Topic 7 : Convexity, Excessive Risk and Bank Regulation

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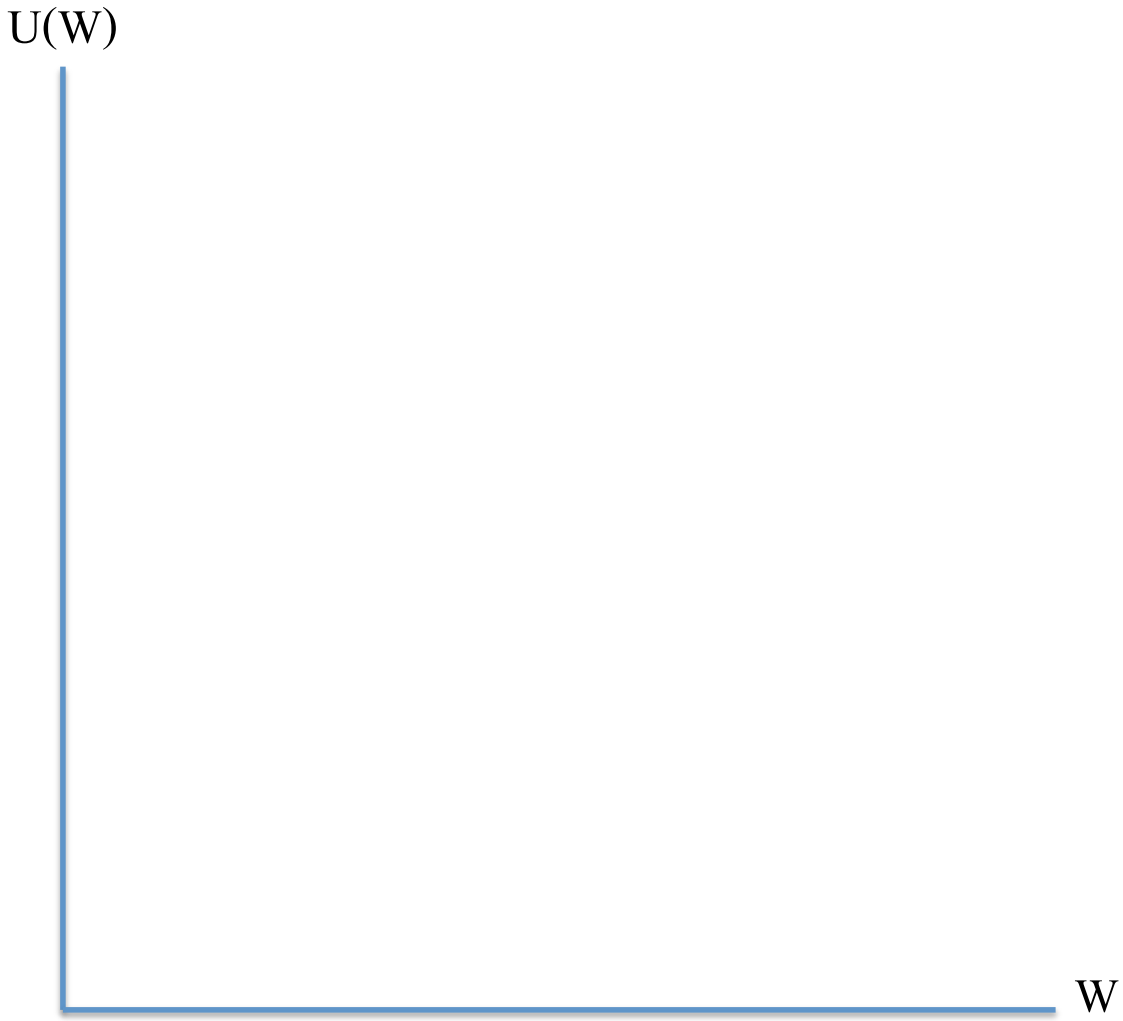
Outline

- Review : Decision Under Uncertainty
- Introduction
- Agency Cost of Debt Finance : Conflict between a firm's bondholders and stockholders
- Asset Substitutions
- How to solve asset substitution problem?
  - Moral Hazard, Bond Covenants, and the Accounting System
  - Bank Loans
  - Public Debt Instruments
  - Banks

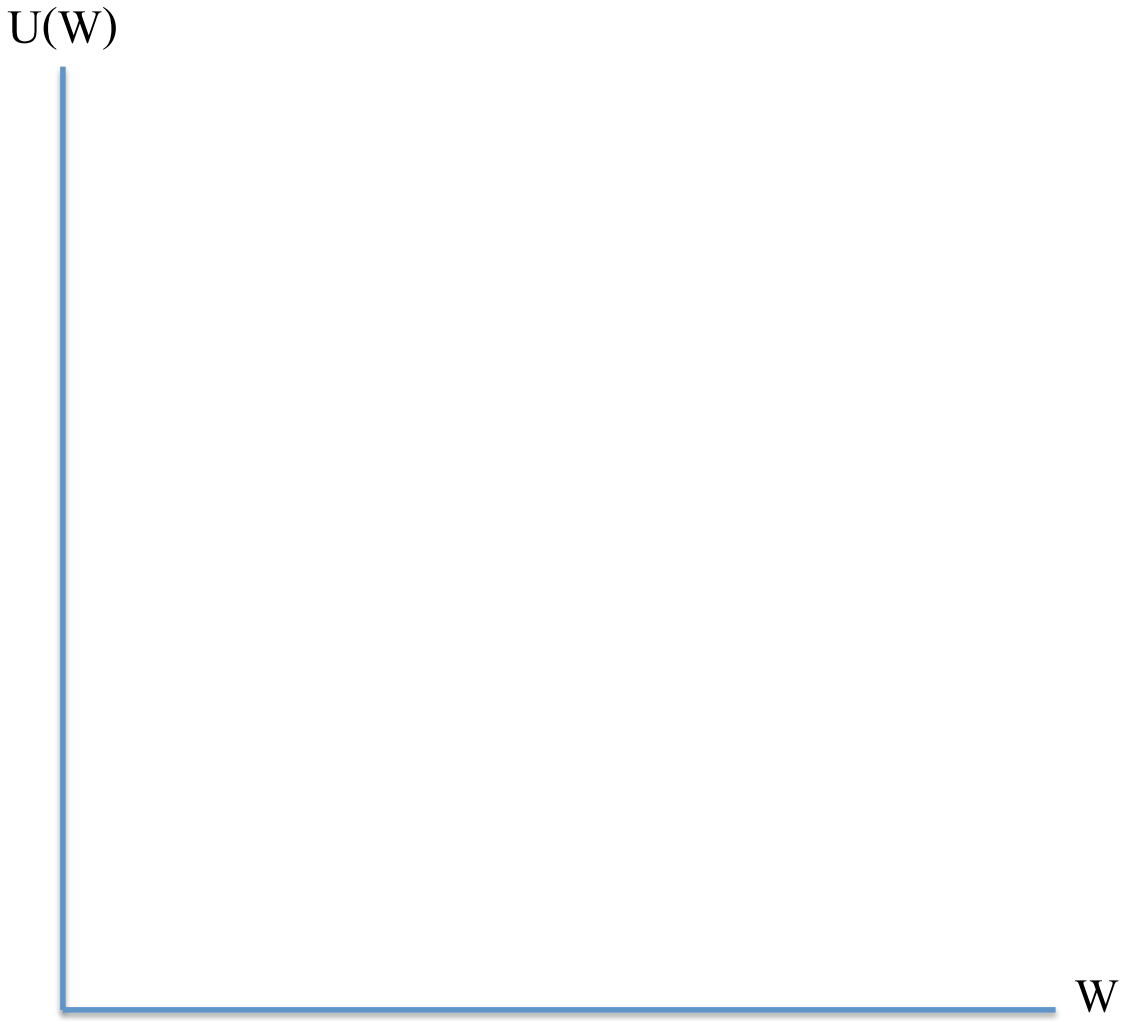
Convexity and Concavity

- A function is strictly concave if $f(tx_1 + (1-t)x_2) > tf(x_1) + (1-t)f(x_2)$, for every $0 < t < 1$ and $x_1 \neq x_2$.
- A function is strictly convex if $f(tx_1 + (1-t)x_2) < tf(x_1) + (1-t)f(x_2)$, for every $0 < t < 1$ and $x_1 \neq x_2$.

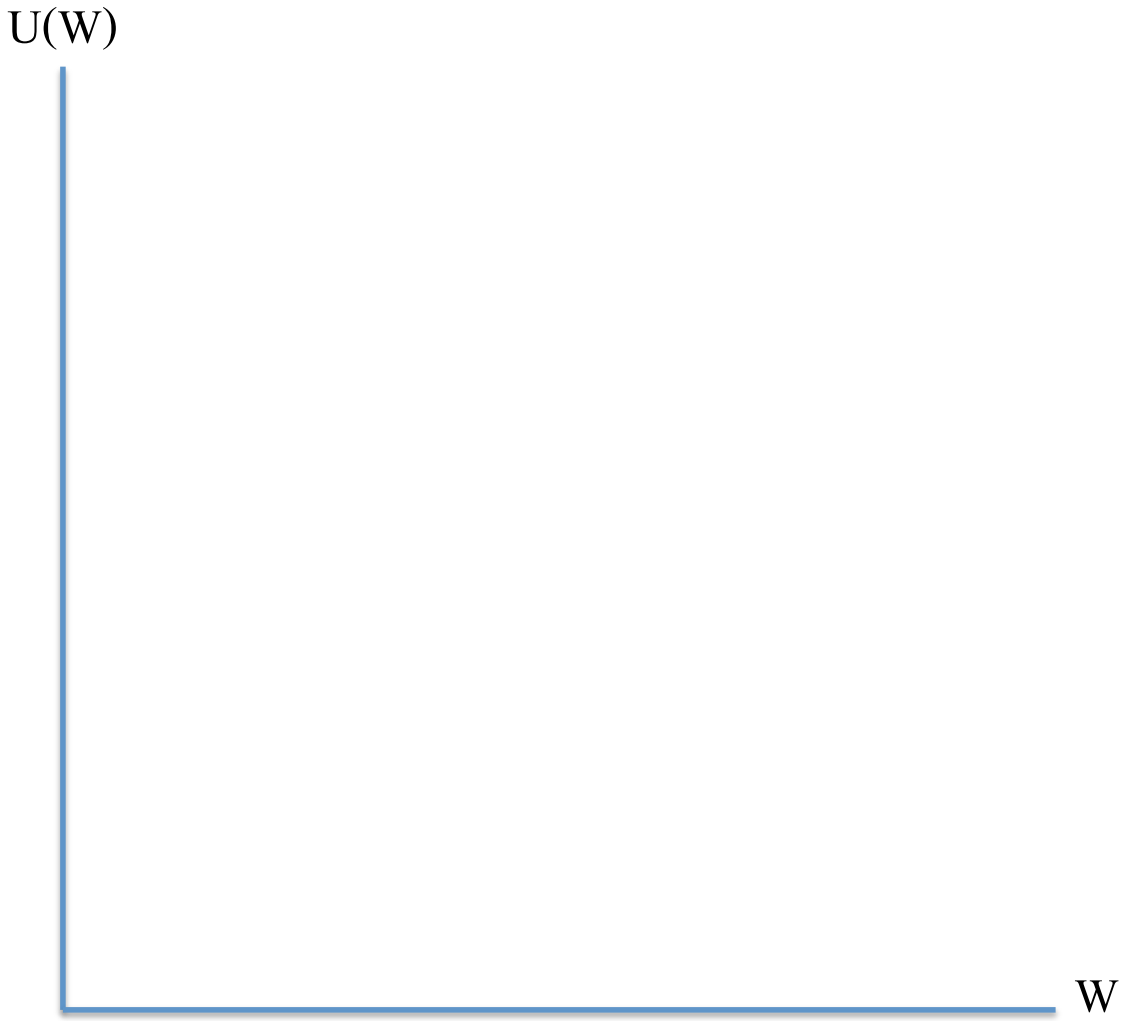
- Risk Averse



- Risk Neutral



- Risk Lover



- Certaity Equivalent Wealth (C.E.)
  - the level of wealth that individual would accept with certainty if the gamble were removed.
  - the sure sum of money which gives the same level of utility as the gamble
- $EU(W) = p_1 U(W_1) + p_2 U(W_2)$
- $E(W) = p_1 W_1 + p_2 W_2$
- Risk premium = $E(W) - C.E.$

- Which one we will prefer, the actuarial value (expected value) of the gamble with certainty or the gamble itself?
- Risk averter : $U(E(W))$ ..... $EU(W)$, Risk premium ..... 0.
  - Risk averter prefer the expected value of the gamble with cetainty to the gamble itself.
- Risk neutral : $U(E(W))$ ..... $EU(W)$, Risk premium ..... 0.
  - Risk neutral is indifferent between the expected value of the gamble with cetainty and the gamble itself.
- Risk lover : $U(E(W))$ ..... $EU(W)$, Risk premium ..... 0.
  - Risk lover prefer the gamble itself to the expected value of the gamble with cetainty.
- Fair price = the expected value of the gamble.

Introduction

- Topic 6 : Theory of Financial Intermediation
  - Bank help resolve asymmetric information problem : confidentiality and bank relationship, economies of scale and diversification
  - Economies of scale: the model shows that monitoring cost is lower for intermediated finance because of economies of scale. The bank is always able to pay its depositors back because of diversification.
- In fact, it is possible for a bank to default.
- Banks are highly financial leverage. They have high debts. Most of their assets are loans which are risky assets. Banks are very risky.
- Followings will be discussed,
  - Debt financing encourages excessive risk-taking.
  - The firm has an incentive to take higher risk after debt incurred.
  - As the debt level increases, the firm has more incentive to take higher risk.
  - If the firm takes higher risk, the shareholders will gain while the bondholders will lose. (conflict of interest)
  - How could the bondholders protect themselves?

The Agency Cost of Debt Finance

- Financial theory of agency analyzes the impact of the conflict between managers and a firm's claimholders, conflict between claimholders on issues related to optimal levels of investment and risk bearing by the firm and capital structure
- Here, the focus is on the conflict between claimholders (bondholders(creditors) and shareholders(owners)) on issues related to risk bearing by the firm
- creditors are bondholders or lenders, shareholders are owners or borrowers
- Assumption
  - The borrower has no equity, needs to borrow principal amount I to finance his investment project
  - Project's yield is Y
  - The borrower are the owner of the project : residual income
  - The lender is the creditor of the project : fix payment (L) with a bankrupcy provision in case of default
  - The borrower are subjected to limited liability.

- (Limited liability : A condition in which owners are not personally held responsible for the debts of by a firm. Corporations are the main form of business in which owners have limited liability. The shareholders of a corporation have limited liability in that their personal assets are protected from the fortunes of the corporation. Limited liability means that after default, the creditor of the corporation cannot sue and attach the personal assets of shareholders. Thus, the shareholders of the corporation risk only their original investment in their businesses or the price that they paid for their common stock.)

- Borrower's payoff
  - If $Y > L$, the borrower will get .....
  - If $Y < L$, the borrower will get .....
  - If $Y = L$, the borrower will get .....
- Then, the borrower's payoff is $\gamma =$.....
- Lender's payoff
  - If $Y > L$, the borrower will get .....
  - If $Y < L$, the borrower will get .....
  - If $Y = L$, the borrower will get .....
- Then, the lender's payoff is $\alpha =$.....

- mean-preserving increase in spread
- Draw a diagram for the return to equity and debt in (Y, L) space.

- Suppose there are two investment projects to choose
  - Project A : “Safe” Project yields L for sure
  - Project B : “Risky” Project returns Y_1 and Y_2 each with equal probability
    - $\bar{Y} = \frac{Y_1 + Y_2}{2} = L$
    - $Y_1 < I < \bar{Y} < Y_2$
    - $\theta = Y_2 - Y_1$: “spread”

- Project A : Expected return on project $_A$ =.....
- Project B : Expected return on project$_B$ =.....
- Compare risk and returns between the two project
- Which one the borrower is prefer?
- Project A : Expected return to equity $_A$ =.....

- Project B : Expected return to equity$_B$ =.....

- θ becomes bigger, the riskiness of project B ..... and project B become ..... attractive from the borrower's point of view.
- The borrower tends to choose the investment project with the ..... risk.

- What's about the lender?
- Project A : $\text{Expected return to debt}_A = \ldots\ldots$
- Project B : $\text{Expected return to debt}_B = \ldots\ldots$
- θ becomes bigger, the riskiness of project B ..... and expected return to the lenders .....
- "conflict of interest" between the lenders and the borrowers.

- Summarize

	Project A	Project B
Return on Project		
Return to Equity		
Return to Debt		

Asset Substitution (numercial examples)

- Asset Substitution : The value of equity can be increased at bondholders' expense by replacing the firm's current (safe) assets with riskier projects. Shifting risk to the bondholders.
- Suppose you have $100 and can take one of the following two mutually exclusive projects which requires an investment 0f $100.

	Bad state	Good state
Probability	0.5	0.5
Project A	110	110
Project B	0	220

- Which one you are going to choose?

- Now suppose that you do not have any initial wealth. You have to borrow $100 at 10% to do one of the two projects. Your lender know that you can choose Project A or Project B. However, your lender is unable to directly control your choice of the project. Which project you are going to choose?

	Bad state	Good state	Expected
Probability	0.5	0.5	
Project A	110	110	110
Debt	.....	.....	.....
Equity	.....	.....	.....
Project B	0	220	110
Debt	.....	.....	.....
Equity	.....	.....	.....

- Substituting project B with Project A, the stockholders ..... the stock value but ..... the debt value.
- Debtholders bear the cost of asset substitution.

Asset Substitution (or excessive risk-taking)

- The borrower will gain from taking higher risk while the lender will lose.
- The debt transfer value from debtholders to equityholders.
- Mathematically, this is because the expected value of a concave function of a random variable falls as the degree of risk increases.
- Return to debt : concave function
- Return to equity : convex function
- Note that return to equity has the same pattern as payoff of a call option. One important distinction is that the holder of a call option cannot influence the riskiness or variance of the underlying asset. The shareholders/ equity holders are in a position to influence the riskiness of the business.
- The borrower has an incentive to substitute high-risk projects for low-risk ones once a debt incurred.
- This is called “asset substitution”
- Convexity encourage managers/owners to undertake a risky projects which has negative social value.

Moral Hazard, Bond Covenants, and the Accounting System

“Moral Hazard is when they take your money and then are not responsible for what they do with it”
“Wallstreet 2 : Money never sleeps”. The movie.

“..any situation in which one person makers the decision about how much risk to take, while someoneelse bear the cost if things go badly.” Krugman.

There are various ways in which the lenders of the firm can protect themselves from moral hazard

- the issuance of convertible bonds (bonds with share purchase option)
- writing covenants that limit the scope for asset substitution
  - limit the issuance of new debt
  - loan collateral (most often used by banks)
  - cashflow covenant : maintain minimum ratio of cashflow to debt, for example, EBIT/interest, EBITDA/debt, other debt service ratios. Cashflow covenants require the firm to trade at a profit.
  - These covenants would be meaningless if the firm's account can be fudged.
  - Effective accounting system is necessary for preventing moral hazard problem.

Limit the issuance of the new debt. Moral hazard problem worsens at higher level of debt.

- Suppose you do not have any initial wealth. You have \$50 and are going to finance your project \$50 with your money and \$50 with debt. The interest rate is 10%. You can take one of the following two mutually exclusive projects.

	Bad state	Good state	Expected
Probability	0.5	0.5	
Project A	110	110	110
Debt	-55	-55	-55
Equity	55	55	55
Project B	0	220	110
Debt	0 (bankruptcy)	-.....	- .....
Equity	0	165	87.75

- Expected rate of return on equity: project A = $\frac{\text{.....} - \text{.....}}{\text{.....}} = 10\%$
- Expected rate of return on equity: project B = $\frac{\text{.....} - \text{.....}}{\text{.....}} = 74.5\%$

- Suppose you do not have any initial wealth. You have $20 and are going to finance your project $20 with your money and $80 with debt. The interest rate is 10%. You can take one of the following two mutually exclusive projects.

	Bad state	Good state	Expected
Probability	0.5	0.5	
Project A	110	110	110
Debt	-88	-88	-88
Equity	22	22	22
Project B	0	220	110
Debt	0 (bankruptcy)	-.....	-.....
Equity	0	132	66

- Expected rate of return on equity: project A = $\frac{\ldots - \ldots}{\ldots} = 10\%$
- Expected rate of return on equity: project B = $\frac{\ldots - \ldots}{\ldots} = 230\%$
- As debt increases, project B is even more interesting compared to project A.

- Risk-taking incentive increases by financial leverage (measured by debt to equity ratio, in this case).
- Hence, one way to reduce excessive risk taking behaviour is to limit the issuance of new debt.
- Equity capital acts as a protective buffer for lenders.
- When shareholders pay themselves dividends, the claims of the bondholders become less secure (lower asset coverage).
- Equity capital declines. Bondholders has less protection against possible losses.
- When equity declines, debt-equity ratio increases. This worsens the asset -substitution problem.

loan collateral (most often used by banks)

- Role of collateral. Suppose the interest rate is 10%. The amount of collateral, C = 110. Collateral is transferred to the lenders upon default. Then, the retuns become

	Bad state	Good state	Expected
Probability	0.5	0.5	
Project A	110	110	110
Debt	-110	-110	-110
Equity	$\underbrace{110}_{\text{Collateral}} + ...$	$\underbrace{110}_{\text{Collateral}} + ...$	55
Project B	0	220	110
Debt	$- \underbrace{110}_{\text{Collateral}}$	-110	-.....
Equity	$\underbrace{110}_{\text{Collateral}} - .....$	$\underbrace{110}_{\text{Collateral}} + ...$	.....

- Using collateral helps reduce moral hazard behaviour.

Bank Loans

- formal covenants are less common in the case of bank loans
  - Banks are given access to insight information
  - Banks can monitor the company effectively since they are bookkeepers (economies of scope)
- a bank usually ask the borrower for collateral
- a bank can punish its borrowers by not giving more loans
- long term relationship to the bank is important for businesses: esp. the case of high-growth companies with intangible assets

Public Debt Instruments

- Government bonds, sovereign debts are not considered to be risk-free asset in the international bond market. How can public bondholders protect themselves from moral hazard problem?

Deposits

“Banks have proved themselves to be the most hazardous economic institution know to man. Breakdowns in banking lie at the centre of most financial crisis. And banks are usually effective at spreading financial distress.”
“Trouble with banks. No body loves them. Everybody needs them.” The Economist.

- Banks are too big to fail.
- Bank regulations to prevent moral hazard in banking: for example. Capital adequacy ratios, Large exposures restrictions