，委托人可以设定一个强制契约，使得**q≠q***时惩罚代理人吗？
- 由于**q(e)**不是一对一的映射，产出函数不再是可逆的。没有任何契约可以让风险规避的代理人实施最优（**first best**）努力水平**e***。

二、生产博弈V

A **first-best contract** *achieves the same allocation as the contract that is optimal when the principal and the agent have the same information set and all variables are contractible.*

A **second-best contract** *is Pareto optimal given information asymmetry and constraints on writing contracts.*

- 经济学中的“最优”多数时候其实是“次优”，或者是“最佳”（**optimal**）。
- 最优和次优的福利差异就是代理成本，或者说交易费用的一部分。
- 如何找到约束条件下的最优契约呢？

二、生产博弈V

- 最优契约三步法：目标函数+PC+IC

$$\underset{w(\cdot)}{Maximize} \quad EV(q(\tilde{e},\theta) - w(q(\tilde{e},\theta))) \tag{18}$$

subject to

$$\tilde{e} = \underset{e}{argmax} \quad EU(e, w(q(e,\theta))) \quad \text{(incentive compatibility constraint) (18a)}$$

$$EU(\tilde{e}, w(q(\tilde{e},\theta))) \geq \bar{U} \quad \text{(participation constraint) (18b)}$$

- 应用：观音菩萨如何确保唐僧师徒成功取经？
- 作业：使用数值模拟软件求解公式（13）。

谢谢

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