# Game Theory and Economics of Contracts
# Lecture 8
# Basics of Adverse Selection Model


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  2. Within the realm of contract theory, relevant situations include a seller who is better informed than a buyer about the cost of producing a specific good.
  3. An employee who alone knows the difficulty of completing a task for his employer.
  4. A divisional manager who can conceal information about his division's investment opportunities from headquarters.

# Adverse Selection: An Intuitive Interpretation

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- so, if she has the right to propose the contract between them, she will propose a contract that works to reduce this information rent.
- Indeed, how the contract proposer—the principal—designs contracts (mechanisms) to mitigate the informational disadvantage she faces.

# The Basics of Contractual Screening

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- The other kind of player without the private information as the **uninformed player**.

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- A contract can be seen as setting the rules of a secondary game to be played by the principal and the agent.

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- The absence of expertise, different experience or location, or other factors exclude the principal from this information (make it prohibitively expensive for her to acquire it). E.g. past jobs may tell a seller how efficient he is—and thus what his costs will be—while ignorance of these past jobs means the buyer has a less precise estimate of what his costs will be.

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- We assume that the reason for this information asymmetry is exogenous. In particular, the informed player is simply assumed to be endowed with his information for the purpose of the situation we wish to model.

# The Basics of Contractual Screening

- Given this information structure, the two parties interact according to some specified rules that constitute the extensive form of a game. In this two-person game, the players must contract with each other to achieve some desired outcome. In particular, there is no ability to rely on some exogenously fixed and anonymous market mechanism.

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- Our focus will be on instances of the game where the informed player can potentially benefit from his informational advantage.
- But, because the informed player does not have the first move—the uninformed player gets to propose the contract—this informational advantage is not absolute: Through her design of the contract (or mechanism), the uninformed player will seek to offset the informed player's inherent advantage.

# Standard 1 Principal-1 Agent Model with Adverse Selection

- The principal may choose some **allocation (assignment or decision)** $x \in X \subset \mathbb{R}$, along with a monetary transfer $t \in \mathbb{R}$, either from A to P or from P to A.

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- The agent acquires the allocation (or take the assignment) $x \in X$ and pays (or collects) a transfer $t \in \mathbb{R}$, his utility is given by

$$v(x, \theta) - t,$$

where $\theta \in \Theta \subset \mathbb{R}$ is the agent's "type".

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- We think of $\theta$ as a random variable, belonging to a distribution $F(\theta)$, whose realization is A's private (hidden) information, unobserved by P, or contractible, i.e., a contract cannot directly depend upon it. But a prior probability distribution over $\theta$ is common knowledge.

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- We assume that P has all the bargaining power in contracting; i.e., he makes a take-it-or-leave-it offer to A. A can accept or reject the contract. If A rejects, the outcome is $(x, t) = (0, 0)$. This is A's reservation bundle. A's reservation utility is therefore $v(0, \theta)$.

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- (IR) is the Agent's Individual Rationality or Participation Constraint.

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  Why?
- This is exactly the **total surplus-maximization problem**, hence the resulting consumption level is socially optimal (also called first-best). Intuitively, since the participation constraint binds regardless of the agent's type, the principal extracts all the surplus above the agent's reservation utility, and therefore has the incentive to maximize it.

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- This setting offers the simplest possible demonstration of the Coase Theorem, which says that private bargaining among parties in the absence of "transaction costs" results in socially efficient outcomes.
- One view of the theorem is as a definition of "transaction costs" as everything that could prevent the parties from achieving efficiency.
- We will see that private information will indeed constitute a "transaction cost," i.e., give rise to inefficiency.

# Additional Assumptions

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- The first-best consumption is strictly increasing in type:
  A2: $v(x,\theta)$ satisfies SCP (rigorously, strict ID) in $(x;\theta)$, that is, $v_x(x,\theta)$ exists and is strictly increasing in $\theta \in \Theta$ for all $x \in X$.
  Intuitively, $v(x,\theta)$ satisfies SCP when the marginal utility of consumption, $v_x$, is increasing in type $\theta$, i.e., higher types always have "steeper" indifference curves in the $x$ space. SCP also implies that large increases in $x$ are also more valuable for higher parameters $\theta$.

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- A3: $c(x)$ is differentiable in $x$.
- A4: $\forall \theta$, $x^*(\theta)$ is in the interior of $X$.

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- Assumptions A2 and A3 imply that the total surplus $v(x, \theta) - c(x)$ satisfies SCP.
- A4 allows us to use **Topkis-Edlin-Shannon Theorem** to conclude that the efficient consumption $x^*(\theta)$ is strictly increasing in $\theta$.
- **Topkis-Edlin-Shannon Theorem**
  Suppose $v(x, \theta)$ is continuously differentiable and satisfies SCP, Let $\theta'' > \theta', x' \in \arg\max_{x \in X} v(x, \theta')$ and $x'' \in \arg\max_{x \in X} v(x, \theta'')$. Then, $x'' \geq x'$. Moreover, if either $x''$ or $x'$ is in the interior of $X$, then $x'' > x'$.

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- A general contracting mechanism is a pair of functions: Assignment rule $\mathbf{x}(\cdot) : M \to X$ and Transfer rule $\mathbf{t}(\cdot) : M \to \mathbb{R}$ in which the agent is asked to report some message $m \in M$ to the principal and receives $\mathbf{x}(m)$ and $\mathbf{t}(m)$ according to the preoffered mechanism.

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- After learning his own type, the agent needs to pick a reporting strategy: $\mathbf{m} : \Theta \to M$.

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- The **optimal reporting strategy $\mathbf{m}^*$** of the agent under a given mechanism $\mathbf{x}(\cdot)$ and $\mathbf{t}(\cdot)$ should satisfy $\forall\theta$,

$$\begin{aligned} v(\mathbf{x}(\mathbf{m}^*(\theta)),\theta) - t(\mathbf{m}^*(\theta)) &\geq v(\mathbf{x}(\mathbf{m}(\theta)),\theta) - t(\mathbf{m}(\theta)), \forall \mathbf{m} \\ v(\mathbf{x}(\mathbf{m}^*(\theta)),\theta) - t(\mathbf{m}^*(\theta)) &\geq v(0,\theta) \end{aligned}$$

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  Any mechanism $\mathbf{x}(\cdot)$ and $\mathbf{t}(\cdot)$ can induce the optimal reporting of strategy of the agent is called **feasible mechanism**.
- The optimal general mechanism design problem **P1**

$$\begin{aligned} & \max_{\mathbf{x},\mathbf{t}} \max_{\mathbf{m}^*} \int_{\Theta} \mathbf{t}(\mathbf{m}^*(\theta)) - \mathbf{c}(\mathbf{x}(\mathbf{m}^*(\theta))dF(\theta) \\ & \text{s.t.} \forall\theta, v(\mathbf{x}(\mathbf{m}^*(\theta)),\theta) - t(\mathbf{m}^*(\theta)) \\ \geq \quad & v(\mathbf{x}(\mathbf{m}(\theta)),\theta) - t(\mathbf{m}(\theta)), \forall \mathbf{m}, \\ & v(\mathbf{x}(\mathbf{m}^*(\theta)),\theta) - t(\mathbf{m}^*(\theta)) \\ \geq \quad & v(0,\theta) \end{aligned}$$

  One additional constraint relative to FB: IC.

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3. The principal receives the message and implement the contracting mechanism.
   Sequential game – Game tree!

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- A direct mechanism $(\mathbf{x}, \mathbf{t})$ is **incentive compatible** if truth-telling is optimal for the agent,

$$v(\mathbf{x}(\theta), \theta) - \mathbf{t}(\theta) \geq v(\mathbf{x}(\theta'), \theta) - \mathbf{t}(\theta'), \forall \theta, \theta' \in \Theta.$$

  A direct mechanism $(\mathbf{x}, \mathbf{t})$ is **individual rational** if truth-telling is better than outside option for the agent,

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# Optimal Direct Mechanism Design

- The optimal direct mechanism design problem **P2**

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  For any feasible general mechanism, there exists an IC and IR (direct) mechanism yielding the same expected payoff for the principal. Thus, P2 is strategically equivalent to P1.

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  For any feasible general mechanism, there exists an IC and IR (direct) mechanism yielding the same expected payoff for the principal. Thus, P2 is strategically equivalent to P1.
- Restricting attention to IC (and IR) (direct) mechanisms out of general mechanism design will not lose any generality.