Topic 7 : Convexity, Excessive Risk and Bank Regulation

Peter D. Spencer, Chapter 9
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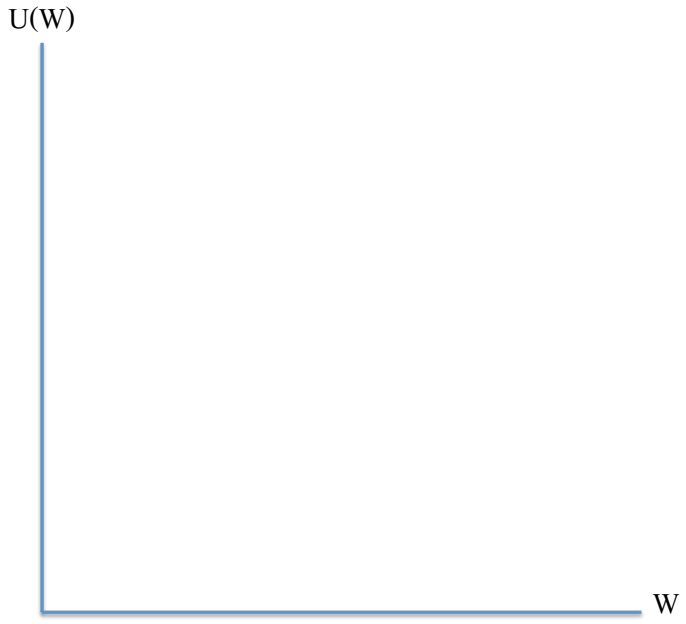
Contents

1 Review : Decision Under Uncertainty

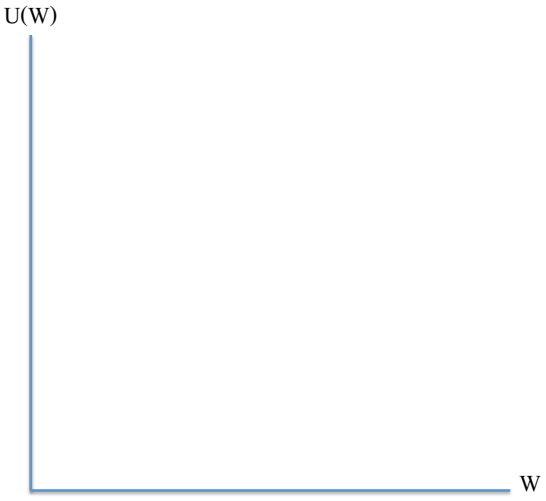
1.1 Convexity and Concavity

- 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

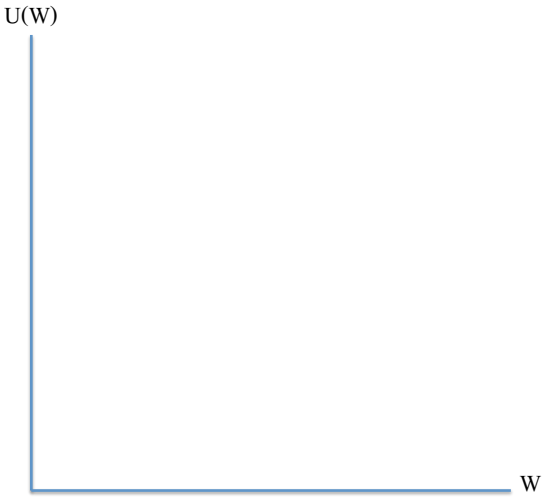
level of wealth for certain, that gives you the same utility as the gamble If you have the gamble at hand, at what level of wealth for certain you are willing to exchange your gamble for that level of wealth.



- 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
- $EU(W) = p_1U(W_1) + p_2U(W_2)$
- $E(W) = p_1W_1 + p_2W_2$
- 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.

2 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.
- This chapter focuses on default risk. Liquidity risk will be discussed in Chapter 8, liquidity, Bank Runs and Deposit Insurance.
- 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?

2.1 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.)
  - [In this chapter, it is not costly to verify the state. Borrower's realization value of the project is public information. Debt constracts are with bankrupcy clause. The moral hazard occurs because borrowers have incentive to change the projects after the loan application is approved. Timeline]

- 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 lender will get .....
    - If $Y < L$, the lender will get .....
    - If $Y = L$, the lender will get .....
  - Then, the lender's payoff is $\alpha =$.....
  - Draw a diagram for the return to equity and debt in (Y, Payoff) 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"
    - Mean-preserving increase in 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 : Expected return to debt $_A$ =.....
- Project B : Expected return to debt$_B$ =.....

- 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	$L = \bar{Y}$	$L = \bar{Y} = \frac{Y_1 + Y_2}{2}$
Return to Equity	$\gamma_A = 0$	$\gamma_A = \frac{\theta}{4}$
Return to Debt	$\alpha_a = L = \bar{Y}$	$\alpha_b = \frac{L + Y_1}{2}$

- Moral Hazard Problem : substitute project A with project B
  - Equity gain = ...
  - Lender loss = ...

3 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 of payoff as 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.

4 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 makes 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

4.1 Bond Covenants

- writing covenants that limit the scope for asset substitution
  - limit the issuance of new debt
  - loan collateral (most often used by banks)
  - These covenants would be meaningless if the firm's account can be fudged.
  - Effective accounting system is necessary for preventing moral hazard problem.
- 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.

4.2 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

4.3 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?

4.4 Deposits

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

5 Numerical Example : Asset Substitution

- Threre are 2 mutually exclusive investment project to choose which requires an investment of $100 each. Borrowing rate is 10%.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. Assume that agents are risk neutral.

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

Expected payoff for both projects = ...

Example 1 : **"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."**

Case 1. Suppose you invest your own money $100. Which one will you choose?

Case 2. **.**Now suppose that you do not have any initial wealth. You have to borrow $100 at 10% to do one of the two projects. Which project will you choose?

Case 2. Equity's payoffs

$L =$

$\gamma_A =$

$\gamma_B =$

Case 2. Bond's payoffs

$L =$

$\alpha =$

$\alpha_A =$

$\alpha_B =$

- Substituting project B with Project A, stockholders gains but bondholders loses.
- Debtholders bear the cost of asset substitution.

Example 2 . "Limit the issuance of the new debt. Moral hazard problem worsens at higher level of debt."

Case 1. Suppose you have \$50 and you are going to finance your project with your money and \$50 with debt.

$$L = 50 \times (1 + 0.10) = 55.$$

$$\begin{aligned} \gamma_A &= \\ &= \end{aligned}$$

$$\begin{aligned} \gamma_B &= \\ &= 82.5 \end{aligned}$$

- the equity gain from investing in project B rather than project A? .....

Case 2. Suppose you have \$50 and you are now can borrow more. You can borrow \$150. Then, you can do 2 projects.

$$L = 150 \times (1 + 0.10) = 165.$$

$$\begin{aligned} \gamma_A &= 220 - 165 \\ &= 55 \end{aligned}$$

$$\begin{aligned} \gamma_B &= 0.5 \times Max(0, 0 - 165) \\ &\quad +0.5 \times Max(0, 440 - 165) \\ &= 137.5 \end{aligned}$$

- the equity gain from investing in project B rather than project A? .....

- As debt increases, project B is even more interesting.

6 Example :

"...Unfortunately, banks do have a reason to take on more risk than they should. The reason, paradoxically, is the safety net that governments put in place to prevent bank failures. By trying to make banks safer, governments give banks the means and the motive to behave recklessly. ..."

Source: "Trouble with banks. Nobody loves them, everybody needs them." The Economist (2003)

- In the context of the agency cost of debt financing, what is the reason for banks "to take more risk than they should"? Graphically illustrate the bank's gain and the depositor's loss from the bank's moral hazard behavior. Give one example for "the safety net that governments put in place to prevent bank failures". Explain how the chosen safety net help reducing the moral hazard behavior of the banks.

- How could the banks' capital base help protecting them against the shocks in property market? Why did too thin capital cushion erode confidence in the big banks? Explain.