Asymmetric Information

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August 15, 2025

Motivation

Story 1

- You're about to buy a used car. The seller says, "It runs perfectly."
- But you don't know whether it's a good car or a lemon.
- The price seems average — but why would they sell a great car?
- **You hesitate, suspecting hidden flaws.**

Key idea: The seller knows the quality (good or bad); you don't. This is a case of **adverse selection**.

- Markets with hidden types may unravel, even if good-quality options exist.

Story 2

- Alex just bought full car insurance.
- A few days later, he starts checking his phone while driving.
- He also parks in riskier spots — after all, the insurer pays if something happens.
- **The insurer can't observe his driving behavior.**

Key idea: After the contract, Alex takes hidden actions that increase risk. This is a case of **moral hazard**.

- Common in insurance, labor, finance.
- Incentives must be aligned to limit bad behavior.

What Is Asymmetric Information?

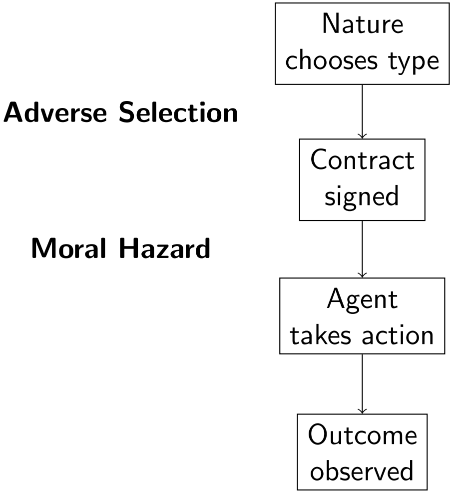
- A situation where one party knows something the other does not.
- Two key forms:
  - **Adverse selection:** Hidden *types* (before agreement)
  - **Moral hazard:** Hidden *actions* (after agreement)

Context	Hidden Type (Adverse Selection)	Hidden Action (Moral Hazard)
Insurance	Risk level of applicant	Behavior after insured
Employment	Skill level	Effort on the job
Loans	Creditworthiness	Repayment behavior

Strategic Behavior Under Asymmetric Info

- **Before contract**
  - ⋆ Agents try to appear better than they are
  - ⋆ Principals try to disclose the quality of the agents.
- **After contract**
  - ⋆ Agents may shirk, take risks, exploit terms
  - ⋆ Principals design incentives, monitor behavior

Timeline of Asymmetric Information



Examples from Everyday Life

Adverse Selection:

→ Buying a used car (Akerlof's "lemons" problem)

→ Health insurance applications

→ Online dating / college admissions

Moral Hazard:

→ Insured drivers becoming careless

→ Employees shirking after probation

→ Bank executives taking risky bets after bailout

Information and Equilibrium

- Asymmetric info changes player behavior and equilibrium outcomes

- Strategic use of:
  - **Signaling**: More informed players act to reveal or mislead
  - **Screening**: Less informed players induce revelation
  - **Incentives**: Contracts designed to align hidden action

- Words may be cheap (cheap talk); actions matter more

Where Are We Going?

Structure:

1. **Adverse Selection:**
   - Signaling (e.g., education in labor markets)
   - Screening (e.g., insurance contracts)
2. **Moral Hazard:**
   - Hidden effort, risk-taking
   - Compensation design and monitoring

Let's begin by looking at how private information before a contract affects behavior: Adverse Selection.

Adverse Selection

Introduction

- In many transactions, **one side knows more** than the other about a key characteristic.
- Examples:
  - A worker knows their true skill and attitude better than the employer.
  - An applicant knows their own health better than the insurer.
  - A seller knows if a used car is a lemon.
- If all types claim to be "high quality", **words become cheap**: everyone has an incentive to lie.
- This undermines trust and leads to inefficiency — good types may leave the market.

Adverse selection: Hidden types lead to market outcomes where low-quality participants dominate.

Insurance and Adverse Selection

- Suppose an insurer offers a policy costing 5 cents per \$1 of coverage.
- This attracts people whose expected costs exceed 5% — i.e., **high-risk individuals**.
- Lower-risk people may avoid the policy or drop out.
- The pool becomes increasingly composed of high-risk applicants.
- The insurer raises the premium $\rightarrow$ even more low-risk types leave.

Result: The insurer "selects" an increasingly bad group — an **adverse selection spiral**.

Key point: When risk is hidden, contracts attract the wrong people — this can unravel markets.

The Market for “Lemons”

Type	Seller Value	Buyer Value	Price if Known
Good (Orange)	\$12,500	\$16,000	\$16,000
Bad (Lemon)	\$3,000	\$6,000	\$6,000

- If buyers **can observe** quality $\rightarrow$ both types are traded.
- If buyers **can’t tell** $\rightarrow$ they offer an average price.
- **Result:** High-quality cars exit the market.
- The price reaches the buyer’s full willingness to pay because we assume a large number of buyers and limited supply of cars. In a more realistic setup, prices would likely reflect some form of bargaining power between buyers and sellers.

The Market for "Lemons"

- Sellers know their car is a lemon or an orange.
- Buyers cannot verify the type before purchase.
- All cars must sell at a single **Citrus price** p.
- Buyers form expectations based on population mix:

$$\text{Expected value} = 16{,}000 \cdot f + 6{,}000 \cdot (1 - f)$$

- Buyers purchase only if:

$$10{,}000 \cdot f + 6{,}000 > p$$

Key insight: If too many lemons, buyers' average willingness to pay falls → oranges may leave the market.

The Market for "Lemons"

- Sellers accept trade if:

$$\text{Citrus price } p > \text{ their own value}$$

- Lemon owner sells if $p > 3{,}000$, orange owner if $p > 12{,}500$
- Trade occurs only if:

$$16{,}000 \cdot f + 6{,}000 \cdot (1 - f) > 12{,}500 \Rightarrow f > 0.65$$

- **If fraction of oranges f is too low:**
  - Buyers won't pay enough for oranges to sell.
  - Market collapses to only lemons.

Result: "Bad drives out the good" — a market version of Gresham's Law

Can Signaling Prevent Market Collapse?

- Honest sellers want to **signal** that their car is good.
- But: signals like "verbal claims" or "check it if you want" are **cheap talk** — easily mimicked.
- Credible signaling requires:
  - Signals that are **costly for lemons** to imitate
  - E.g., warranties, third-party inspections, reputation
- In labor markets: **education** can signal skill — if it's hard for low-skill types to obtain.

Key idea: A signal must be *less costly for high types* than for low types to be credible (Spence, 1973).

Signaling

- Consider a case in which employers are trying to deduce the productivity of potential employees.
- Employers don't observe productivity before hiring.
- Workers know their own productivity type:
  - High-productivity (H)
  - Low-productivity (L)
- Education does not increase productivity — but it can signal it.
- Idea: **High types choose education** to distinguish themselves.

Key Assumption: Education is **less costly** for high-productivity workers than for low-productivity ones.

Two Key Constraints: IC and IR

When designing mechanisms (like pricing menus or contracts), the principal must respect two constraints:

- **Incentive Compatibility (IC):** Each agent prefers the contract designed for their type.

  Agent chooses the option meant for them.

- **Individual Rationality (IR):** Each agent is willing to participate.

  Agent gets at least as much as their outside option.

These ensure:

- Agents reveal their private information truthfully (IC).
- Agents prefer joining rather than walking away (IR).

Signaling with Education

Type	**Wage if Signaled**	**Wage if Not**	**Cost of Education**
High (H)	\$100,000	\$50,000	\$20,000
Low (L)	\$100,000	\$50,000	\$60,000

- High types: net benefit = \$30,000 $\rightarrow$ **choose education**
- Low benefit: net loss = -\$10,000 $\rightarrow$ **do not mimic**

Result: Only high-productivity workers get education $\rightarrow$ it's a credible signal.

Signaling

- A signal must be:
  - **More attractive for high types**
  - **Too costly for low types to mimic**
- Education works in this case because:
  - High types pay less (lower effort, time, or opportunity cost)
  - Low types don't benefit enough from the signal
- **Separating equilibrium:** Only high types signal, and employers trust the signal.

Signaling is effective when: It is *incentive-compatible* for types to self-sort.

Screening

- **Screening** is when the less informed party designs choices or tests to learn about the other's type.
- Common in:
  - Insurance: Deductibles screen for risk
  - Labor: Contract menus screen for productivity
  - Education: Entry exams screen for ability
- Key idea: Let agents **reveal themselves** by what they choose.

Screening in Insurance

Plan	Premium	Deductible
A (Safe plan)	\$1,200	\$250
B (Risky plan)	\$600	\$1,500

- High-risk individuals expect many claims → choose Plan A.
- Low-risk individuals prefer lower premiums → choose Plan B.

Result: Each type selects the plan best suited to them → the firm learns their risk indirectly.

Simple Example: Menu of Contracts

Firm offers two contracts:

- **Contract A:** Wage = \$50,000, Requires certification A.
- **Contract B:** Wage = \$80,000, Requires certification B.

Two types of workers:

- Type L (Low productivity): Cost of A = \$10,000, B = \$40,000
- Type H (High productivity): Cost of A = \$5,000, B = \$15,000

Check IC and IR:

- ✓ **IC-H:** Type H prefers B: \$80k - \$15k $\geq$ \$50k - \$5k $\rightarrow$ OK
- ✓ **IC-L:** Type L prefers A: \$50k - \$10k $\geq$ \$80k - \$40k $\rightarrow$ OK
- ✓ **IR:** Both types get positive utility $\rightarrow$ both participate

Conclusion: The menu is both IC and IR compliant $\rightarrow$ a valid screening mechanism.

Screening Example

Scenario:

- D-MOR is a monopolist that produces two PC types: Low-End and High-End.
- Two types of buyers:
  - Casual Users: value PCs less
  - Intensive Users: value PCs more
- Buyer types are **private information**; D-MOR only knows half are casual, half intensive.
- Objective: Choose whether to produce one or both types, and at what prices.

PC Type	Cost	Benefit (Casual)	Benefit (Intensive)
Low-End	1	4	6
High-End	3	5	9

Screening Example: Only Low-End PCs

- All buyers compare: benefit – price.
- Set price $p_L = 4$ so that both types get nonnegative payoff:
  - Casual: $4 - 4 = 0$
  - Intensive: $6 - 4 = 2$
- Both types buy $\rightarrow$ market fully covered.
- Cost $= 1 \rightarrow$ profit per unit $= 3$.

Total profit: $3 \times 100\% = 3$

Screening Example: Only High-End PCs

- Sell only to intensive users: set $p_H = 9$
- Net payoff:
  - Casual: $5 - 9 = -4 \rightarrow$ won't buy
  - Intensive: $9 - 9 = 0 \rightarrow$ indifferent $\rightarrow$ buys
- Cost $= 3 \rightarrow$ profit per intensive user $= 6$

Total profit: $6 \times 50\% = 3$

Case 4c: Screening with a Menu

Objective: Offer two PCs at prices p_L, p_H such that:

- Casual buys Low-End
- Intensive buys High-End

Constraints:

- **IC1 (Casual prefers Low-End):** $4 - p_L \geq 5 - p_H$
- **IC2 (Intensive prefers High-End):** $9 - p_H \geq 6 - p_L$
- **IR1 (Casual willing to buy):** $p_L \leq 4$
- **IR2 (Intensive willing to buy):** $p_H \leq 9$

Solution: Maximizing under constraints gives: $p_L = 4, \quad p_H = 7$

Which Strategy Is Best?

- Case 4a: All users buy Low-End $\rightarrow$ profit/user $= 3$
- Case 4b: Only intensive users buy High-End $\rightarrow$ profit/user $= 6 \times 50\% = 3$
- Case 4c: Self-selection
  - Casual buys at $p_L = 4$, cost $= 1 \rightarrow$ profit $= 3$
  - Intensive buys at $p_H = 7$, cost $= 3 \rightarrow$ profit $= 4$
  - Average profit: $(3 + 4)/2 = 3.5$

Conclusion: Case 4c is optimal.
Outcome: *Separating equilibrium via screening.*

Mechanism Design

- In the D-MOR exercise, the firm (D-MOR) doesn't know each consumer's type.
- It designs a menu of contracts (prices and products) to induce buyers to self-select.
- This is a classic example of a **mechanism design** problem.

Principal–Agent Framework:

- ⋆ **Principal:** the less-informed party (e.g., firm, government)
- ⋆ **Agent:** the better-informed party (e.g., consumer, worker)
- ⋆ Goal: Design an **incentive-compatible mechanism** that aligns the agent's behavior with the principal's objective.

Mechanism Design

Real-World Applications:

- **Taxation:** Incentivize truthful income reporting (Mirrlees, Nobel 1996)
- **Auctions:** Design rules to elicit honest bids (Vickrey, Myerson, Maskin)
- **Insurance:** Create menus that separate low/high risk clients
- **Labor contracts:** Design bonuses, hours, or promotions based on self-selection

Mechanism Design

Key Insight: When information is hidden, good outcomes depend on clever rules — not just good intentions.

Mechanism design is a unifying theory for pricing, contracts, auctions, and policy.

- You are not just solving math — you are designing institutions that work even when people act in their own interest.

Moral Hazard

Moral Hazard

- In many relationships, one party takes actions that the other cannot observe.
- Examples:
  - An employee's effort is not fully visible to the employer.
  - A driver's carefulness is not observable by the insurer.
- These situations are known as **moral hazard problems**.
- The principal (e.g., employer or insurer) must design a **contract or scheme** that aligns the agent's incentives with their own.

Moral hazard: Hidden actions after an agreement, where the agent chooses effort or behavior that affects outcomes but is not directly observable.

Designing Incentives Under Moral Hazard

- The principal must induce the agent to behave in a way that benefits both parties.
- Since actions are hidden, this is done by linking rewards to observable outcomes (e.g., bonuses after success).
- To ensure the contract works, two constraints must be satisfied:
  - **Incentive Compatibility (IC):** The agent prefers to take the desired action (e.g., exert effort).
  - **Individual Rationality (IR):** The agent prefers participating over their outside option.
- These tools will guide our analysis of moral hazard problems, including the supervision example.

Hidden Effort and Supervision

Scenario:

- A firm hires a manager to supervise a project.
- Good supervision increases success probability:
  with effort $\Rightarrow$ 50%, without effort $\Rightarrow$ 25%.
- The payoff of the project if succeed is \$1,000,000.
- Manager currently earns \$100,000 elsewhere (outside option).
- Extra effort costs manager \$50,000 (in time, stress, etc.).
- The manager's effort is **not observable**.

Key challenge: How do we design a contract (salary + bonus) so the manager chooses effort — even though we can't observe it?

If Effort Were Observable

Contract:

- $\star$ Base wage: \$100,000
- $\star$ Extra pay for effort: \$50,000

Firm's Profit with effort:

$$0.5 \times 1{,}000{,}000 - 150{,}000 = 350{,}000$$

Firm's Profit without effort:

$$0.25 \times 1{,}000{,}000 - 100{,}000 = 150{,}000$$

If Effort Were Observable

Constraint Check:

- ✓ **Individual Rationality (IR):** Manager's utility from accepting the contract:

$$100{,}000 + 50{,}000 - 50{,}000 = 100{,}000 \geq \text{outside option}$$

  So IR is satisfied (agent is indifferent and willing to accept).

- ✓ **Incentive Compatibility (IC):** Effort is observable $\rightarrow$ the principal can enforce it directly. No need to induce effort via payoffs $\rightarrow$ IC is trivially satisfied.

Conclusion: With observable effort, contracts are easy to write. When effort is hidden, the contract must be carefully designed to satisfy IC.

Optimal Contract When Effort Is Hidden

Contract: Pay manager only if project succeeds.
Let s be the base salary, and b the bonus if success.

IC constraint (effort preferred):

$$s + 0.5b - 0.05 \geq s + 0.25b \Rightarrow b \geq 0.2$$

IR constraint (participation):

$$s + 0.5b - 0.05 \geq 0.1 \quad \text{(outside option)}$$

Optimal solution:

$$b = 0.2, \quad s = 0.15 - 0.1 = 0.05$$

Interpretation: Manager is paid \$200,000 bonus if project succeeds, and \$50,000 as a base salary.

Insurance and Moral Hazard

Story: You own a \$100,000 necklace. To protect it, you:

- Store it in a bank when not in use
- Remain constantly vigilant when wearing it

Outcomes:

- Careful $\rightarrow$ 1% chance of loss (\$1,000 expected loss)
- Careless $\rightarrow$ 6% chance of loss (\$6,000 expected loss)
- Cost of being careful = \$500 (time, stress, inconvenience)

Key issue: Once insured, you have less incentive to be careful $\rightarrow$ **moral hazard**.

Moral Hazard Distorts Behavior

Without insurance:

- ✓ Carefulness is worth it: saves \$5,000 on expected losses at cost of \$500

With full insurance:

- × No incentive to be careful — you are fully covered
- × Expected claim rises to \$6,000

Problem: The insurer must charge at least \$6,000 $\rightarrow$ too expensive $\rightarrow$ no one buys it

Lesson: Full insurance removes incentives for good behavior, which backfires on everyone.

How to Fix It: Offer Partial Insurance

Mechanism: Share the loss with the insured to preserve incentives:

- **Deductible:** You pay first \$40,000 of loss
- **Co-insurance:** Insurer covers only 60% of loss

Outcome:

- ✓ You still have incentive to be careful (your expected loss = \$2,400 if careless)
- ✓ You're happy to pay \$900 for coverage worth \$2,400
- ✓ The insurer expects to pay only \$600 → everyone wins

Conclusion: Partial insurance solves moral hazard by making sure the agent still bears some risk.

A more complicated exercise

Context: You are hiring an advertising agency to promote a product.

- Outcome: \$600,000 profit if launch succeeds; \$0 if not.
- Agency chooses effort level $e \in \{0, 1, 2\}$:
  - Cost of effort $=$ \$50k $\times$ e^2
  - Success probability $= e/3$
- Outside option: \$30,000 and no effort.

Goal: Design a contract (fixed pay or bonus) to induce the desired effort.
Cases:

- Effort is observable
- Effort is hidden; must incentivize via outcome-contingent pay

Effort Is Observable

You can enforce effort level and make a take-it-or-leave-it offer.

Compare expected profits:

- $e = 0$: Success $= 0$
- $e = 1$: Success $= 1/3 \rightarrow$ Profit $=$ $200{,}000 - 80{,}000 = 120{,}000$
- $e = 2$: Success $= 2/3 \rightarrow$ Profit $=$ $400{,}000 - 230{,}000 = 170{,}000$

Conclusion: Choose $e = 2$ and offer payment of \$230,000. This gives maximum expected profit of \$170,000.
Note: With observability, IC is trivial — you can enforce effort.

Effort is hidden

Compensation scheme: Salary s + bonus b if success
Participation Constraint (PC):

- $e = 0$: $s \geq 30$
- $e = 1$: $s + \frac{1}{3}b - 50 \geq 30$
- $e = 2$: $s + \frac{2}{3}b - 200 \geq 30$

Incentive Compatibility Constraints (IC):

- To induce $e = 1$: $s + \frac{1}{3}b - 50 \geq s + \frac{2}{3}b - 200$ and $s + \frac{1}{3}b - 50 \geq s$
- To induce $e = 2$: $s + \frac{2}{3}b - 200 \geq s + \frac{1}{3}b - 50$ and $s + \frac{2}{3}b - 200 \geq s$

We will now compare feasible contracts.

Case 4c: Optimal Contract and Expected Profit

Best (s, b) to induce effort level:

- $\star$ $e = 0 \Rightarrow s = 30, b = 0 \Rightarrow \text{Profit} = -30{,}000$
- $\star$ $e = 1 \Rightarrow s = 30, b = 150 \Rightarrow \text{Profit} = 120{,}000$
- $\star$ $e = 2 \Rightarrow s = 0, b = 450 \Rightarrow \text{Profit} = 100{,}000$

Conclusion: Best to induce medium effort $e = 1 \rightarrow$ Optimal contract is $s = 30{,}000, b = 150{,}000$

Takeaway: Even though $e = 2$ gives higher success rate, it is too costly to incentivize under moral hazard.

What Have We Learned?

Asymmetric Information is Everywhere. Markets, jobs, insurance, and daily interactions involve hidden info.

We explored:

- ✓ **Adverse Selection:** Hidden types lead to bad market outcomes unless we use *signaling* or *screening*.
- ✓ **Moral Hazard:** Hidden actions require incentive-compatible contracts to align behavior.
- ✓ **Mechanism Design:** Smart rules or pricing menus can turn private incentives into socially efficient outcomes.

These tools help explain why markets work (or fail) — and how to design better ones.

Why This Matters for You

In your life and career, you will:

- ⋆ Hire or be hired — can you design a contract that motivates the right effort?
- ⋆ Buy insurance, choose healthcare, or shop online — how do you assess quality with limited info?
- ⋆ Start a business — how do you attract the right customers or partners?
- ⋆ Evaluate policies — how do you design rules that work when people respond strategically?

Big Idea: Understanding asymmetric information helps you reason more clearly in uncertain, strategic environments.
Markets and relationships depend not just on incentives, but on how well they handle what is hidden.