Introduction

Motivation and (lots of) Terminology
Review: Perfect Information

- The "perfectly competitive market" paradigm assumes perfect information.
- Examples:
  - **Topic 2**: productivity ("type") of a prospective employee:
    - workers are paid the value of their productivity: \( MP_l = w_l / p \)
  - **Topic 1b**: the accident probability (p) ("type") of a prospective insured:
    - actuarially fair insurance at rate \( \gamma = p \)
  - **Topic 2**: what a worker does ("action"):
    - workers own the firm; they maximize profits

Asymmetric Information

- Information is often asymmetrically distributed: one party knows more than the other.
- Examples:
  - a worker’s productivity may not be observable before hiring:
    - what happens to \( MP_l = w_l / p \) ?
  - prospective insureds may have different and unobservable accident probabilities:
    - what happens to actuarially fair insurance?
  - monitoring may not be feasible:
    - how are workers motivated to maximize profits?
The Bad News

- The bad news is that under asymmetric information, many of the “nice” results about competitive markets do not hold.
- Examples:
  - a market equilibrium may not exist
  - individuals may not be able to insure fully
  - risk sharing is not optimal

Information and Contracts

- Trading under asymmetric information is sometimes referred to as *contracting*.
  - Sometimes, writing a contract that specifies what happens for each observable outcome can mitigate the problems from asymmetric information.
    - Example (insurance): I could write insurance contracts such that individuals with different accident probabilities self-select into buying the appropriate contract.
    - Example (incentives): I could write a contract that specifies a wage depending on a worker’s observable output.
  - Information economics is therefore sometimes referred to as *contract theory*.
Principals and Agents: A Method

- In general, contracting is a complex bargaining problem.
  - Economics isn't very good at modeling bargaining.
- We therefore give one party all the bargaining power (she can make a “take-it-or-leave-it” contractual offer).
  - We refer to this individual as the principal.
- The other party can either accept or decline the contract.
  - We refer to this individual as the agent.

Adverse Selection, Moral Hazard

- Adverse Selection:
  - In adverse selection models, the informational asymmetry already exists before trading (before contracting).
    - Example (insurance): You have private information (about your accident probability) before I offer you insurance.
- Moral Hazard:
  - In moral hazard models, the informational asymmetry arises after trading (after contracting).
    - Example (incentives): You acquire private information (about your effort) after you are employed.
Hidden Information, Hidden Action

- **Hidden Information:**
  - In hidden information models, the informational asymmetry is about the informed party’s “type” (what she *is*).
    - Example (insurance): I don’t know what your accident probability is.
  - Example (insurance): I don’t know what your accident probability is.

- **Hidden Action:**
  - In hidden action models, the informational asymmetry is about the informed party’s action (what she *does*).
    - Example (incentives): I don’t know whether you work or shirk.

The Usual Suspects

- The usual combinations are:
  - adverse selection - hidden information
    - Example (insurance): I don’t know what your type (your accident probability) is, but you know. And you know before I insure you.
  - moral hazard - hidden action
    - Example (incentives): I don’t know whether you work or shirk (what your effort is), but you know. But you only acquire this information once you are employed (which is when you start working or shirking).
  - (We could have adverse selection - hidden action, or moral hazard - hidden information, or combine with both. But these are uncommon models.)
Adverse Selection, Signaling and Screening

Introduction to Adverse Selection, Unobservable Productivity, Signaling, Screening, Medical Insurance.

Adverse Selection: Definition

- **Definition**: Adverse selection is a situation in which a party’s decision to enter a contract depends on private information in a way that adversely affects her trading partner’s interests.
  - **Note**: pre-contractual private information.
  - **The nature of the information can be**:
    - hidden information (the usual model)
    - hidden action
    - both
Adverse Selection: Examples

- Workers have private knowledge about their productivity. More productive workers are more likely to reject a given offer in favor of working at home.
- The owner of a used car is more likely to sell if she is dissatisfied with her car’s performance (it is a “lemon”).
- Insureds have private information about their risk of accident or loss and are more likely to buy insurance if the risk is high.
- Individuals have private information about the value of their endowments. How do we tax endowments if we cannot observe them? ("optimal taxation")

Adverse Selection: The Problem

Two Examples
Akerlof (1970)
Adverse Selection I: An Example

Hidden Information (Productivity)
The Discrete Case

Perfect Information & Efficiency I

- There are two types of workers (of productivity, $\theta$):
  - high productivity ($\theta_2 = 2$) workers; reservation wage $r_2 = 1.6$,
  - low productivity ($\theta_1 = 1$) workers; reservation wage $r_1 = 0.8$.
- When the employer can observe $\theta$, she will offer wage $w_2 = 2$ to the high productivity workers and $w_1 = 1$ to the low productivity workers:
  - competition among employers drives the wage up to $\theta$.
- Employment:
  - a high productivity worker accepts employment if $w_2 > r_2$,
  - a low productivity worker accepts employment if $w_1 > r_1$;
  - accept if $2 > 1.6$ ($1 > 0.8$ for the low pr. worker) i.e. always.
- This is of course efficient.
Adverse Selection I

- Suppose employers cannot observe productivity.
- Employers know that a workers’ productivity is $\theta = 2$ with probability $1 - q = 0.5$ and $\theta = 1$ with probability $q = 0.5$.
- Productivity is unobservable at the point of contracting: every worker must be paid the same wage $w$:
  - That wage has to be equal to the average (or, expected) productivity.
    - Why the average productivity?
    - The firm maximizes expected profits, so if it pays the average productivity, it expects to pay, on average, the correct wage.

Adverse Selection I, cont’d

- If high & low productivity workers accept employment, average productivity is: $0.5 \times 2 + 0.5 \times 1 = 1.5$.
  - The wage has to be equal to the average (or, expected) productivity: $w = 1.5$.
  - But high productivity workers will not accept employment at this wage (accept if $1.5 > r_2$, i.e. if $1.5 > 1.6$, i.e. don’t accept).
- Therefore only low productivity workers accept employment, so average productivity is $1$.
  - The wage has to be equal to the average (or, expected) productivity: $w = 1$.
  - At this wage, low productivity workers will accept employment (accept if $1 > r_1$, i.e. if $1 > 0.9$).
- Presence of low productivity workers is an externality.
Adverse Selection II: An Example

Hidden Information (Productivity)
The Continuous Case

Perfect Information & Efficiency II

- A worker is characterized by her productivity, $\theta$ and by her reservation wage, $r$.
- Suppose higher productivity workers have higher reservation wages: $r(\theta) = \frac{2}{3} \theta$.
- When the employer (the “principal”) can observe $\theta$, she will offer wage $w(\theta) = \theta$:
  - competition among employers drives the wage up to $\theta$.
- The worker (the “agent”) accepts the offer if $w(\theta) > r$ and declines otherwise.
  - Accept if $w(\theta) > r$, that is, if $\theta > \frac{2}{3} \theta$, i.e. always.
- This is efficient because workers’ welfare is maximized; all firms earn zero profits.
Adverse Selection II

- Suppose employers cannot observe productivity.
- But employers know that workers’ productivities are distributed uniformly between 0 and 1.

Productivity is unobservable at the point of contracting: every worker must be paid the same wage $w$:
- that wage has to be equal to the average (or, expected) productivity:
  - the firm maximizes expected profits, so if it pays the average productivity, it expects to pay, on average, the correct wage;
- The workers who accept employment are those for whom $w > r$.
  - Accept if $w > r$, that is, if $w > 2/3 \theta$; i.e. if $\theta < 3/2 w$.
- If the workers who accept employment are those with productivity $< 3/2 w$, their average productivity is $3/4 w$.
  - Recall: $w$ has to equal the average productivity: $w = 3/4 w$. This of course is impossible.
Adverse Selection and Markets

- Under adverse selection, the “nice” (efficiency) properties of markets disappear:
  - In the discrete case (case I), no high productivity workers are employed.
  - In the continuous case (case II), there is no market equilibrium in this market.
- The nature of the inefficiency is an externality: the presence of low productivity workers. High productivity workers cannot credibly distinguish themselves.

Solutions?

- Are there any economic mechanisms that mitigate the problem?
  - Signaling
    - Spence M (1973) “Job Market Signaling” Quarterly Journal of Economics 87
  - Screening
Signaling

What is Signaling?
Example: Job Market Signaling
Spence (1973)

Signaling: The Basic Intuition

- The basic intuition:
  - Suppose there are agents of different types, and each agent has private information about her type. (So there is hidden information.)
  - There may be (costly and observable) actions that agents can take before contracting, so that each different type of agent finds it optimal to take a different action.
    - Actions have to be costly, or anyone could take them.
    - Taking an action that marks you out as a specific type of agent has to be too costly for other types: no mimicry.
  - By observing actions we can infer the agents’ type.
Signaling: Examples

Examples:

- Education as a signal of productivity:
  - High productivity workers find it less costly to acquire a certain level of education than low productivity workers.
  - High productivity workers acquire education, low productivity workers don’t.

- Advertising as a signal of quality:
  - High quality products generate repeat sales, low quality products don’t (so advertising has a higher payoff to a high-quality producer).
  - Firms that sell a high quality product spend more on advertising than producers of low quality products.

Separating and Pooling Equilibria

- An equilibrium with the property that each type finds it optimal to take a different action (thereby revealing their type) is a separating equilibrium.

- An equilibrium in which every type takes the same action (and there is therefore no revelation of types) is a pooling equilibrium.
Job Market Signaling

- Suppose there are two types of workers (of productivity, θ):
  - low productivity (θ₁ = 1),
  - high productivity (θ₂ = 2).
- Suppose employers cannot observe θ.
- Employers know that a workers’ productivity is θ₁ = 1 with probability q and θ₂ = 2 with probability (1-q).
- Workers can acquire a level of education, y, at a unit cost c₀ of:
  - 1 (for low productivity workers),
  - 0.5 (for high productivity workers).
- A worker’s utility is: w - c₀ y (where w is the wage).

Job Market Signaling, cont’d

- Is there a separating equilibrium?
- We want to know whether there is a level of education y* that “separates” high and low productivity workers:
  - We want high productivity workers to find it optimal to acquire that level of education and receive a wage w = 2 (the “correct” wage, i.e. w = MP), rather than to acquire a different level of education (y = 0), be thought to be a low quality worker and receive a wage w = 1. And:
    - We want low productivity workers to find it optimal not to acquire that level of education (and therefore acquire no education) and receive a wage w = 1, rather than to acquire y*, be thought to be a high quality worker and receive a wage w = 2.
Job Market Signaling, cont’d

- Suppose there is a level of education $y^*$ that separates high from low productivity workers.
- High productivity workers:
  - utility from acquiring $y = y^*$ and obtaining $w = 2$ is $2 - 0.5 y^*$
  - utility from not acquiring $y = y^*$ (and therefore acquiring $y = 0$) and obtaining $w = 1$ is $1 - 0 = 1$
  - we want $2 - 0.5 y^* > 1$; i.e. $y^* < 2$
- Low productivity workers:
  - utility from acquiring $y = 0$ and obtaining $w = 1$ is $1 - 0 = 1$
  - utility from acquiring $y^*$ and obtaining $w = 2$ is $2 - y^*$
  - we want $1 > 2 - y^*$; i.e. $y^* > 1$
- There is a separating equilibrium for $1 < y^* < 2$.  

![Job Market Signaling Diagram](image)
Separating Equilibria and Welfare

- In this model, education is unproductive (does not change a worker’s productivity). Apart from its signaling function, it is wasteful.
- Any education level $y^*$, such that $1 < y^* < 2$, separates workers: there are (infinitely) many separating equilibria.
- But these separating equilibria can be ranked in terms of welfare:
  - low productivity workers get 1,
  - high productivity workers get $2 - 0.5y^*$.

S. E. and Welfare, cont’d

- In order to differentiate themselves, the high productivity workers incur a socially wasteful expenditure.
- The separating equilibria are inefficient.
- Again, the presence of low productivity workers imposes an externality on the high productivity workers.
We have already seen some pooling equilibria:

If the required education level is outside the interval \((1, 2)\), the equilibrium will be a pooling equilibrium:

- either all workers acquire education \(y^*\),
- or all workers acquire no education;
- and in any pooling equilibrium, workers are paid the average productivity:
  \[ w = q \times 1 + (1 - q) \times 2 = 2 - q. \]

This is, of course, also inefficient: \(w \neq MP\).
Pooling & Separating Equilibria

- In a pooling equilibrium, high and low productivity workers earn a wage \( w = 2 - q \).
  - Remember: \( q \) is a probability, so \( q \) is between 0 and 1.
- In a separating equilibrium, the wage is:
  - 1 for low productivity workers,
  - \( 2 - 0.5 y^* \) for high productivity workers.
  - Remember: \( y^* \) is between 1 and 2 in a separating equilibrium.
- Low productivity workers are better off in a pooling equilibrium.
- High productivity workers are worse off in a pooling equilibrium if:
  - \( 2 - 0.5 y^* > 2 - q \). So: if \( q < 0.5 \), they are definitely worse off.

Screening

What is Screening?
Example: Private Medical Insurance
Rothschild and Stiglitz (1976)
Screening: The Basic Intuition

- The basic intuition:
  - Suppose there are agents of different types, and each agent has private information about her type. (So there is hidden information.)
  - A principal may be able to offer a menu of contracts (or trading opportunities) to the agents, so that each different type of agent finds it optimal to take a different contract (or trading opportunity).
  - By taking different contracts, the agents reveal their type.

Screening: Examples

- An insurer offers two medical insurance policies: policy A offers full cover at a high premium, policy B offers partial cover at a low premium. High-risk individuals will buy policy A, low-risk individuals will buy policy B.
- Electricity suppliers offer quantity discounts. High-elasticity buyers prefer to buy more than low-elasticity buyers (second-degree price discrimination).
- Airlines offer high-priced flexible (business class) tickets and low-priced (economy class) tickets with restrictions. Business travelers will buy business class tickets, leisure travelers will buy economy class tickets.
Review: Insurance (one type)

- Probability of loss: \( p \).
- Actuarially fair premium at rate \( \gamma = p \).
  - Slope of the "fair-odds line": \( -\frac{1-p}{p} \).
- At that rate, a risk-averse individual will want to insure fully.

Note: the insurer's profits are:
- zero - on the fair odds line
- positive - below the fair odds line
- negative - above the fair odds line

Two Types: The Setup

- There are two “types” of prospective insureds: they differ with respect to their probability of loss:
  - two types, H, L, with probabilities of loss, \( p^H, p^L \) (with \( p^H > p^L \)).
- The fraction of H types in the population is \( \lambda \), and the fraction of L types is \( (1 - \lambda) \).
- The insurance market is competitive:
  - free entry,
  - insurers make zero profit.
Two Types (\( p \) observable)

- Two types, H, L, with probabilities of loss, \( p^H \), \( p^L \) (with \( p^H > p^L \)).
- The insurer knows each insured's type:
  - Type L agents obtain actuarially fair insurance at rate \( \gamma = p^L \).
    - Slope: \( - (1-p^L) / p^L \).
  - Type H agents obtain actuarially fair insurance at rate \( \gamma = p^H \).
    - Slope: \( - (1-p^H) / p^H \).
- Both types want to insure fully at the rate based on their probability.

Two Types (\( p \) unobservable): I

- Is a pooling equilibrium possible?
  - Remember: in a pooling equilibrium there is no revelation of types: all types "do" the same thing (buy the same contract).
  - This would have to be an insurance contract based on the "average" or "pooled" fair odds line:
    - the average risk is \( \lambda p^H+(1-\lambda) p^L \).
- B upsets the proposed pooling equilibrium A.
- can A be an equilibrium?
Nonexistence of Pooling Equilibria

Any pooling equilibrium that could be an equilibrium (i.e. in which insurers make zero profits) can be upset in the following way:

Another insurer could offer an alternative contract that is preferred by the low risk types, and not preferred by the high risk types.

The original insurer is left with an “adverse selection” of high risk types; the entrant “cream skims” the low risk types, and makes nonnegative profits.
Two Types (p unobservable): II

Is a separating equilibrium possible?
- Remember: in a separating equilibrium different types voluntarily reveal their type (buy different contracts).

Claim: offering the two contracts C, D may be a separating equilibrium.

- H types find it optimal to buy C rather than D.
- L types find it optimal to buy D rather than C.

Nonexistence of Separating Eqm.
Nonexistence of S. E., cont'd

- A separating equilibrium may not exist, when the proportion of low risk individuals \((1-\lambda)\) is high:
- Another insurer could offer the pooling contract \((E)\) which is preferred by both types and, if bought by both types makes nonnegative profits.
- But: this pooling contract is not stable.

Competitive Insurance Markets

- Under asymmetric information, competitive insurance markets are inefficient:
  - A pooling equilibrium (in which everyone obtains insurance at the same rate) does not exist.
  - A separating equilibrium may not exist:
    - even if it does exist, some individuals (the low-risk individuals) will not insure fully: risk sharing is not optimal.
- Nature of the inefficiency: the presence of high-risk agents imposes an externality on low-risk agents (low risk agents cannot costlessly distinguish themselves).
Universal Healthcare: An Application

Why Provide Publicly Funded Healthcare?
Barr (1992)

Compulsory Pooling

- Competitive (private) medical insurance markets are inefficient (*market failure*):
  - either no equilibrium exists, or
  - some agents do not insure fully.
- Compulsory pooling may improve the outcome.
  - Everyone “buys” the same full insurance contract.
- This is just what a publicly funded healthcare system does: It is funded out of general taxation, and everyone obtains full insurance.
Second-Degree Price Discrimination: An Application

… when there is not enough information to (third-degree) price discriminate …

(Shy)

Review: Third-Degree Price Disc.

- When the monopolist can observe the price elasticity of demand for each customer, she will charge the low elasticity customers a high price, and the high elasticity customers a low price.
  - Example: private and business telephony; MC=0

![Graphs showing private and business demand curves with price (P) on the y-axis and quantity (Q) on the x-axis.](image-url)
Second-Degree Price Disc.

- **Proposition**: The above (right) nonlinear pricing schedule achieves the same market prices as those achieved by a (third-degree) price discriminating monopolist.

- **Pricing scheme**:
  - standard: pay \( p = 6 \) per call;
  - discount: pay \( p = 3 \) per call, but pay for at least nine calls.

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Second-Degree Price Disc., cont’d

- **Private users prefer to join the standard rate scheme**:
  - cons. surplus (standard rate): \( CS = (6 \times 3)/2 + 6 \times 3 - 6 \times 3 = 9 \)
  - discount rate: \( CS = (12 \times 6)/2 - 3 \times 6 - 3 \times 3 = 9 \)
    - (make 6 calls at \( p = 3 \) each; pay for 3 calls they never make)

- **Business users prefer the discount scheme**:
  - standard rate: \( CS = 0 \) (at price \( p = 6 \), demand is zero)
  - discount rate: \( CS = ((6-1.5) \times 9)/2 + 1.5 \times 9 - 3 \times 9 = 6.75 \)
Second-Degree Price Disc.

- When given this “nonlinear” pricing schedule (or “contract”), the agents reveal their type:
  - private users use the standard rate scheme,
  - business users use the discount rate scheme.
- This contract is an example of a “screening” contract.
- If there are more than two types, the pricing schedule may look even more “nonlinear”.

Moral Hazard

Monitoring and Incentives: How do I make you work?
Moral Hazard: Definition

- **Definition**: Moral hazard is a situation in which a party’s behavior under a contract is imperfectly monitored and may be chosen in a way contrary to her trading partner’s interests.
  - **Note**: post-contractual private information.
  - The nature of the information can be:
    - hidden action (the usual model)
    - hidden information
    - both

Moral Hazard: Examples

- The owner(s) of a firm want workers / management to put in (the right kind of) effort. Monitoring is either not possible or its level is not optimal (free-rider problem). Rewards are therefore based on observables (e.g. profit: managers are rewarded partly in share options).
  - We will talk about high and low effort, but this can easily be interpreted to mean: the right kind of effort.
- I want you to work hard, but cannot observe your effort. I can however observe output (workouts, exams), so I base reward (final grade) on output so as to give you the greatest incentive to work hard.
Moral Hazard: Examples, cont’d

Moral Hazard: Providing Incentives

Certainty,
Uncertainty (and Risk Neutrality),
Uncertainty (and Risk Aversion).
Incentives: The Basic Intuition

- Example: Incentives inside the firm. How does the owner (the principal) motivate the worker (the agent) to work hard?
- If the principal cannot observe effort, paying a constant wage provides no incentives: the agent will shirk.
- But the principal can observe output (or revenue), so if output (revenue) is related to effort, she can make the wage depend on what is observable.

Incentives: Basic Intuition, cont’d

- What could this incentive scheme (wage schedule) look like?
  - Pay a high wage when output (revenue) is high,
  - pay a low wage when output (revenue) is low.
- But: the agent is also an optimizer.
  - The principal needs to take into account that she cannot force the agent to do just anything: the agent has to do things voluntarily.
  - There are certain “constraints” on what the principal can make the agent do.
Incentives: Basic Intuition, cont’d

- The agent has to:
  - prefer working hard and obtaining the wage for the (probably high) output that she produces,
  - to shirking and obtaining the wage for the (probably low) output that she produces:
  - The wage scheme has to satisfy incentive compatibility (IC).

- The agent has to:
  - prefer working (hard) for the principal, to quitting:
  - The wage scheme has to satisfy individual rationality (IR) (or: the participation constraint).

Moral Hazard and Certainty

- Setup:
  - The agent’s effort is unobservable.
  - There is no uncertainty: when the agent works hard, output (revenue) is high (for certain), when she shirks, output is low (for certain).

- Agent:
  - e: effort level
    - low: e = 0
    - high: e = 2
  - w: wage
  - u: utility
    - u = (w - e) when she devotes effort e
    - u = 10 when she leaves ("reservation utility")
Moral Hazard and Certainty, cont'd

- Principal:
  - $r$: revenue: depends on effort, so we write $r(e)$
    - $r(2) = H$ (i.e. if the agent works hard: effort $e = 2$)
    - $r(0) = L$ (i.e. if the agent shirks: effort $e = 0$)
  - $\pi$: profit
    - $\pi = r(e) - w$, i.e.
      - $\pi = (H - w)$ if the worker works hard (effort $e = 2$)
      - $\pi = (L - w)$ if the worker shirks (effort $e = 0$)
  - Principal’s objective:
    - to motivate the agent to work hard, and
    - to maximize her own profits (that is, pay the lowest wage that motivates the agent to work hard).

What is the optimal incentive (wage) scheme?

- It has to satisfy the agent’s IR constraint:
  - $w^H - 2 \geq 10$
  - (the agent has to prefer to work hard, and therefore produce revenue $r = H$, to quitting).
- It has to satisfy the agent’s IC constraint:
  - $w^H - 2 \geq w^L - 0$
  - (the agent has to prefer to work hard, and therefore produce revenue $r = H$, to shirking, and therefore producing revenue $r = L$).
Moral Hazard and Certainty, cont’d

So:
- (IR): \( w^H - 2 \geq 10 \)
- (IC): \( w^H - 2 \geq w^L - 0 \)

In fact, both hold with equality:
- (IR): \( w^H - 2 = 10 \)
- (IC): \( w^H - 2 = w^L - 0 \)

From (IR) we have: \( w^H = 12 \).
Then, (IC) gives us: \( w^L = 10 \).

Moral Hazard and Certainty, cont’d

Under certainty, there is no problem:
- If the agent shirks, output is L: she gets \( w = 10 \).
  » This is just the same as her reservation utility, i.e. just enough to keep her in the firm (remember that when she shirks her effort \( e = 0 \)).
- If the agent works, output is H: she gets \( w = 12 \).
  » This is just enough to compensate her for her effort \( e = 2 \); so again the wage is just enough to keep her in the firm.

Is this surprising?
- No. Without uncertainty, the principal can infer precisely from output (revenue) what the effort was:
- This is as if effort were observable.
Moral Hazard and Uncertainty

Setup:
- The agent’s effort is unobservable.
- Uncertainty: when the agent works hard, output (revenue) is likely to be high, when she shirks, output is likely to be low.
- Principal and agent are risk neutral.

Agent:
- e: effort level
  - low: e = 0
  - high: e = 2
- Ew: expected wage
  - when the agent devotes effort e, the outcome is uncertain. If she is paid a wage that depend on the outcome, the wage is uncertain.

Moral Hazard & Uncertainty, cont’d

Principal:
- r: revenue: depends on effort, and chance:
  - r(2) = (the agent works: effort e = 2)
    - H with probability 0.8
    - L with probability 0.2
  - r(0) = (the worker shirks: effort e = 0)
    - H with probability 0.4
    - L with probability 0.6
- Eπ: expected profit
  - Eπ = Er(e) - w
- Principal’s objective:
  - to motivate the agent to work hard, and
  - to maximize her own profits (that is, pay the lowest wage that motivates the agent to work hard).
Moral Hazard & Uncertainty, cont’d

- Agent (cont’d):
  - Recall: the agent is risk-neutral, so expected utility is the same as expected value.
  - $v$: expected utility
    - $v = (Ew - e)$ when she devotes effort $e$,
    - $v = 10$ when she leaves (“reservation utility”),
  - that is:
    - $v = (0.8 \, w^H + 0.2 \, w^L - 2)$ when she devotes effort $e = 2$,
    - $v = (0.4 \, w^H + 0.6 \, w^L - 0)$ when she devotes effort $e = 0$.

Moral Hazard & Uncertainty, cont’d

- What is the optimal incentive (wage) scheme?
- It has to satisfy the agent’s IR constraint:
  - $0.8 \, w^H + 0.2 \, w^L - 2 \geq 10$
  - (the agent has to prefer to work hard, and therefore produce revenue $r = H$, to quitting).
- It has to satisfy the agent’s IC constraint:
  - $0.8 \, w^H + 0.2 \, w^L - 2 \geq 0.4 \, w^H + 0.6 \, w^L - 0$
  - (the agent has to prefer to work hard, and therefore produce revenue $r = H$, to shirking, and therefore producing revenue $r = L$).
Moral Hazard & Uncertainty, cont’d

So:
- (IR): \(0.8 \, w^H + 0.2 \, w^L - 2 \geq 10\)
- (IC): \(0.8 \, w^H + 0.2 \, w^L - 2 \geq 0.4 \, w^H + 0.6 \, w^L - 0\)

In fact, both hold with equality:
- (IR): \(0.8 \, w^H + 0.2 \, w^L - 2 = 10\)
- (IC): \(0.8 \, w^H + 0.2 \, w^L - 2 = 0.4 \, w^H + 0.6 \, w^L - 0\)

From (IR) we have:
- \(0.8 \, w^H + 0.2 \, w^L = 12\), or \(w^L = 60 - 4 \, w^H\)

From (IC) we have:
- \(0.4 \, w^H - 0.4 \, w^L = 2\), or \(w^L = w^H - 5\)

That is:
- \(60 - 4 \, w^H = w^H - 5\), or: \(5 \, w^H = 65\), or: \(w^H = 13\)

And consequently:
- \(w^L = 13 - 5\), or: \(w^L = 8\)

That is, if the outcome is good, the agent is rewarded; if it is bad, she is punished.
Moral Hazard and Incentives

- If a principal (owner of the firm, professor) wants to give her agent (worker, student) incentives to work hard, she should reward them according to what is observable:
  - If the output is low, the agent should be punished; if the output is high, the agent should be rewarded.
- In general, paying a wage that is not constant (i.e. high when output is high, low when output is low) puts risk on the agent:
  - When the agent is risk averse, risk sharing in an incentive contract such as the one above is not optimal.
- But: paying a constant wage gives no incentives.

Moral Hazard & Incentives, cont’d

- The basic trade-off in moral hazard models:
  - incentives v risk sharing.
- Example:
  - Piece rates are not optimal, because they place too much risk on the agent.
  - But they give the agent the incentive to work hard.
- We can be more methodical about what the optimal wage scheme looks like when the agent is risk averse. First, review graphically what we have just done:
Moral Hazard & Uncertainty again

- Risk neutral agent (linear utility function).
- Individual Rationality: expected utility has to be (greater than or) equal to the outside utility (10).
- Incentive Compatibility: expected utility from high effort ($e=2$) has to be (greater than or) equal to the expected utility from low effort ($e=0$).

What about the trade-off between incentives and risk sharing?
The question does not arise: risk neutrality.

Moral Hazard & Risk Aversion

- Risk averse agent: IC and IR violated
Moral Hazard & Risk Aversion, ct’d

- Risk averse agent: optimal incentive scheme
  - IC and IR hold (with equality)

    ![Graph showing utility vs. wealth with two utility functions, one for different levels of risk aversion.

Incentives v Risk Sharing

- The optimal incentive scheme rewards for high output and punishes for low output:
  - The agent faces risk.
  - We normally assume that the principal is risk neutral.
    (She can diversify risk.)
- Risk sharing is not optimal.
- (Optimal risk sharing: the risk neutral person should face all the risk.)

This is the basic inefficiency in moral hazard models: inefficient risk sharing.
Sadly ...

THE END