CHAPTERS 14-15

Moral Hazard and Adverse Selection

Definition of Moral Hazard

- Moral hazard (principal-agent) problems arise whenever there is a *separation of ownership and control*.
  - The principal delegates decision-making authority to the agent
- Moral hazard refers to the *risk* that the agent will not act in the best interests of the principal.
- Moral hazard exists because it is not possible for the principal to monitor all actions taken by the agent.

Examples of principal-agent relationships

- In corporate governance, the owner-manager relationship.
- In corporate finance, the creditor-owner relationship.
- In insurance, the insurer-policyholder relationship.
- In civil litigation, the client-lawyer relationship.
- In a broader "stakeholder" context, the society-firm relationship.

Principal-Agent Problems and Moral Hazard

- General solution to principal-agent problems
  - Design contracts so that they are incentive compatible.
  - Incentive compatible contracts scale agent compensation to the benefit received by the principal; examples include:
    - Managerial compensation typically includes bonuses related to profit or share price (in addition to salary).
    - Policyholders are not offered full (complete) insurance coverage; consequently, they are exposed to a partial loss and this reinforces incentives to prevent/mitigate loss.
    - Lawyers often receive contingent fees related to size of award.

Insurance and Moral Hazard

In the *absence* of insurance, expected wealth ($E(W)$) is written as

$$E(W) = W_0 - c(s) - p(s)L. \qquad (1)$$

Next, we maximize $E(W)$ by differentiating (1) with respect to s and solving for the value of s^* that causes the resulting equation to be equal to zero:

$$\frac{dE(W)}{ds} = -c'(s^*) - p'(s^*)L = 0. \qquad (2)$$

Rearranging (2), we obtain a very familiar result; the optimal level of safety occurs when the marginal cost of safety ($c'(s^*)$) is equal to the marginal benefit of safety ($-p'(s^*)L$); i.e.,

$$\underbrace{c'(s^*)}_{\text{Marginal Cost}} = \underbrace{-p'(s^*)L}_{\text{Marginal Benefit}}. \qquad (3)$$

Insurance and Moral Hazard

Next, we introduce insurance in which the insurer covers the proportion α of the risk for a premium of $\$\alpha P$. Thus expected wealth is

$$E(W) = W_0 - c(s) - (1-\alpha)p(s)L - \alpha P, \tag{4}$$

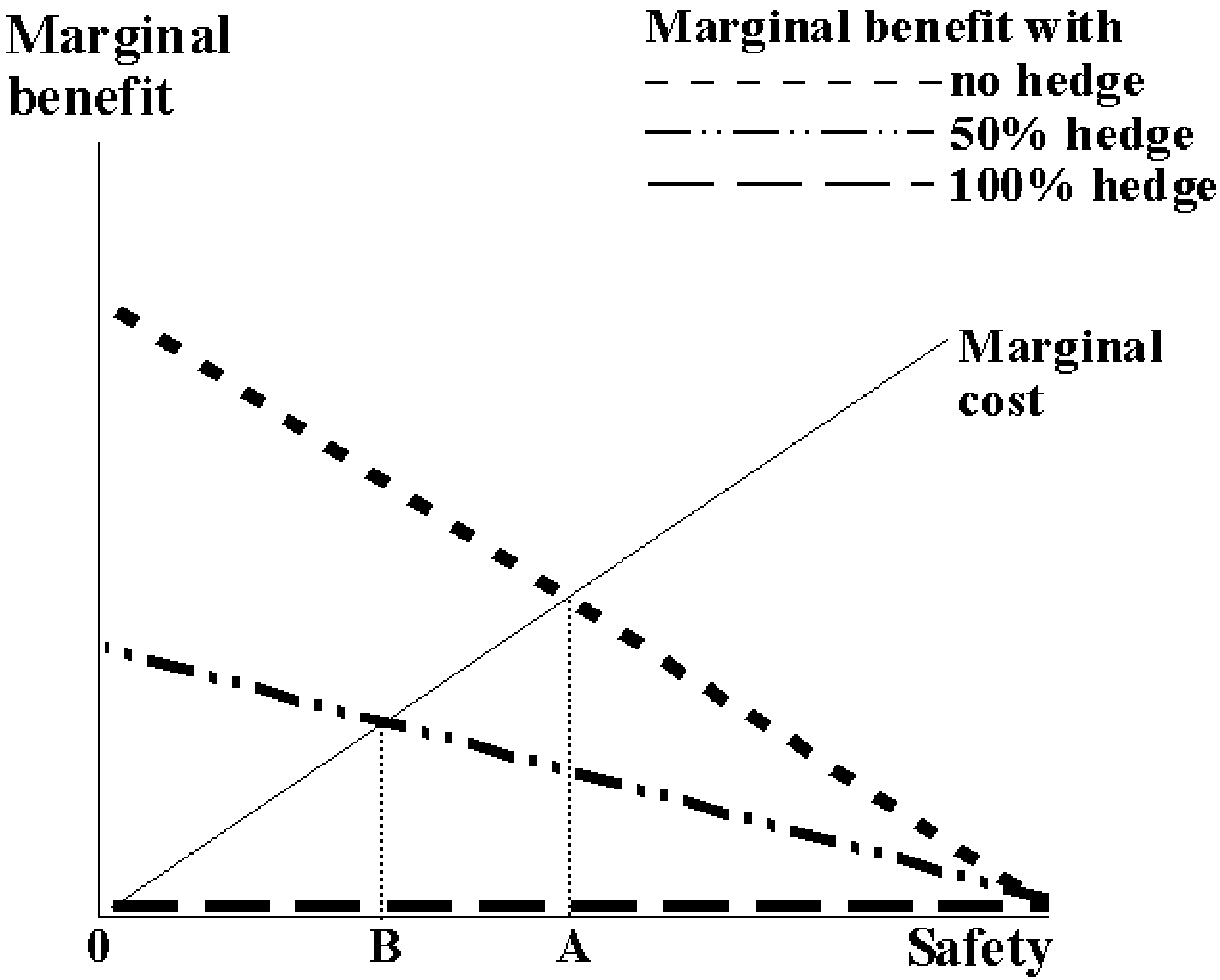
and s^* is determined by the following equation:

$$\frac{dE(W)}{ds} = -c'(s^*) - (1-\alpha)p'(s^*)L = 0; \text{ consequently,} \tag{5}$$

$$\underbrace{c'(s^*)}_{\text{Marginal Cost}} = \underbrace{-(1-\alpha)p'(s^*)L}_{\text{Marginal Benefit}}. \tag{6}$$

Since coinsurance proportionately scales down the marginal benefit of safety, s^* is lower when insurance is purchased. If $\alpha = 1$, then there is no benefit to investing in safety; consequently, the optimal value for s^* is $s^* = 0$. Herein lies the moral hazard problem!

Insurance and Moral Hazard



Insurance and Moral Hazard

The solution to this dilemma is for the insurer to make the premium itself a function of the *level of investment in safety*. In other words, let $P = P(s)$, where $P'(s)<0$. Thus (4) is rewritten as:

$$E(W) = W_0 - c(s) - (1-\alpha)p(s)L - \alpha P(s), \tag{7}$$

and s^* is determined by the following equation:

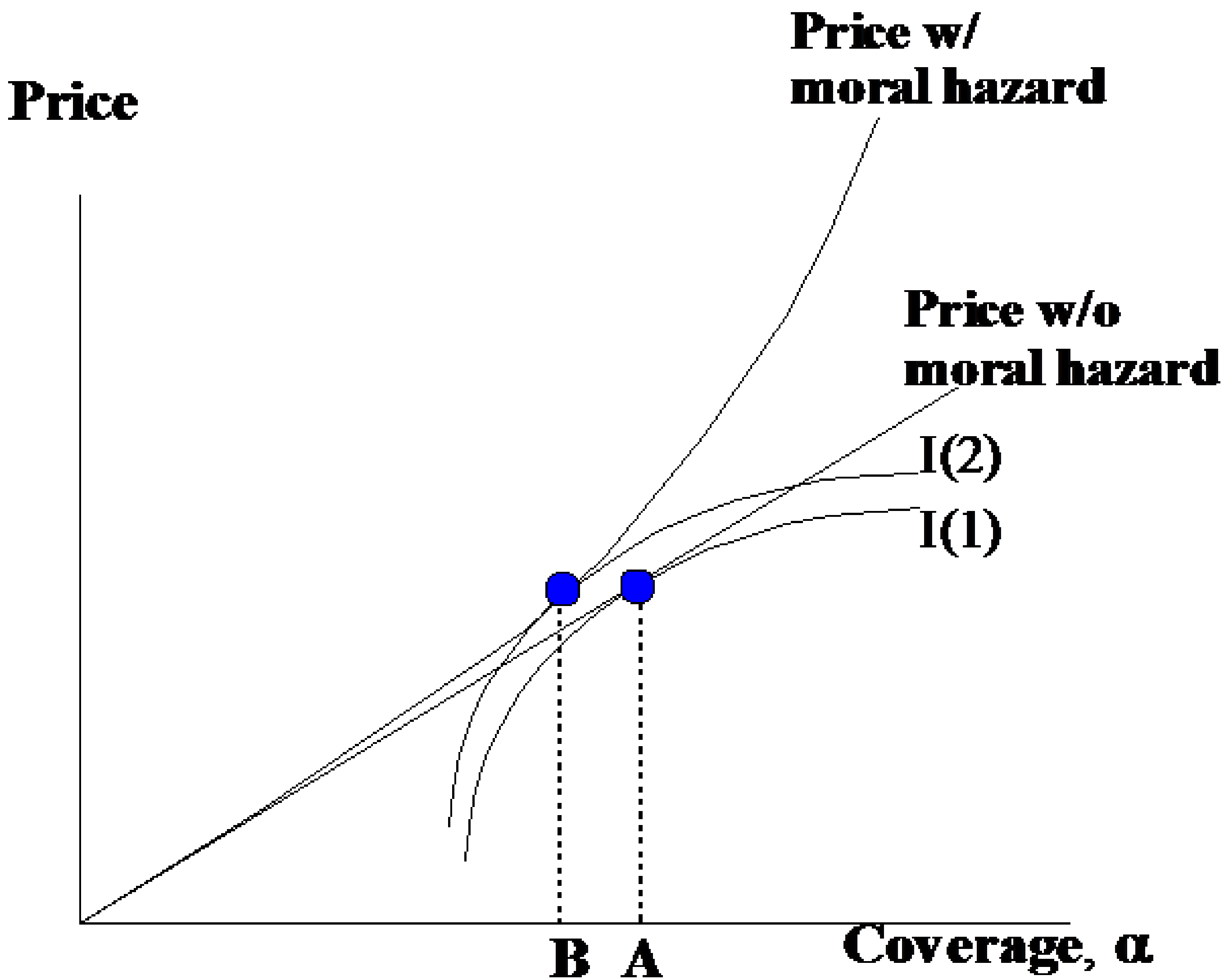
$$\frac{dE(W)}{ds} = -c'(s^*) - (1-\alpha)p'(s^*)L - P'(s^*) = 0. \tag{8}$$

Thus the equilibrium condition of marginal cost equaling marginal benefit is written as follows:

$$\underbrace{c'(s^*)}_{\text{Marginal Cost}} = \underbrace{-(1-\alpha)p'(s^*)L - \alpha P'(s)}_{\text{Marginal Benefit}}. \tag{9}$$

In (9), even when $\alpha = 1$, it will be optimal to invest in safety, since the premium charged is sensitive to the level of investment in safety.

Insurance and Moral Hazard



Insurance and Moral Hazard

- Risk transfer creates moral hazard
- Contractual and pricing strategies for mitigating moral hazard:
  - Contractual strategy: Risk sharing (e.g., “partial” instead of “full” insurance coverage)
  - Pricing strategy: Experience rating (a form of "*ex post*" settling up)

Class Problem 14.1 (Incentive Compensation)

- Currently the CEO receives a fixed salary of \$500,000. This salary represents her "reservation" salary; if the utility value of \$500,000 for certain is breached, then she will take a job elsewhere. The Board of Directors is concerned that she may be just "going through the motions" and would work harder if she were paid a bonus based upon the firm's profits.
- The CEO's utility function is $U = W^{0.5}$, where W comprises initial wealth ($W_0 = \$1,000,000$), salary ($S$), bonus ($B$), and cost of effort ($C = \$50,000$, which represents the opportunity cost of hard work for the CEO); thus, $W = W_0 + S + B - C$. C is only incurred by the CEO if she works hard. The firm's owners are risk neutral, so they are interested in maximizing the expected value of profit after taking the CEO's compensation into account.

Class Problem 14.1 (Incentive Compensation)

1. Under the current compensation scheme, is the Board correct in its assessment of the effort of the CEO? Why or why not?
2. Will the Board's new compensation scheme have its intended effect, i.e., will the CEO work hard?
3. What is the minimum level of bonus for the CEO in order for the Board's new compensation scheme to have its intended effect?
4. Suppose it turns out that the CEO values her cost of effort at $200,000 instead of $50,000. If this were the case, would the Board's new compensation scheme have its intended effect? If not, what is the minimum level of bonus required in order to incentivize the CEO to work hard?
5. Suppose the CEO values her cost of effort at $500,000. What is the minimum level of bonus in this case? Should you pay this bonus?

Class Problem 14.1 (Incentive Compensation)

The table below provides estimates of the firm's profit (before CEO compensation is deducted) under three states of the world. The proposed new compensation plan would cut the CEO's salary (*S*) from $500,000 to $300,000 but give her a $500,000 bonus if the firm's profit (before CEO compensation is deducted) is greater than or equal to $10,000,000.

	States of the World		
	Good Economy Probability = 0.3	Average Economy Probability = 0.3	Weak Economy Probability = 0.4
CEO Goes Through The Motions	$10,000,000	$8,000,000	$6,000,000
CEO Works Hard	$15,000,000	$12,000,000	$9,000,000

Limited Liability and the Creditor-Owner Relationship

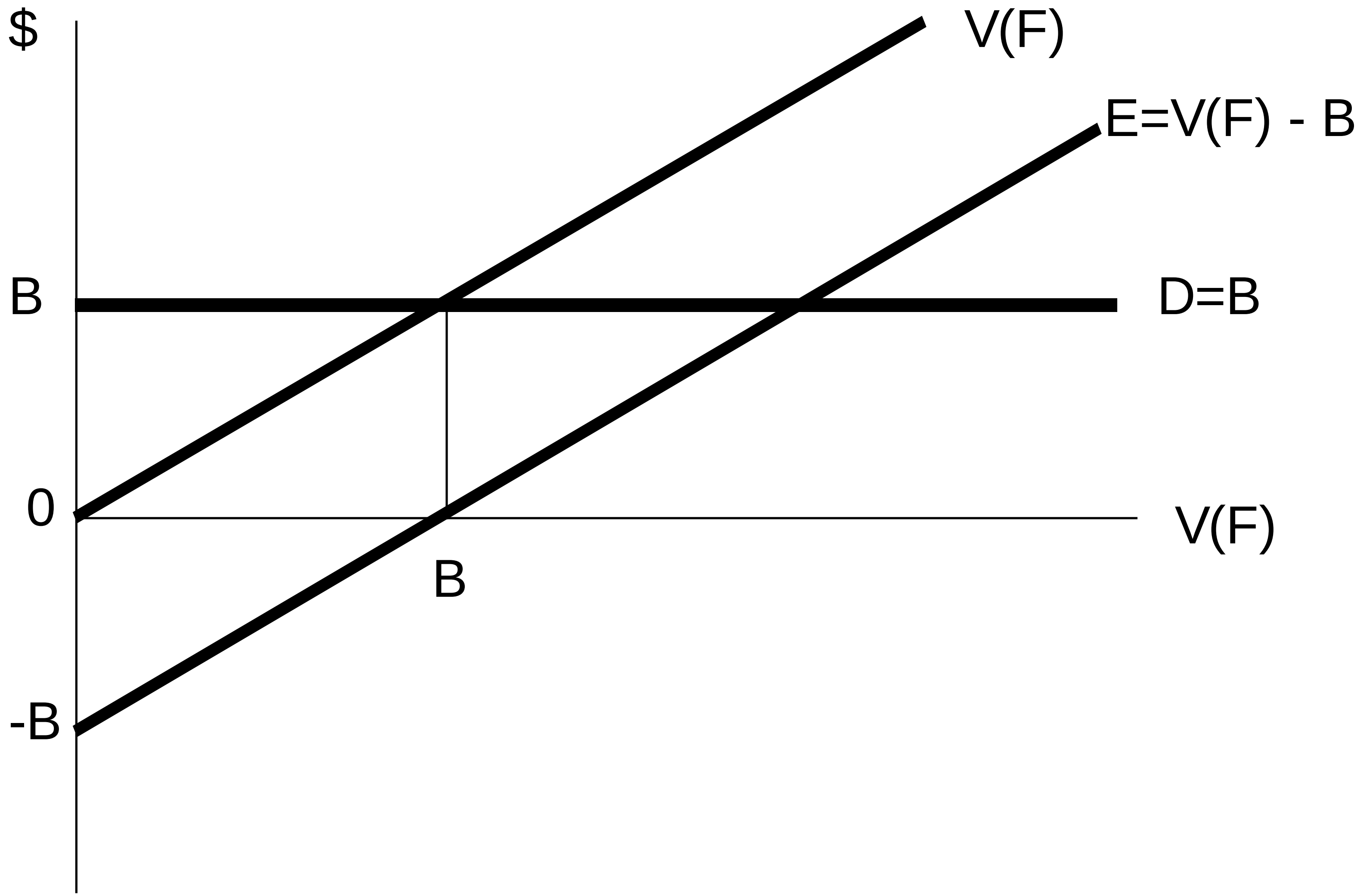
- Assume a single period – the firm is formed at $t=0$, and cash flows are realized at $t=1$.
- Let $V(F)$, D, and E represent the $t=1$ payoffs on the firm's assets, its debt, and equity. Assume the firm has promised to repay debtholders $\$B$ at $t=1$. Under *unlimited liability*, these payoffs can be written:

$$V(F) = D + E;$$

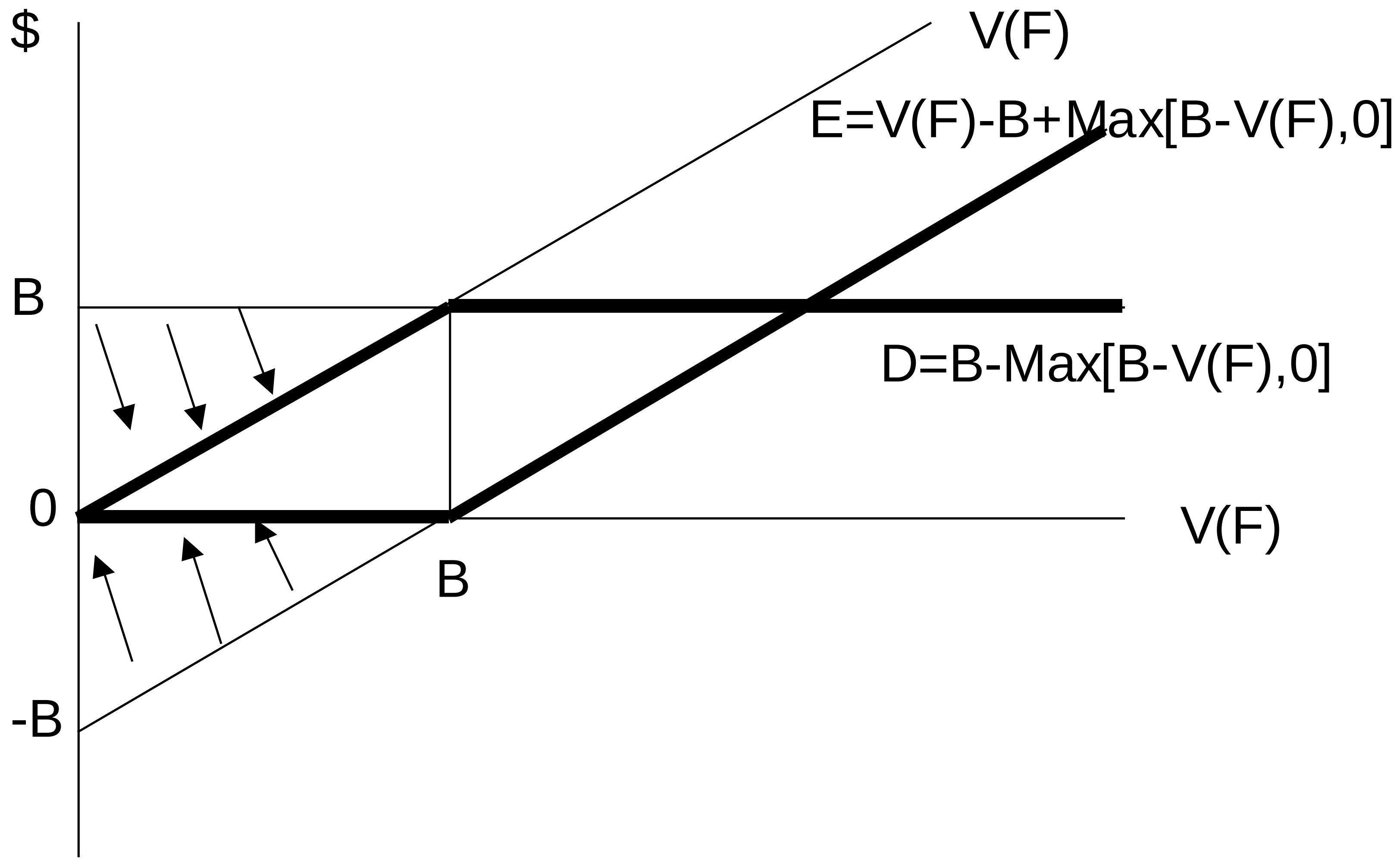
$$E = V(F) - B; \text{ and}$$

$$D = B.$$

Limited Liability and the Creditor-Owner Relationship



Limited Liability and the Creditor-Owner Relationship



The Asset Substitution Problem

- Future earnings have an expected present value (PV) of either 100 or 200 each with a 0.5 probability.
- The firm has existing senior debt with a face value of 100.
- Firm value is $150; debt value is $100, equity value is $50.

The firm now faces this choice; it can select one of the following new investments:

	Capital cost	Earnings	NPV
Project A	200	220	20
Project B	200	20; probability 0.5 or 310; probability 0.5	-35

The Asset Substitution Problem

NEW PROJECT → / ORIGINAL OPERATIONS ↓	A
	220 **(1.0)**
100 **(0.5)**	320 (0.5)
200 **(0.5)**	420 (0.5)

← B →	
20 **(0.5)**	**310** **(0.5)**
120 (0.25)	410 (0.25)
220 (0.25)	510 (0.25)

The Asset Substitution Problem

Value of the firm if project A is chosen

Value of the firm	0.5(320 + 420)	= 370
Senior Debt	0.5(100 + 100)	= 100
Junior Debt	0.5(200 + 200)	= 200
Equity	0.5(20 + 120)	= 70

Value of the firm if project B is chosen

Value of the firm	0.25(120 + 220 + 410 + 510)	= 315
Senior Debt	0.25(100 + 100 + 100 + 100)	= 100
Junior Debt	0.25(20 + 120 + 200 + 200)	= 135
Equity	0.25(0 + 0 + 110 + 210)	= 80

The Asset Substitution Problem: Precommit to Hedge Project Risk

NEW PROJECT → ORIGINAL OPERATIONS ↓	**B*** **165** **(1.0)**
100 **(0.5)**	265 (0.5)
200 **(0.5)**	365 (0.5)

The Asset Substitution Problem: Precommit to Hedge Project Risk

- Since there is no risk in A, there is no need to hedge project risk; thus debt and equity values are exactly the same as previously shown.
- However, project B is risky and, with a costless hedge, the firm could replace a fair lottery of 20 and 310 with a certain payoff of 165.

Value of the firm if project A is chosen

Value of the firm	0.5(320 + 420)	= 370
Senior Debt	0.5(100 + 100)	= 100
Junior Debt	0.5(200 + 200)	= 200
Equity	0.5(20 + 120)	= 70

Value of the firm if project B is chosen

Value of the firm	0.5(265 + 365)	= 315
Senior Debt	0.5(100 + 100)	= 100
New Debt	0.5(165 + 200)	= 182.5
Equity	0.5(0 + 65)	= 32.5

The Asset Substitution Problem: Fund with equity

- If the new project were to be financed with equity, project A would be chosen. This follows since the total debt is now only 100 (old debt) and there is no chance that firm value would fall below 100 whatever project is chosen.
- Suppose that the firm chooses to raise 100 in new equity and 100 in new debt.

Value of the firm if project A is chosen

Value of the firm	0.5(320 + 420)	= 370
Senior Debt	0.5(100 + 100)	= 100
Junior Debt	0.5(100 + 100)	= 100
Equity	0.5(120 + 220)	= 170

Value of the firm if project B is chosen

Value of the firm	0.25(120 + 220 + 410 + 510)	= 315
Senior Debt	0.25(100 + 100 + 100 + 100)	= 100
Junior Debt	0.25(20 + 100 + 100 + 100)	= 80
Equity	0.25(0 + 20 + 210 + 310)	= 135

Definition of Adverse Selection

- Adverse selection is a "Hidden Information" problem
  - If there is an informational asymmetry, such that one party to a contract has better information than the other, then the informed party may be inclined to take advantage of the uninformed party.
  - Adverse selection refers to the *risk* that this will occur.

Examples of adverse selection

- The seller of a used car has more information about the car than the potential buyers.
- Insurers know less about the true risk characteristics of their policyholders than the policyholders themselves.
- When a firm hires a worker, it knows less than the worker does about his abilities.
- The manufacturer of a product knows more about product failure rates than the consumer.

Strategies for mitigating adverse selection

- Risk Classification
- Signaling
- Resolving adverse selection through self-selection (contract design innovations)

Adverse Selection in Insurance

- To see how adverse selection can arise in insurance markets, consider the case of automobile insurance.
- Assume there are only two states of the world (loss and no loss), and drivers can be grouped into two risk classes: those with a high accident probability (p_H = 75%), and those with a low accident probability (p_L = 25%). Suppose also that we can correctly identify the low and high risk drivers.
- Except for accident risk, drivers are identical in all respects; i.e., W_0 = \$125 and L = \$100. Thus if there are no transactions costs,

$E(W_L) = W_0 - E(L_L)$ = \$125-.25(\$100) = \$100 for low risk drivers, and

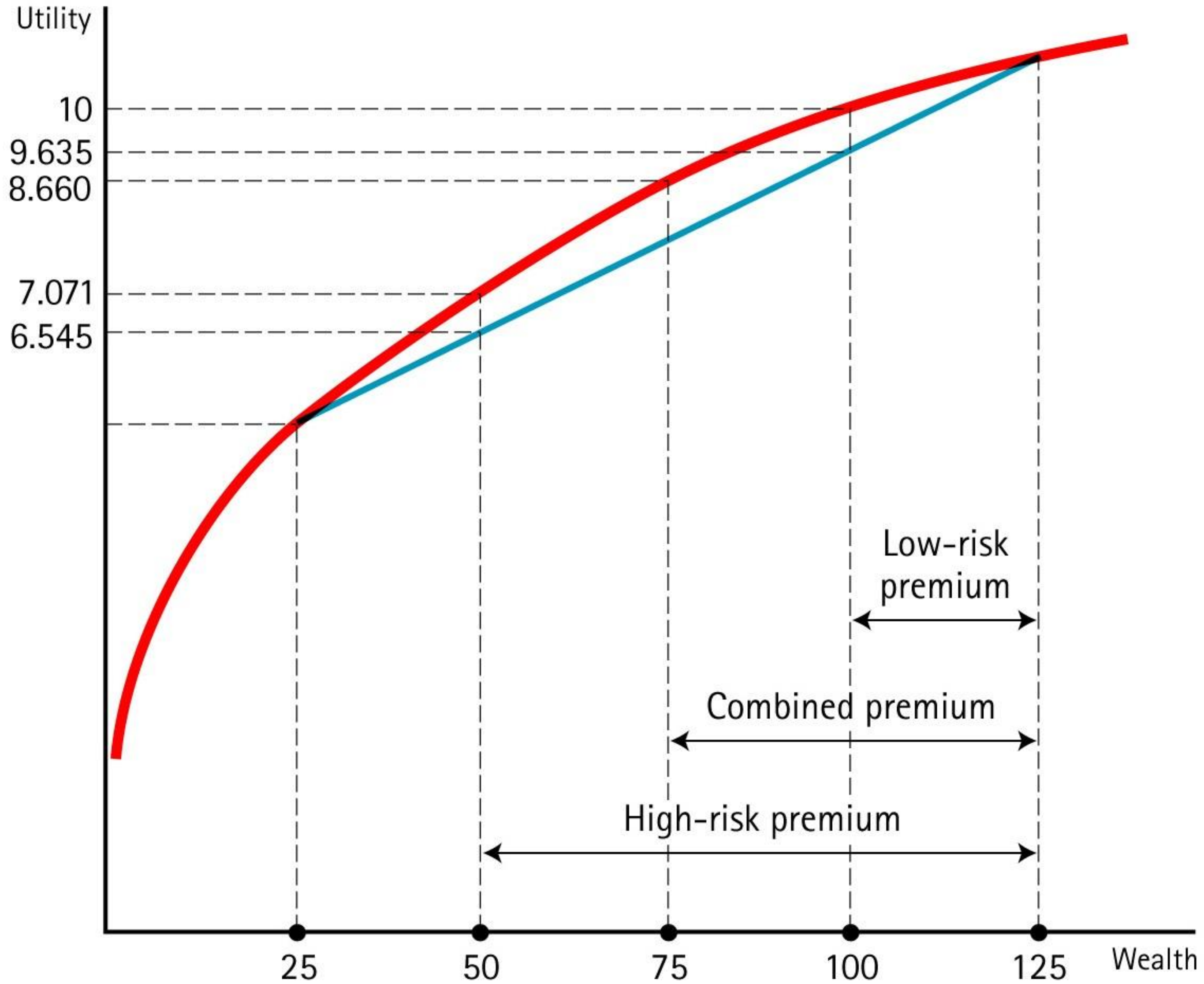
$E(W_H) = W_0 - E(L_H)$ = \$125-.75(\$100) = \$50 for high risk drivers.

- With premiums set at the expected value of loss for each insured (\$25 for low risk drivers and \$75 for high risk drivers), the Bernoulli principle implies that each would fully insure.

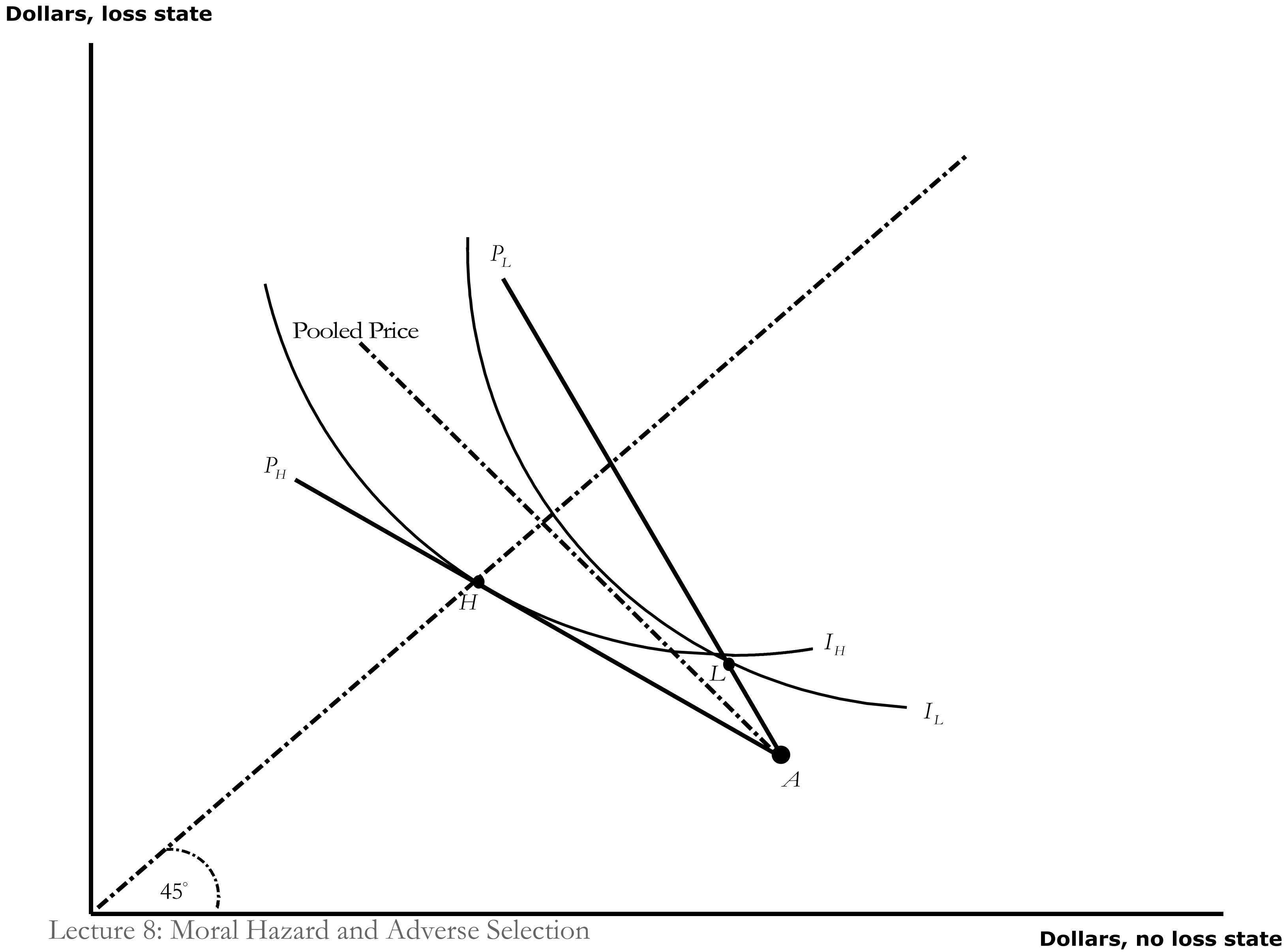
Adverse Selection in Insurance

- Suppose that we cannot identify the low and high risk drivers. However, we do know that there are equal numbers of low and high risk drivers. What to do?
  - One possibility - Charge an average premium of $50. What's wrong with this strategy?
    - High risk drivers now receive even more utility from insuring. However, low risk drivers cancel their policies because the expected utility of being uninsured is higher than the expected utility of being insured.
    - Consequently, the insurer is stuck with a portfolio of high-risk drivers and an inadequate premium.

Adverse Selection in Insurance



Resolving adverse selection through self-selection



Practical Implications of Rothschild-Stiglitz

- The Rothschild-Stiglitz "separating equilibrium" model shows that an insurer can mitigate adverse selection by limiting the set of contract choices offered to consumers.
  - In the "real world", insurers anticipate that bad risks will select lower deductibles than good risks; consequently, insurers adjust low deductible insurance policy premiums to reflect the anticipated cost of adverse selection.
  - Therefore, if you are a good risk, you ought to select high deductible insurance policies.

Class Problem 15.1

- Assume that consumers are identical in all respects expect for their loss probabilities; some are high risk, and others are low risk.
  - Members of the high-risk group have loss probability $p_H = 65\%$, whereas members of the low risk group have loss probability $p_L = 35\%$.
- Each consumer has initial wealth of $100 and utility $U(W) = W^{.5}$.
- There are only two possible states of the world, loss and no loss. If a loss occurs, then consumers lose their initial wealth of $100.
- Insurance contract offerings
  - Policy A provides full coverage for a price of $65.
  - Policy B provides full coverage for a price of $45.50.
  - Policy C provides 60% coverage for a price of $39.
  - Policy D provides 30% coverage for a price of $13.65.
- Which policy pair should you offer, assuming that you are interested in maximizing profit?