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Advanced Microeconomics

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Lecture 15: Incentive contracts with moral hazard and limited liability

Essential reading:

- McMillan, John. Games, Strategies and Managers. Oxford University Press. 1992, chapter 8.
- Patrick Bolton and Mathias Dewatripont. Contract Theory. MIT Press. 2005, chapter 4.

The role of contracts

- We now extend the analysis by allowing parties to conclude contracts
- such contracts govern a wide variety of relationships
  - contracts for firms and workers that specify wages and other aspects of the employment relationship
  - contracts of homeowners with building contractors
  - contracts of firms with suppliers and customers
  - contracts of nations about trade (WTO) and security (NATO) issues

The role of contracts

Definition: A **contract** is an agreement about behavior that is intended to be enforced.

- A contractual relationship consists of two phases:
  - Contracting phase, in which players set the terms of their contracts
    - Often this is simplified by assuming that one party can make a take-it-or-leave it offer
  - Implementation phase, in which contract is carried out and enforced

Moral hazard

- Frederick Taylor (1856-1915)
  - “Hardly a competent worker can be found who does not devote a considerable amount of time to studying just how slowly he can work and still convince his employer that he is going at a good pace.”

- moral hazard due to
  - Asymmetric information and
  - divergences in the objective functions of the actors

Moral hazard: some examples

- field sales employee
  - Employer wishes that field sales employee works hard
  - Employee wants to have more (and longer) breaks and monitoring is difficult
- Borrowed capital
  - If owners have limited liability in case of bankruptcy, a firm may invest in overly risky projects
  - the bank wishes a more conservative investment policy
- Car insurance
  - After purchasing a theft insurance, the owner is less careful
  - The insurance firm wants him to take more care
  - 30% of car accidents with fully comprehensive insurance end up in court due to alleged gross negligence of the insured

Trade-offs in incentive schemes

- Sometimes the principal can reduce trade-offs through the selection of a suitable agent
  - Family businesses
- if there are conflicts of objectives, often incentives schemes are used
  - In the standard principal-agent model, incentive schemes will be modelled as **monetary rewards**
  - e.g., parcel carriers are paid per parcel
- Lemieux et al. (2009) report for the fraction of labor contracts with incentive components by the end of the 1990s
  - In the US 30% for craftsmen, 78% for sales workers, average of 45% across all jobs
  - In Europe ranging from 10 to 15% in some Mediterranean countries to more than 30% for Nordic countries

Principal-Agent model

- **Principal-Agent model** with **moral hazard**
  - Principal-agent: one party – the principal – hires another party – the agent – to work on a project on her behalf
  - moral hazard: the agent's effort is not verifiable
    - hence parties can not write an externally enforced contract about this effort
    - standard assumption: only the outcome of the project is verifiable, which depends not only on effort but also on random events

Linear incentive contracts with risk neutral actors

- Model:
  - Risk neutral agent chooses effort $e \in [0,1]$
  - Effort costs: $0{,}5e^2$
  - alternative income (outside option): A
  - Efforts of the agent produce output $Q = e + u$
  - u is a random variable with expected value $E[u] = 0$
  - e and u cannot be observed by the principal, only Q
  - Stage 1: risk-neutral principal offers the agent a linear incentive contract with payment $p = s + rQ$
  - Stage 2: Agent decides on acceptance
  - Stage 3: Agent chooses effort; output and payments result
- Note: because contract is agreed to ex-ante, there is no strategic move after the agent has chosen his non-observable effort
  - Hence this is a simple dynamic game that can be solved by backwards induction for subgame perfect equilibrium

Linear incentive contracts with risk neutral actors

- Solving the game through backward induction
- agent's expected net return on effort *:*

- The agent's objective function is thus:

  - r represents strength of the incentive contract
    - $r = 0$: the agent makes no effort
    - $r = 1$: the agent bears full responsibility for his activity
- expected net income of the agent (as $e = r$):

Linear incentive contracts with risk neutral actors

- Solving the game through backward induction
- agent's expected net return on effort *:*

$$s + r \cdot \underbrace{E(Q|e)}_{e+E(u)=e} - 0{,}5e^2$$

- The agent's objective function is thus:

$$\max_e \; s + re - \frac{e^2}{2} \qquad \Rightarrow \;\; \text{FOC:} \;\; r - e = 0 \;\; \text{or} \;\; e = r$$

  - r represents strength of the incentive contract
    - $r = 0$: the agent makes no effort
    - $r = 1$: the agent bears full responsibility for his activity
- expected net income of the agent (as $e = r$): $\pi = s + 0.5r^2$

Linear incentive contracts with risk neutral actors

- participation constraint of the agent: $\pi = s + 0.5r^2 \geq A$
- principal maximises $\Pi =$
  - principal keeps s as small as possible. Why?
    - i.e. the participation condition binds:
- by substitution, the maximisation problem simplifies to

- In the optimal incentive contract, the agent thus receives the entire output

Linear incentive contracts with risk neutral actors

- participation constraint of the agent: $\pi = s + 0.5r^2 \geq A$
- principal maximises $\Pi = E(Q) - [s + rE(Q)]$:

$$\max_{r,s} \; r - (s + r^2) \qquad \text{s.t.} \quad s + 0.5r^2 \geq A$$

  - principal keeps s as small as possible. Why?
    - i.e. the participation condition binds: $s = A - 0.5r^2$
- by substitution, the maximisation problem simplifies to

$$\max_{r} \quad r - A - 0.5r^2$$
$$\Rightarrow \quad \text{FOC:} \quad r^* = 1, \qquad s^* = A - 0.5, \quad e^* = 1$$

- If $s^* < 0$ this is called „franchise contract“: agent pays a fixed fee and in return gets all of the realized benefits

Pareto-efficient solution

- Without the moral hazard problem, the principal can set the desired effort level e and wage w
- Profit maximisation of the principal:

- the participation condition binds. Why?

- That is, in this example, the solution is Pareto-efficient despite the moral hazard problem. Why?

Pareto-efficient solution

- Without the moral hazard problem, the principal can set the desired effort level e and wage w
- Profit maximisation of the principal:

$$\max_{e,w} \; e - w \qquad \text{s.t.} \quad \mathrm{w} - 0.5e^{\,2} \geq A$$

- the participation condition binds. Why?

$$w = A + 0.5e^2 \quad \Rightarrow \qquad \max_{e} \; e - A - 0.5e^2$$

$$\text{FOC:} \;\; e^* = 1, w^* = A + 0.5$$

- That is, in this example, the solution is Pareto-efficient despite the moral hazard problem. Why?

Pareto-efficient solution

- Note: Even in the situation without a moral hazard problem, the principal must give incentives to the agent:

  – The incentive structure is trivial: $w = \begin{cases} 0 & e < 1 \\ w^* & e \geq 1 \end{cases}$

Bonus contract versus linear incentive contracts

- Above we have considered a linear incentive contract with payment $p = s + rQ$
  - Fixed payment s plus bonus r per unit of output
- In practice, incentive contracts often provide that a bonus β is paid if a target Q^* is met, yielding wage payment

$$w = \begin{cases} \alpha & Q < Q^* \\ \alpha + \beta & Q \geq Q^* \end{cases}$$

- This bonus contract can be designed such that it is equivalent to linear incentive contract (i.e., provides same incentives)
  - Note: If the random variable u is equally distributed over the interval $[a, b]$, the bonus contract that is equivalent above linear incentive contract has

$$\alpha = s + (Q - b)r \quad \text{and} \quad \beta = (b - a)r$$

Non-monetary incentive schemes

- In the real world, often non-monetary incentives are used
  - Promotion (due to a good evaluation)
  - Layoff (due to a bad evaluation)
  - „Perks“, e.g. bigger office, business car etc. (due to a good evaluation)

- Also such non-monetary incentives can be evaluated monetarily
  - 2 examples on next slide

Non-monetary incentive schemes

- Tombola
  - In the 1940s a company reduced days of absence by conducting a daily tombola
  - Winners got goods that were difficult to obtain during the war
  - Workers had to be present
- Bonus points in a car company
  - One bonus point for each day being present
  - Points could be converted into prizes (e.g. plane tickets to a popular vacation destination)
  - Points were given not to the workers, but to their spouses
  - The involvement of spouses into the control of the workers turned out to be very effective
- Reference: R.G. Ehrenberg and Robert S. Smith, 1988, Modern Labor Economics, Scott Foresman and Company, Glenview Illinois, p.417

Moral hazard and Pareto efficiency

- The encouraging result that incentive contracts may solve the moral hazard problem and lead to efficient solution was based on some implicit assumptions
- One of them is that the agent has unlimited liability
  - Example 1: investment bankers often get high boni if their investments are profitable
    - but they are hold responsible for losses to a much smaller extent
    - Hence they have an incentive to take risks that are too high
  - General problem behind example: „gains are privatized, losses are socialized“
    - Reflects limited liability for losses

Linear incentive contracts with payment constrained agents

- Agents can often make no – or only limited – payments to the principal
  - e.g. because their assets are limited
- we therefore add a payment restriction to the model: $s \geq 0$
- Problem of the principal:

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- Problem of the principal:

$$\max_{r,s} e - (s + re) \qquad \text{s.t.}$$

$$e = \arg\max_{\tilde{e}} \; s + r\tilde{e} - \frac{\tilde{e}^2}{2} \qquad \text{(IC: incentive constraint)}$$

$$s + re - \frac{e^2}{2} \geq 0 \qquad \text{(PC: participation constraint)}$$

$$s \geq 0 \qquad \text{(LL: payment constraint)}$$

Linear incentive contracts with payment constrained actors

- Analysis of the incentive constraint:

$$\max_e \; s + re - \frac{e^2}{2} \qquad \Rightarrow \quad \text{FOC:}$$

- Substitution into the participation and payment constraint:

$$s + re - 0.5e^2 = \qquad (\text{PC})$$

$$s \geq 0 \qquad (\text{LL})$$

  - assuming PC binds. Then $s =$ $\Longrightarrow$ Violation of (LL)
    - $\Longrightarrow$ PC does not bind
    - $\Longrightarrow$ LL binds
      - otherwise the principal could reduce s and thus increase his profits

Linear incentive contracts with payment constrained actors

- Analysis of the incentive constraint:

$$\max_e \; s + re - \frac{e^2}{2} \qquad \Rightarrow \quad \text{FOC:} \quad r - e = 0 \quad \text{or} \quad e = r$$

- Substitution into the participation and payment constraint:

$$s + re - 0.5e^2 = s + 0.5r^2 \geq 0 \qquad \text{(PC)}$$

$$s \geq 0 \qquad \text{(LL)}$$

  - assuming PC binds. Then $s = -0.5r^2 < 0 \quad \Longrightarrow$ Violation of (LL)

    $\Longrightarrow$ PC does not bind

    $\Longrightarrow$ LL binds

      - otherwise the principal could reduce s and thus increase his profits

Linear incentive contracts with payment constrained actors

- from (IC) and (LL) it follows: $e = r$ and $s = 0$
- Substitution into problem of principal, $\max_{r,s,e} e - (s + re)$, results in

- the incentive parameter is thus only half as high as in the efficient solution without moral hazard ($r^* = 1$)

Linear incentive contracts with payment constrained actors

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- Substitution into problem of principal, $\max_{r,s,e} e - (s + re)$, results in

$$\max_r r - r^2 \qquad \text{BeO:} \quad 1 - 2r = 0 \qquad \Rightarrow \quad r^{**} = 0{,}5$$

- the incentive parameter is thus only half as high as in the solution without limited liability ($r^* = 1$)

Linear incentive contracts with payment constrained actors

- Intuition:
  - Without wealth constraint, the principal sets
    - $r = 1$ to set optimal effort incentives
    - appropriates the profits from the P-A relationship through a negative fixum s
  - With wealth constraint, this is no longer possible and the principal faces a trade-off:
    - Appropriation of profits requires reduction of r
    - However, this reduces the incentives of the agent
  - the principal balances these effects and sets $r = 0{,}5$
    - the agent therefore receives a rent
    - i.e. his participation condition does not bind

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$$s + re - 0.5e^2 = 0.5r^2 = 1/8 > 0$$

    - i.e. his participation condition does not bind

Linear incentive contracts with payment constrained actors

- Example: Waitresses at the Oktoberfest receive
  - no fixed salary
  - 9% of the revenue they collect
  - they are usually only employed during the Oktoberfest, which lasts 18 days
    - due to the short duration of the contract, a good incentive structure is particularly important
- Source: Ray Rees (Royal Economic Society Newsletter, Issue 142, 2008)