

Economics 101A

(Lecture 25)

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April 28, 2015

Outline

1. Asymmetric Information: Introduction
2. Hidden Action (Moral Hazard)
3. The Takeover Game

1 Asymmetric Information: Introduction

- Nicholson, Ch. 18, pp. 641-645
- Common economic relationship
- Contract between two parties:
 - Principal
 - Agent
- Two parties have asymmetric information
 - Principal offers a contract to the agent
 - Agent chooses an action
 - Action of agent (or his type) is not observed by principle

- Example 1: *Manager and worker*
 - Manager employs worker and offers wage
 - Worker exerts effort (not observed)
 - Manager pays worker as function of output
- Example 2: *Car Insurance*
 - Car insurance company offers insurance contract
 - Driver chooses quality of driving (not observed)
 - Insurance company pays for accidents
- Example 3: *Shareholders and CEO*
 - Shareholders choose compensation for CEO
 - CEO puts effort
 - CEO paid as function of stock price

- In all of these cases (and many more!), common structure
 - Principal would like to observe effort (of worker, of CEO, of driver)
 - Unfortunately, this is not observable
 - Only a related, noisy proxy is observable: output, accident, success
 - Contract offered by principal is function of this proxy
- This means that occasionally an agent that put a lot of effort but has bad luck is ‘punished’
- Also, agents that shirked may instead be compensated
- These principle-agent problems are called *hidden action* or *moral hazard*

- Second category (next lecture): *hidden type* or *adverse selection*
- Example 1: *Manager and worker*
 - Manager employs worker and offers wage
 - Worker can be hard-working or lazy
- Example 2: *Car Insurance*
 - Car insurance company offers insurance contract
 - Drivers ex ante can be careful or careless
- Example 3: *Shareholders and CEO*
 - Shareholders choose compensation for CEO
 - CEO is high-quality or thief

- Problem is similar (action is not observed), but with a twist
 - *Hidden action*: principal can convince agent to exert high effort with the appropriate incentives
 - *Hidden type*: agent's behavior is not affected by incentives, but by her type
- Different task for principal:
 - *Hidden action*: Principal wants to incentivize agent to work hard
 - *Hidden type*: Principal wants to make sure to recruit 'good' agent, not 'bad' one
- Two look similar, but analysis is different
- Start from *Hidden Action*

2 Hidden Action (Moral Hazard)

- Nicholson, Ch. 18, pp. 645-650
- Example 3: *Shareholders and CEO*
 - Division of ownership and control
- Shareholders (owners of firm):
 - Have capital, but do not have time to run company themselves
 - Want firm run so as to maximize profits
- CEO (manager)
 - Has time and managerial skill
 - Does not have capital to own the firm

- If CEO owns the company (private enterprises), problem is solved \rightarrow Infeasible in large companies
- Agent chooses effort e (unobserved)
 - Induces output $y = e + \varepsilon$, where ε is a noise term, with $E(\varepsilon) = 0$
 - Example: Despite putting effort, investment project did not succeed
- Principal pays a salary w to the agent
 - Salary is a function of output y : $w = w(y)$
 - Remember: Salary cannot be function of effort e

- Principal maximizes expected profits

$$E[\pi] = E[y - w(y)] = e - E[w(y)]$$

- Agent is risk averse and maximizes

$$E[U(w(e + \varepsilon))] - c(e)$$

– $c(e)$ is cost of effort: assume $c'(e) > 0$ and $c''(e) > 0$ for all e

– Utility function U satisfies $U' > 0$ and $U'' < 0$

– Notice: Agent is risk-averse, Principal is risk-neutral

- Assume $U(w) = -e^{-\gamma w}$ and $\varepsilon \sim N(0, \sigma^2)$

- Can solve explicitly for $EU(w)$:

$$EU(w) = -\frac{1}{\sqrt{2\pi\sigma^2}} \int e^{-\gamma w} e^{-\frac{1}{2} \frac{(w-\mu_w)^2}{\sigma_w^2}} dw = \mu_w - \frac{\gamma}{2} \sigma_w^2$$

[Take this for granted]

- Expected utility of agent is $EU(w) = \mu_w - \frac{\gamma}{2}\sigma_w^2$
- Note: μ_w is average salary and σ_w^2 is variance of salary
 - Agent likes high mean salary μ_w
 - Agent dislikes variance in salary σ_w^2
 - Dislike for variance increases in risk aversion γ
- Assume that contract is linear: $w = a + by = a + be + b\varepsilon$
 - Compute $\mu_w = E(w) = E[a + be + b\varepsilon] = a + be + bE[\varepsilon] = a + be$
 - Compute $\sigma_w^2 = Var[a + be + b\varepsilon] = b^2\sigma^2$
- Rewrite expected utility as

$$EU(w) = a + be - \frac{\gamma}{2}b^2\sigma^2$$

- Back to Principal-Agent problem
- Solve problem in three Steps, starting from last stage (backward induction)
 - **Step 1** (*Effort Decision*). Given contract $w(y)$, what effort e^* is agent going to put in?
 - **Step 2.** (*Individual Rationality*) Given contract $w(y)$ and anticipating to put in effort e^* , does agent accept the contract?
 - **Step 3.** (*Profit Maximization*) Anticipating that the effort of the agent e^* (and the acceptance of the contract) will depend on the contract, what contract $w(y)$ does principal choose to maximize profits?

- **Step 1.** Solve effort maximization of agent:

$$\text{Max}_e a + be - \frac{\gamma}{2} b^2 \sigma^2 - c(e)$$

- Solution:

$$c'(e) = b$$

- If assume $c(e) = ce^2/2 \rightarrow e^* = b/c$
- Check comparative statics
 - With respect to $b \rightarrow$ What happens with more pay-for-performance?
 - With respect to $c \rightarrow$ What happens with higher cost of effort?

- **Step 2.** Agent needs to be willing to work for principal

- *Individual rationality* condition:

$$EU(w(e^*)) - c(e^*) \geq 0$$

- Substitute in the solution for e^* and obtain

$$a + be^* - \frac{\gamma}{2}b^2\sigma^2 - c(e^*) \geq 0$$

- Will be satisfied with equality: $a^* = -be^* + \frac{\gamma}{2}b^2\sigma^2 + c(e^*)$

- **Step 3:** Owner maximizes expected profits

$$\max_{a,b} E[\pi] = e - E[w(y)] = e - a - be$$

- Substitute in the two constraints: $c'(e) = b$ (Step 1) and $a^* = -be^* + \frac{\gamma}{2}b^2\sigma^2 + c(e^*)$ (Step 2)

- Obtain

$$\begin{aligned} E[\pi] &= e - \left(-be + \frac{\gamma}{2}b^2\sigma^2 + c(e) \right) - c'(e)e \\ &= e + be - \frac{\gamma}{2}b^2\sigma^2 - c(e^*) - c'(e)e \\ &= e + c'(e)e - \frac{\gamma}{2}(c'(e))^2\sigma^2 - c(e^*) - c'(e)e \\ &= e - \frac{\gamma}{2}(c'(e))^2\sigma^2 - c(e^*) \end{aligned}$$

- Profit maximization yields f.o.c.

$$1 - \gamma c'(e)\sigma^2 c''(e) - c'(e) = 0$$

and hence

$$c'(e^*) = \frac{1}{1 + \gamma\sigma^2 c''(e^*)}$$

- Notice: This implies $c'(e^*) < 1$
- Substitute $c(e) = ce^2/2$ to get

$$e^* = \frac{1}{c} \frac{1}{1 + \gamma\sigma^2 c}$$

- Comparative Statics:
 - Higher risk aversion $\gamma \rightarrow \dots$
 - Higher variance of output $\sigma \rightarrow \dots$
 - Higher effort cost $c \rightarrow \dots$

- Also, remember $b^* = c'(e^*) = ce^*$ and hence

$$b^* = ce^* = c \frac{1}{c} \frac{1}{1 + \gamma\sigma^2 c} = \frac{1}{1 + \gamma\sigma^2 c}$$

- Notice $0 < b^* < 1$:
 - Agent gets paid increasing function of output to incentivize
 - Does not get paid one-on-one ($b = 1$) because that would pass on too much risk to agent
 - (Remember $w^* = a^* + b^*y = a^* + b^*e + b^*\varepsilon$)
 - Comparative Statics: what happens to b^* if $\gamma = 0$ or $\sigma = 0$? Interpret

- Consider solution when effort is observable
- This is so-called **first best** since it eliminates the uncertainty involved in connecting pay to performance (as opposed to effort)
 - Principal offers a flat wage $w = a$ as long as agent works e^*
 - Agent accepts job if

$$a - c(e^*) \geq 0$$

- Principal wants to pay minimal necessary and hence sets $a^* = c(e^*)$
- Substitute into profit of principal

$$\max_{a,b} E[\pi] = e - E[w(y)] = e - a^* = e - c(e)$$

- Solution for e^* : $c'(e^*) = 1$ or

$$e_{FB}^* = 1/c$$

- Compare e^* above and e_{FB}^* in first best
- \rightarrow With observable effort (first best) agent works harder

- Summary of hidden-action solution with risk-averse agent:

- **Risk-incentive trade-off:**
 - Agent needs to be incentivized ($b^* > 0$) or will not put in effort e
 - Cannot give too much incentive (b^* too high) because of risk-aversion
 - Trade-off solved if
 - * Action e observable OR
 - * No risk aversion ($\gamma = 0$) OR
 - * No noise in outcome ($\sigma^2 = 0$)
 - Otherwise, effort e^* in equilibrium is sub-optimal

- Same trade-off applies to other cases

- Example 2: *Insurance* (Not fully solved)
 - Two states of the world: Loss and No Loss
 - Probability of Loss is $\pi(e)$, with $\pi'(e) < 0$
 - * Example: Careful driving (Car Insurance)
 - * Example: Maintaining your house better (House insurance)
 - * Agent chooses quantity of insurance α purchased
 - Agent risk averse: $U(c)$ with $U' > 0$ and $U'' < 0$

- Qualitative solution:
 - No hidden action \rightarrow Full insurance: $\alpha^* = L$
 - Hidden action \rightarrow
 - * Trade-off risk-incentives \rightarrow Only Partial insurance $0 < \alpha^* < L$
 - * Need to make agent partially responsible for accident to incentivize
 - * Do not want to make too responsible because of risk-aversion

3 Takeover Game

- “The Takeover Game” (Samuelson and Bazerman, 1985)
- See hand-out