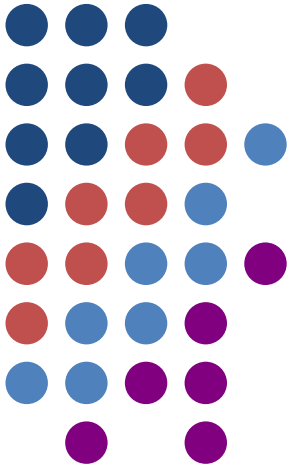
Enterprise Risk Management

Tsutomu Chano, Ph.D

Musashi Univ.

chano@cc.musashi.ac.jp



Self-introduction

- **＜Education＞**
  - Faculty of Economics, Osaka University, Osaka, Japan, March 1987.
  - Osaka School of International Public Policy, Osaka University, March 1999.

- **＜Experience＞**
  - 1990-2005:Sumitomo-Life Research Institute, Tokyo, Japan
    - Senior Researcher of Financial Research Department

Self-introduction

- 2005-2008　Sumitomo Life Insurance Company, Tokyo, Japan
  - Senior Special Staff Manager of Corporate Risk Management Department

＜Main Publication＞

- *The Guarantee Interest Rate Problem and the Future of Japanese Life Insurance Industry* ,Toyo Keizai Inc, February 2002.
- *Japanese Life Insurance Industry in the Global Competition Era* ,Toyo Keizai Inc, June 1997

1. Why do we need to manage our risks ?

- **The view from academia**
  - ✓(Financial) Hedge: Zero-sum Game
    ①In perfect financial markets, risk management doesn't make new value to companies ! !
    ②However, an agency cost might be reduced by its process

1. Why do we need to manage our risks ?

- **The view from trenches**
  - ✓Assuming that financial markets are imperfect, we need to
    - ① Hedge our risks considering cost,
    - ② Reduce variation of our income,
    - ③ Make our investors comfortable,
    - ④ Maximize our corporate value.

2. Basic concept

➢①Exposure

- ✓Assumed the maximum amount of Loss

  Q1: You`ll lend $100dollar or $10,000 to friend. In which case is your risk larger?

  A1: $10,000

➢②Time Horizon

- ✓Duration exposed to risk

  Q2: You want to lend much money for one year? Or for one week?

  A2: One week

2. Basic concept

➢③Probability

✓Possibility that risk events happen

Q3: Which friend will you lend money? Honest one or not honest one.

A3: Honest

➢④Volatility

✓Degree of variability of each events

Q4: Do you like buying lottery or depositing money in a bank?

A4: Depositing

2. Basic concept

➢⑤Correlation

✓Relation of risk events each other

Event	Toyota (A)	Honda (B)	Tokyo Electric Power	A+B (positive)	A+C (negative)
Depreci-ation of the yen	↗	↗	↘	↗ ↘	↗ ↘
Appreci-ation of the yen	↘	↘	↗	↘ ↗	↘ ↗

2. Basic concept

➢⑥Risk type

Risk Type	Description	Typical Measurement
Market/ALM	The risk of adverse movements in market factors	VaR, Scenario Analysis
Credit	The risk of loss resulting from failure of obligators to honor their payments	Expected Loss, Unexpected Loss
Life	The risk of loss due to unforeseen increase in life claims	Surplus Testing
Catastrophe	The risk of loss due to catastrophe	Simulation
Non-Catastrophe P&C	The risk of loss due to unforeseen increase in non-catastrophe claims	Frequency Severity Modelling
Event	The risk of loss due to fraud, natural disaster, litigation , etc.	Extreme Value Theory
Business	The risk of loss due to adverse condition in revenue	Historical Earnings Volatility

Source) Oliver, Wyman & Company(2001)

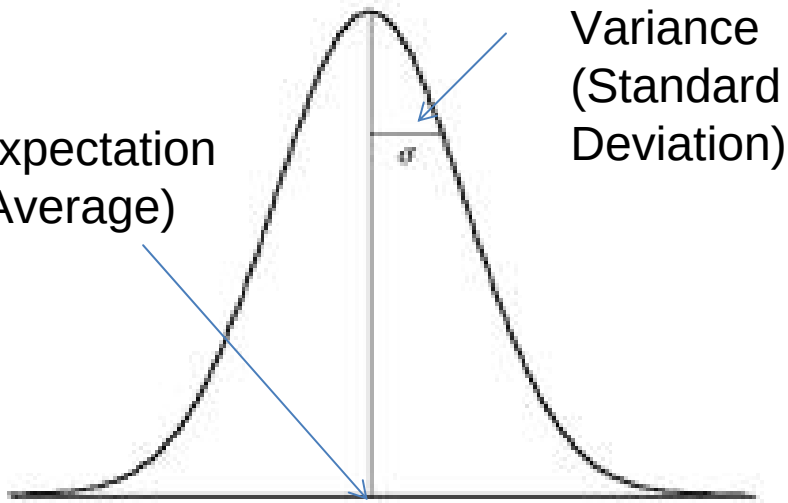
3. Trad-Risk Management

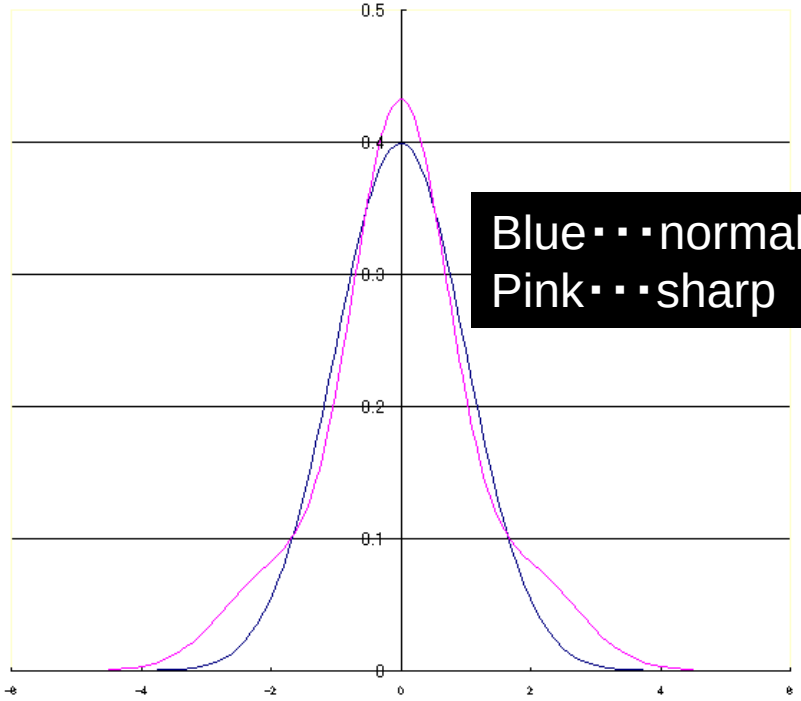
- Silo-Approach（⇔Integrated Approach）
  - ✓ Measuring the price distribution of asset.
  - ✓ Considering the **Taylor** expansion of the distribution.
    - ✓ In two-parameter approach, making decision to use its first and second order differential.

$$f(x)=f(a)+\underbrace{\frac{f'(a)}{1!}(x-a)}+\underbrace{\frac{f''(a)}{2!}(x-a)^2}+\underbrace{\frac{f'''(a)}{3!}(x-a)^3}+\underbrace{\frac{f^{(4)}(a)}{4!}(x-a)^4}+\ldots$$

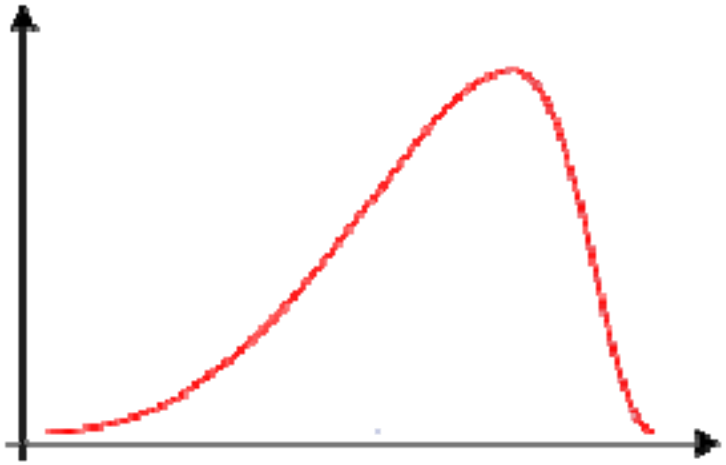
Expectation | Variance | Skewness | Kurtosis

3. Trad-Risk Management

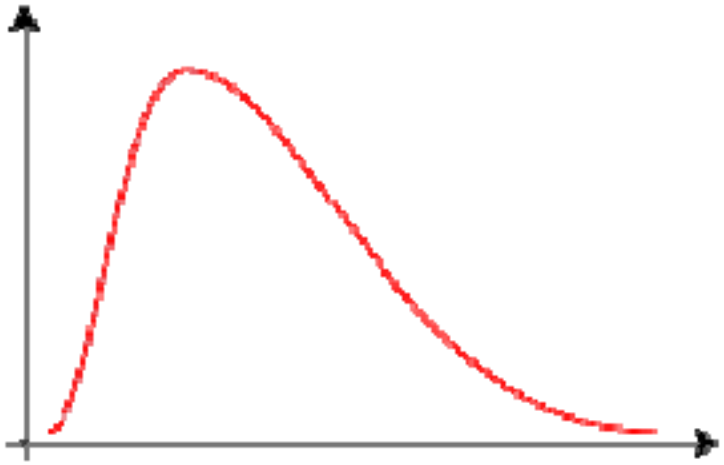




Blue・・・normal
Pink・・・sharp



Negative Skew



Positive Skew

3. Trad-Risk Management

Ex . Interest rate (ALM) risk

- The loss caused by interest rate fluctuation and shape variation of yield curve
- **Taylor** expansion of bond price（P:Bond price, y:Yield to maturity）.

$$dP/P = -D \cdot dy + (1/2)CX \cdot dy^2$$

D：modified duration, CX：convexity

- Duration matching : Measure the D and CX , and control it to the adequate level
- Immunization : $MV_A \times D_A = MV_L \times D_L$

3. Trad-Risk Management

Case . Short-term Bond

- One-year interest-bearing bond
- *Amount of redemption: 1,000,000yen*
- *Coupon: 60,000yen*
- ① market interest rate 4%

  P=(60,000+1,000,000)÷（1+0.04）=1,019,000
- ② market interest rate 6%

  P=(60,000+1,000,000)÷（1+0.06）=1,000,000
- ③ market interest rate 8%

  P=(60,000+1,000,000)÷（1+0.08）= 981,000

3. Trad-Risk Management

- **Case . Long-term Bond**
  - Comsolidated bond
  - *Coupon: 60,000yen*
  - *Bond Price= Coupon ÷ interest rate*
  - ① market interest rate 4%

    P=60,000÷0.04 =1,500,000
  - ② market interest rate 6%

    P=60,000÷0.06 =1,000,000
  - ③ market interest rate 8%

    P=60,000÷0.08 = 750,000

3. Trad-Risk Management

Ex. Delta Hedge

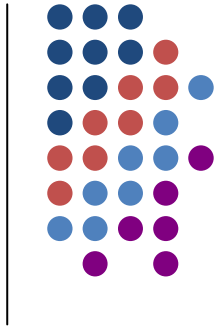
- Hedge: Pay the premium and move the risk to the third party
- Hedging instruments: Derivatives（Future, Forward, Option, Swap･･･）

- Value change of stock portfolio
- $= \alpha + \beta \times \Delta$TOPIX（stock market index）
- When you expect fall in value of your stock portfolio, you should sell the β of TOPIX future.

3. Trad-Risk Management

- Silo-Approach is suitable for the marginal price change of individual assets（class）.
- However, we are up against various risk and think the integrated risk management is to be needed.
- Value at Risk（VaR）is a good risk measurement for integrated risk management.

4. VaR



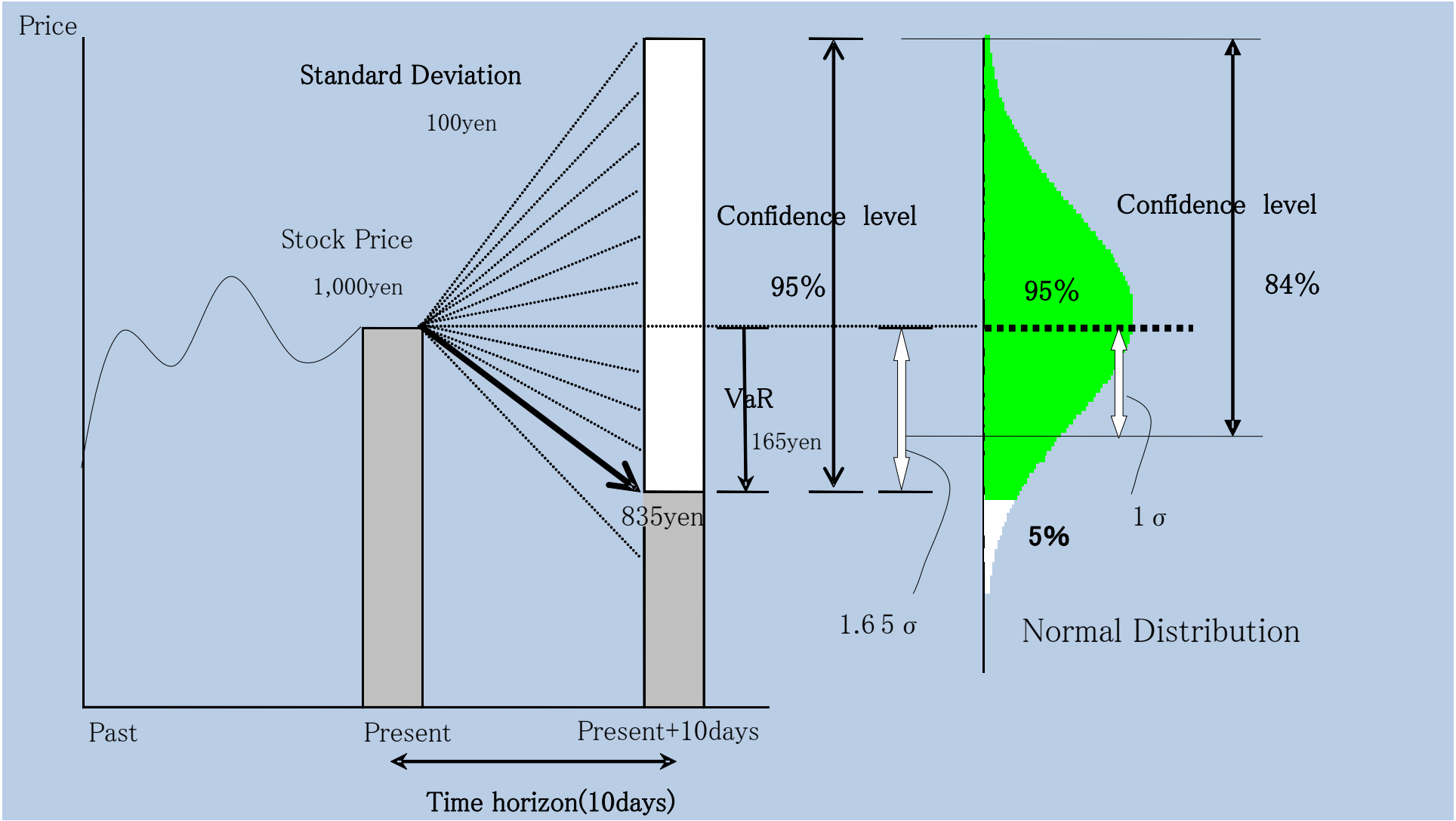
- **VaR**:
  - If a portfolio of stocks has a one-day 95% VaR of $1 million, there is a 0.05 probability that the portfolio will fall in value by more than $1 million over a one day period.
- **3 kinds of VaR**
  - ***Parametric approach（Variance-Covariance approach）***
  - ***Monte-Carlo simulation approach***
  - ***Historical simulation approach***

4. VaR

- Variance-Covariance approach
- VaR ＝【 Exposure 】
  ×【 Volatility in time horizon 】
  ×【 Confidence coefficient 】

Confidence level	84%	90%	95%	99%	99.5%	99.9%
Confidence coefficient	1.000	1.282	1.645	2.326	2.576	3.090

4. VaR


Price
Standard Deviation
100yen
Stock Price
1,000yen
Confidence level
95%
VaR
165yen
835yen
Confidence level
84%
95%
5%
1 σ
1.6 5 σ
Normal Distribution
Past
Present
Present+10days
Time horizon(10days)

4. VaR

Table. Example of a call option

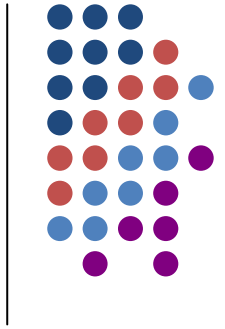
	Normality	Linearity	VaR
Parametric	○	○	$24,935
Monte-Carlo	○	×	$32,624
Historical	×	×	$36,038

- Normality: Symmetry Bell Curve
- Linearity: $F(x+y)=F(x)+F(y)$ and $F(ax)=a \cdot F(x)$

4. VaR

- Advantage
  - ✓ As the amount of money is displayed to the risk, the management understands risk magnitude and the necessary capital amount easily.
  - ✓ It is so common standard that it is possible to compare and analyze it to all trades.
- Disadvantage→→Tail-VaR（or Conditional VaR）
  - ✓ The size of the loss that exceeds the confidence level is not considered. When actual loss distribution is a fat tail, the risk is undervalued.
  - ✓ Sub-additivity（Risk(A+B)＜ Risk(A)+Risk(B))is not met.

5. Making Choices



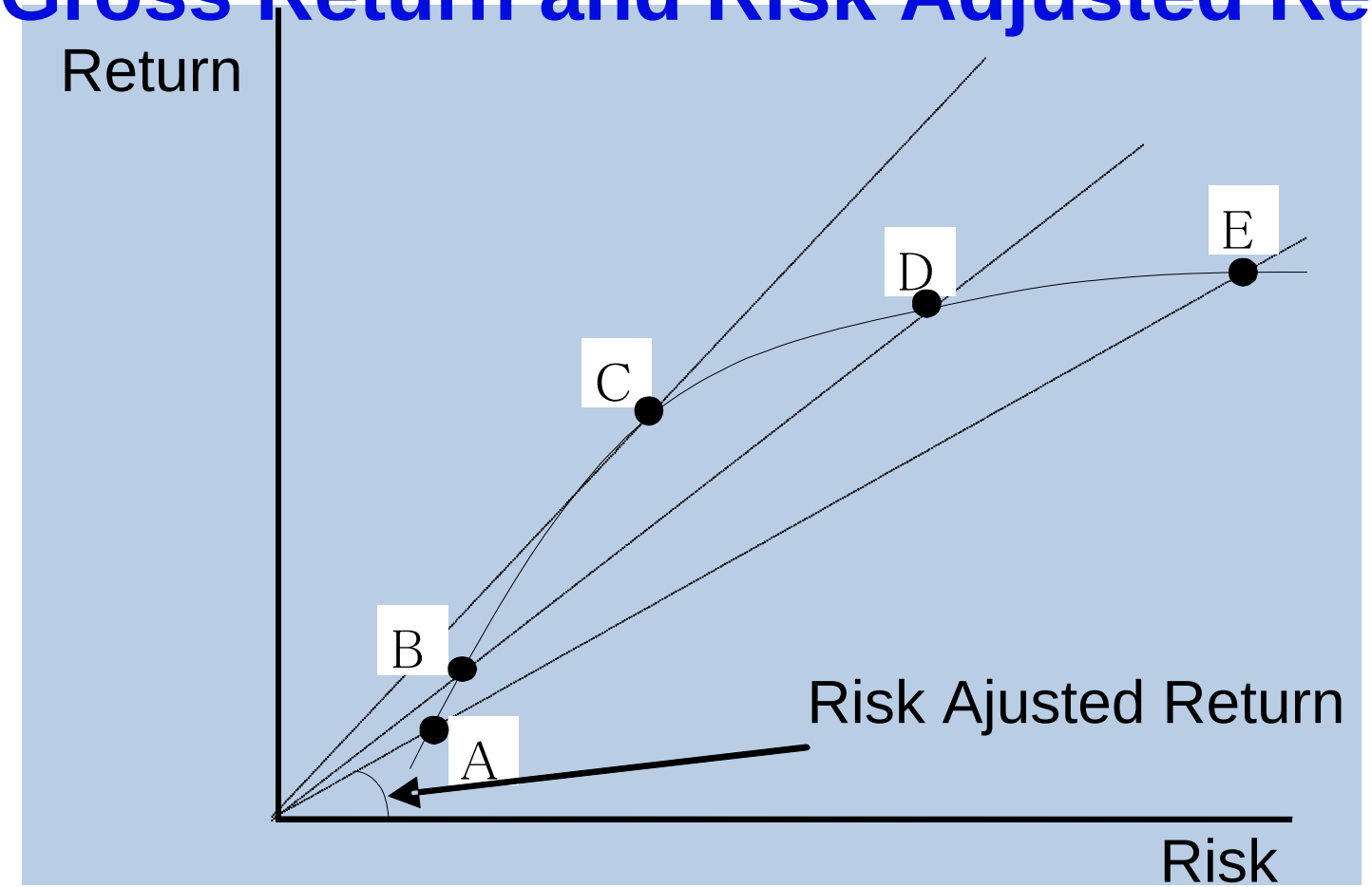
➢Risk Management（RM）

✓ **Mission of RM** is not only measuring risk but also making decision under uncertainty.

✓**The most important** is to consider and keep the adequate balance between risk and return.

5. Making Choices

- **Gross Return and Risk Adjusted Return**



5. Making Choices

- **Two Parameter Approach**
  - ✓ **Expectation**

$$\mu = p_1 x_1 + p_2 x_2 + \cdots\cdots + p_n x_n$$
$$= \Sigma\ p_i x_i$$

p : probability x:random variable

  - ✓ **Variance(Standard Deviation)**

$$\sigma^2 = p_1 (x_1 - \mu)^2 + p_2 (x_2 - \mu)^2 + \cdots\cdots + p_n (x_n - \mu)^2$$
$$= \Sigma\ p_i (x_i - \mu)^2$$

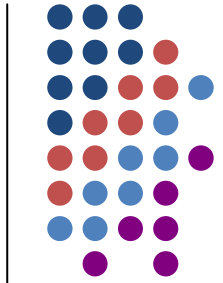
5. Making Choices

- Q5. How much will you pay to lottery?

	Prize	Number of winning	probability
First	$1,000	1	1%
Second	$100	4	4%
Third	$10	10	10%
losing	$0	85	85%
合計		100	

$1,000×1%＋$100×4%＋$10 ×10%＋$ 0×85%
=$15

5. Making Choices



- Q6. Which do you like A or B?

【Stock A】

Return (dollar)	Probability (%)
▲ 500,000	0
10,000	25
50,000	70
100,000	5
500,000	0

【Stock B】

Return (dollar)	Probability (%)
▲ 500,000	10
10,000	12.5
50,000	52.5
100,000	15
500,000	10

5. Making Choices

【Stock A】

Return (dollar)	Prob. (%)	Expected Return
▲ 500,000	0	0
10,000	25	2,500
50,000	70	35,000
100,000	5	5,000
500,000	0	0
		42,500

【Stock B】

Return (dollar)	Prob. (%)	Expected Return
▲ 500,000	10	−50,000
10,000	12.5	1,250
50,000	52.5	26,250
100,000	15	15,000
500,000	10	50,000
		42,500

→Expected return of A is the same of the expected return of B !

5. Making Choices

→We need risk measurement , or variance (standard deviation) of return !

【A株式】

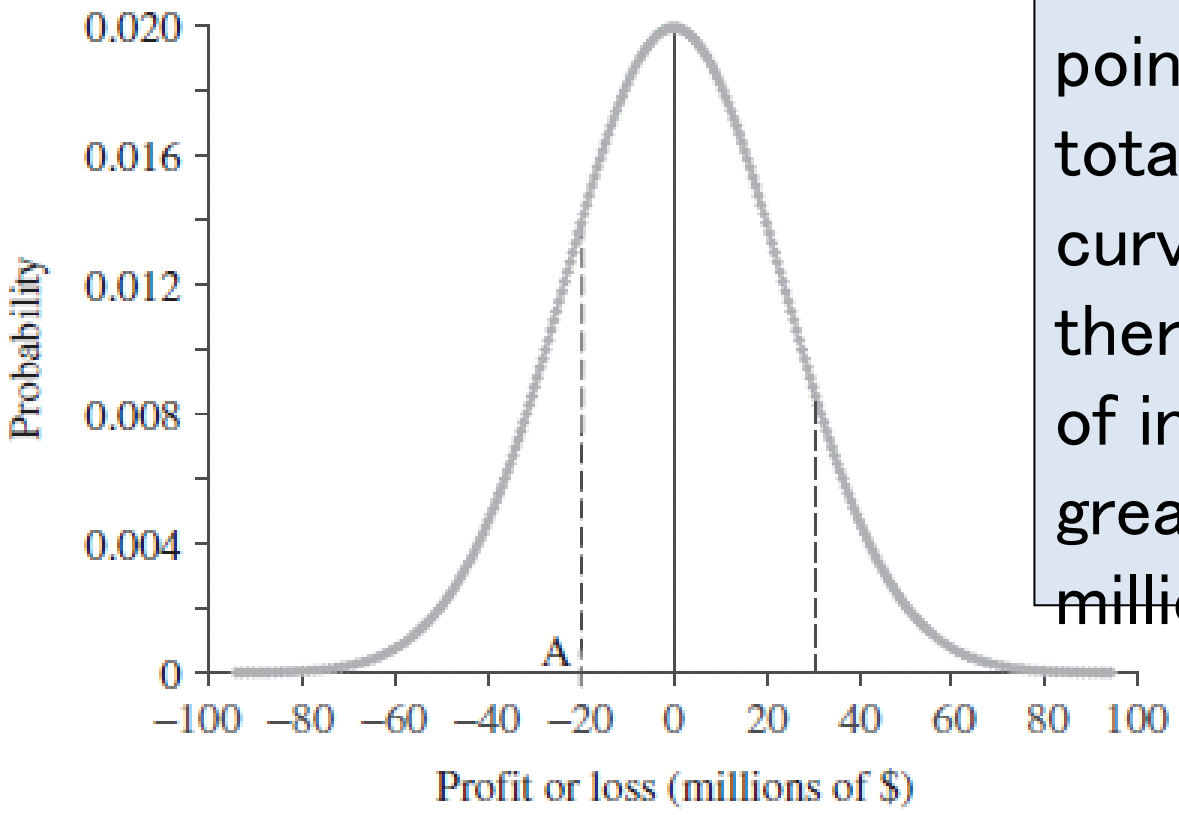
収益額(円) ①	確率(%) ②	期待値 ③=Σ(①×②)	偏差 ④=①−③	偏差の二乗 ⑤=④×④	分散 ⑥=Σ(⑤×②)	標準偏差 ⑦=√(⑥)
▲ 500,000	0	0	▲ 542,500	294,306,250,000	0	
10,000	25	2,500	▲ 32,500	1,056,250,000	264,062,500	
50,000	70	35,000	7,500	56,250,000	39,375,000	
100,000	5	5,000	57,500	3,306,250,000	165,312,500	
500,000	0	0	457,500	209,306,250,000	0	
		42,500			468,750,000	21,651

【B株式】

収益額(円) ①	確率(%) ②	期待値 ③=Σ(①×②)	偏差 ④=①−③	偏差の二乗 ⑤=④×④	分散 ⑥=Σ(⑤×②)	標準偏差 ⑦=√(⑥)
▲ 500,000	10	-50,000	▲ 542,500	294,306,250,000	29,430,625,000	
10,000	12.5	1,250	▲ 32,500	1,056,250,000	132,031,250	
50,000	52.5	26,250	7,500	56,250,000	29,531,250	
100,000	15	15,000	57,500	3,306,250,000	495,937,500	
500,000	10	50,000	457,500	209,306,250,000	20,930,625,000	
		42,500			51,018,750,000	225,873

5. Making Choices

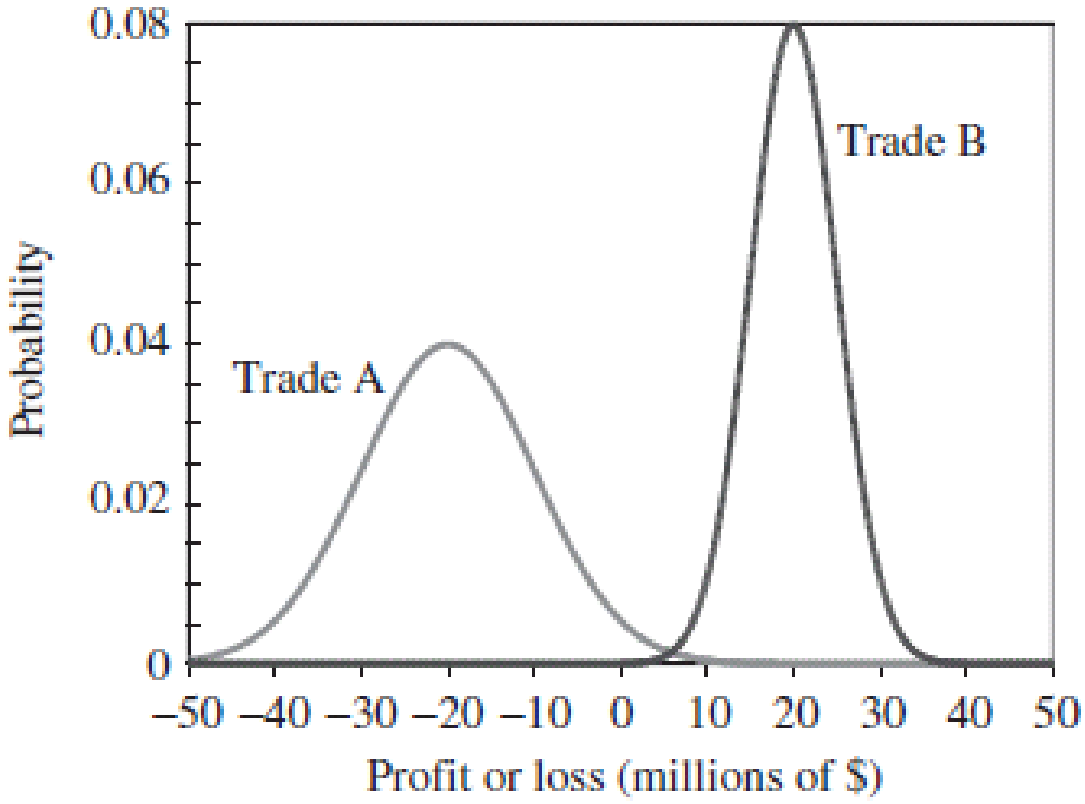
- Figure 5.1. A profit-and-loss distribution



The area to the left of point A is 20% of the total area under the curve, indicating that there is a 20% chance of incurring a loss greater than $20 million.

5. Making Choices

- Figure 5.2. The profit-and-loss distributions for two trades (A and B)

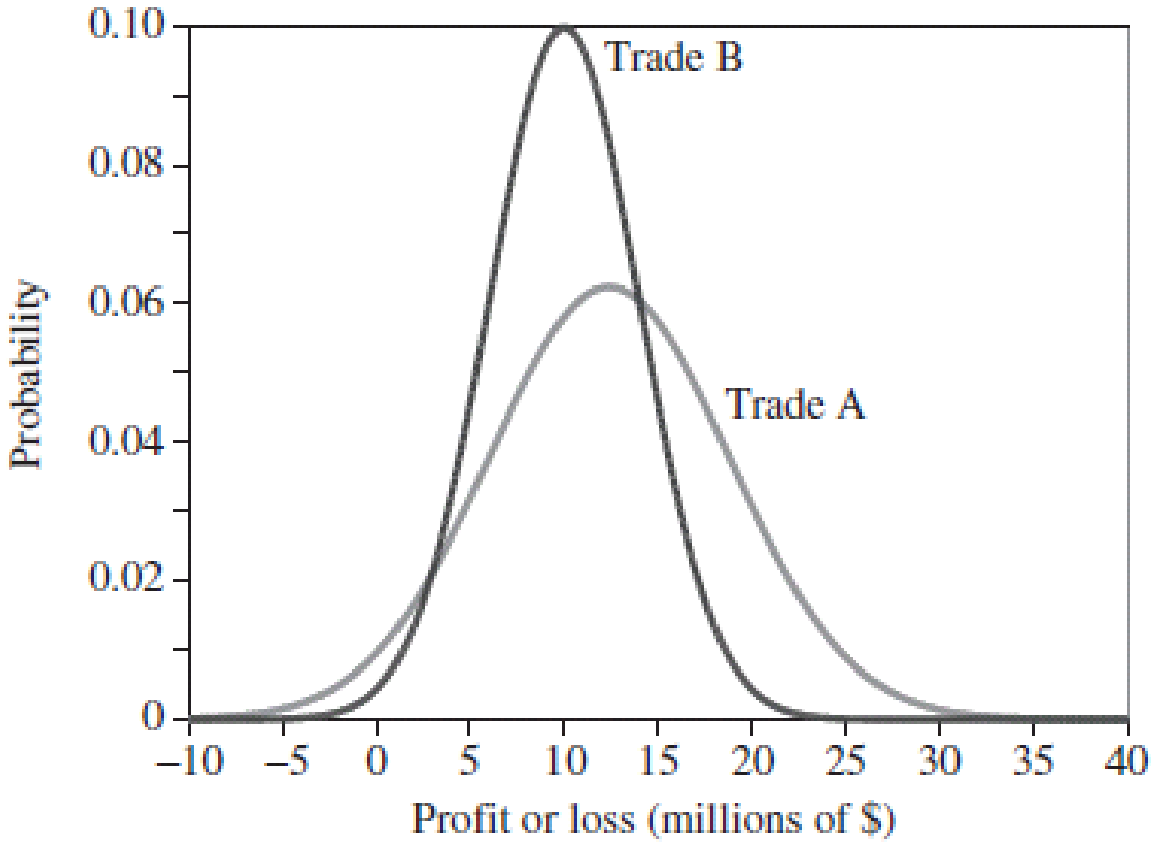


Q7. Which trade do you prefer to ?

→However, such situation does not exist because of arbitrage transaction.

5. Making Choices

- Figure 5.3. The profit-and-loss distributions for two other trades



Q8. Do you still find it just as obvious which one you prefer to?

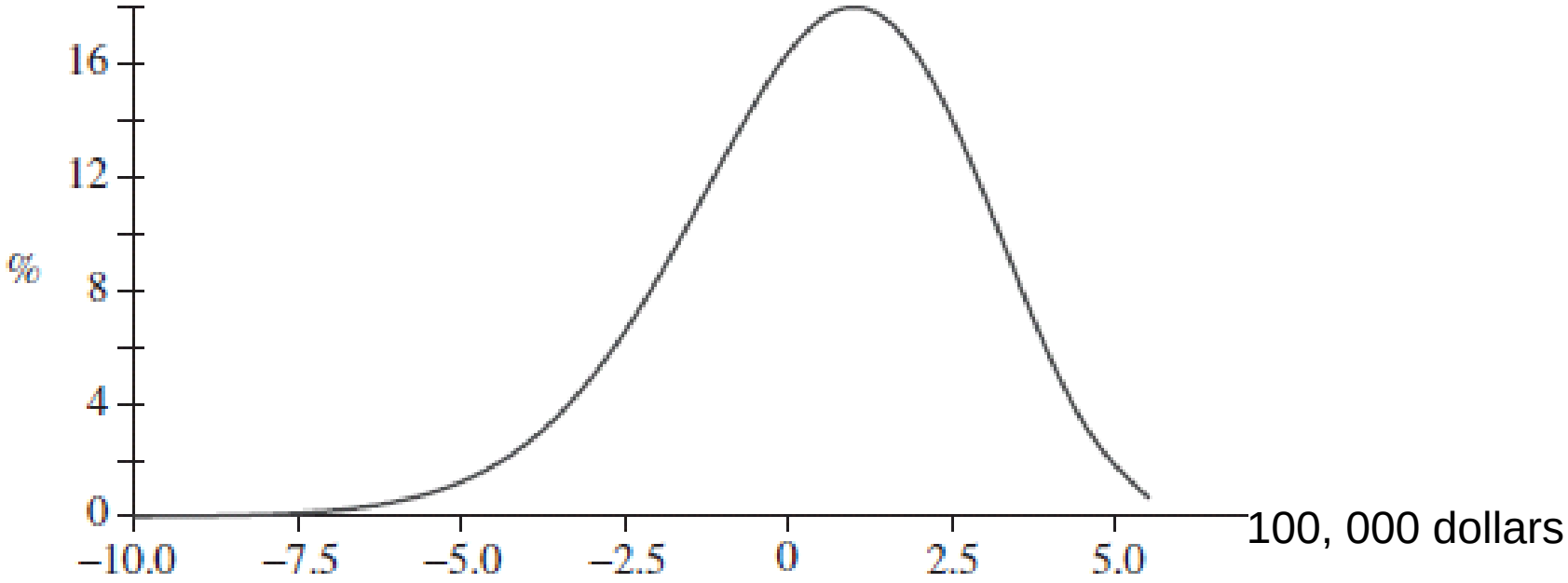
→It depends on the utility function (risk averse degree) of investors.

5. Making Choices

- **Profit-and-loss distribution form**
  - ✓Above discussion makes normal distribution assumption.
  - ✓Is the distribution of trades of all kinds normal distribution?
  - ✓The distribution of the stock might be approximated by normal distribution.
  - ✓But, How about loan or derivative trades?

5. Making Choices

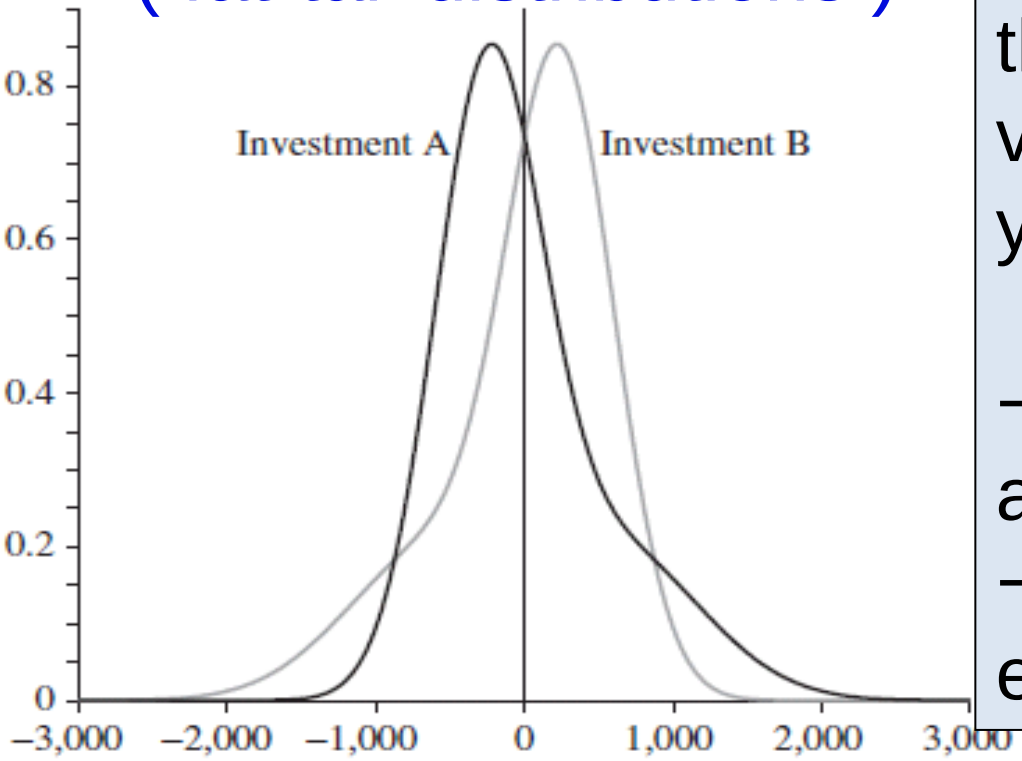
- Figure 5.4. The profit-and-loss distribution obtained from advancing $1,000,000 to 1,000 (independent) companies.（default probability 0.5%）



5. Making Choices

- Figure 5.5. The profit-and-loss distributions from investments A and B

(fat-tail distributions)



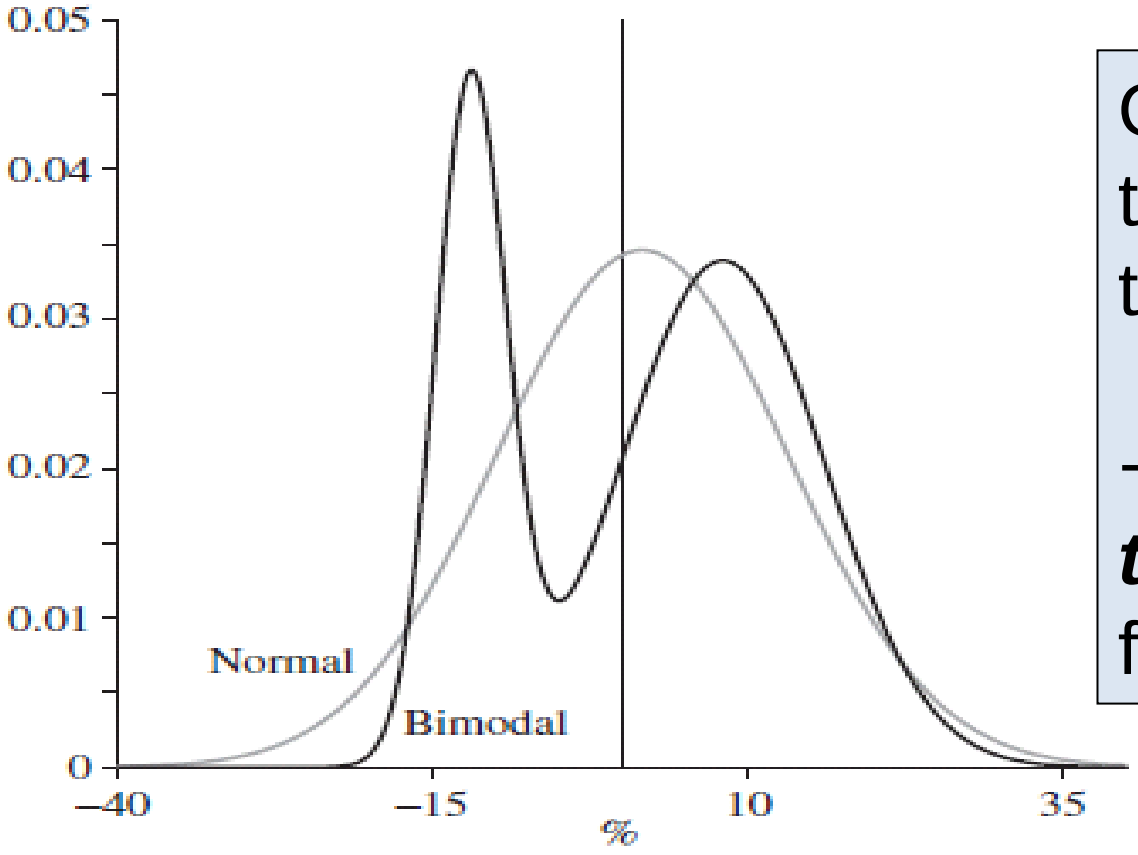
Q9. The distributions from both the investments have the same expectation and variance. Which trade do you prefer to ?

→Limit of two parameter approach

→A is preferred in an economic experiment.

5. Making Choices

- Figure 5.6. Two profit-and-loss distributions with the same mean and variance

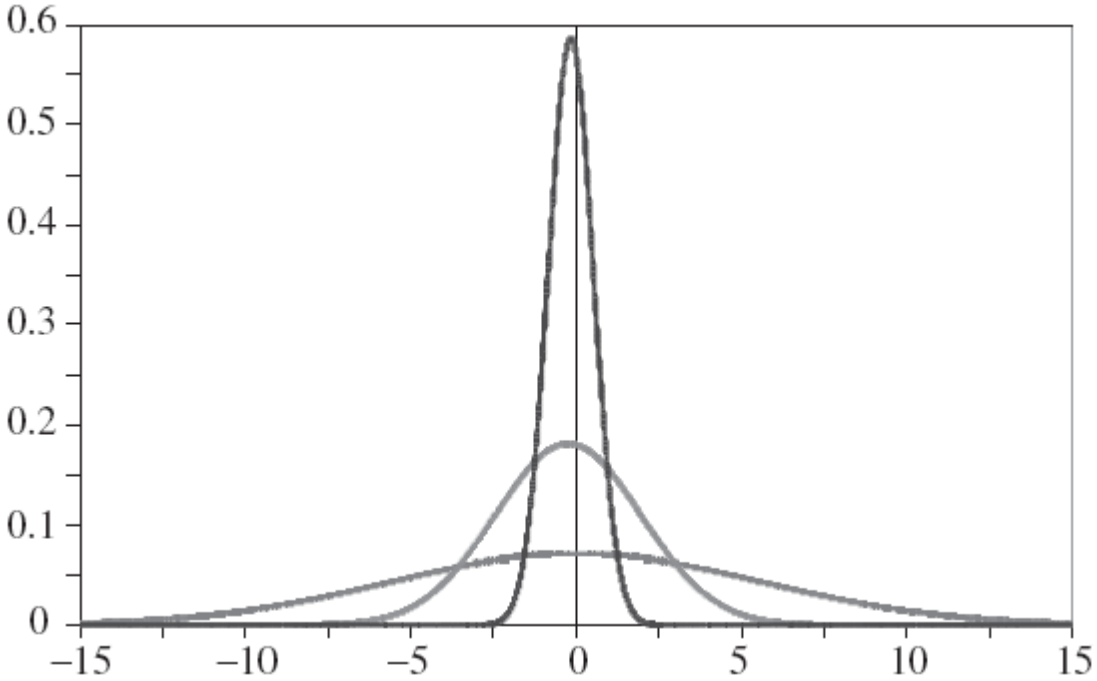


Q10. Again, which trade do you prefer to ?

→We don't have ***the magic formula*** for making decision.

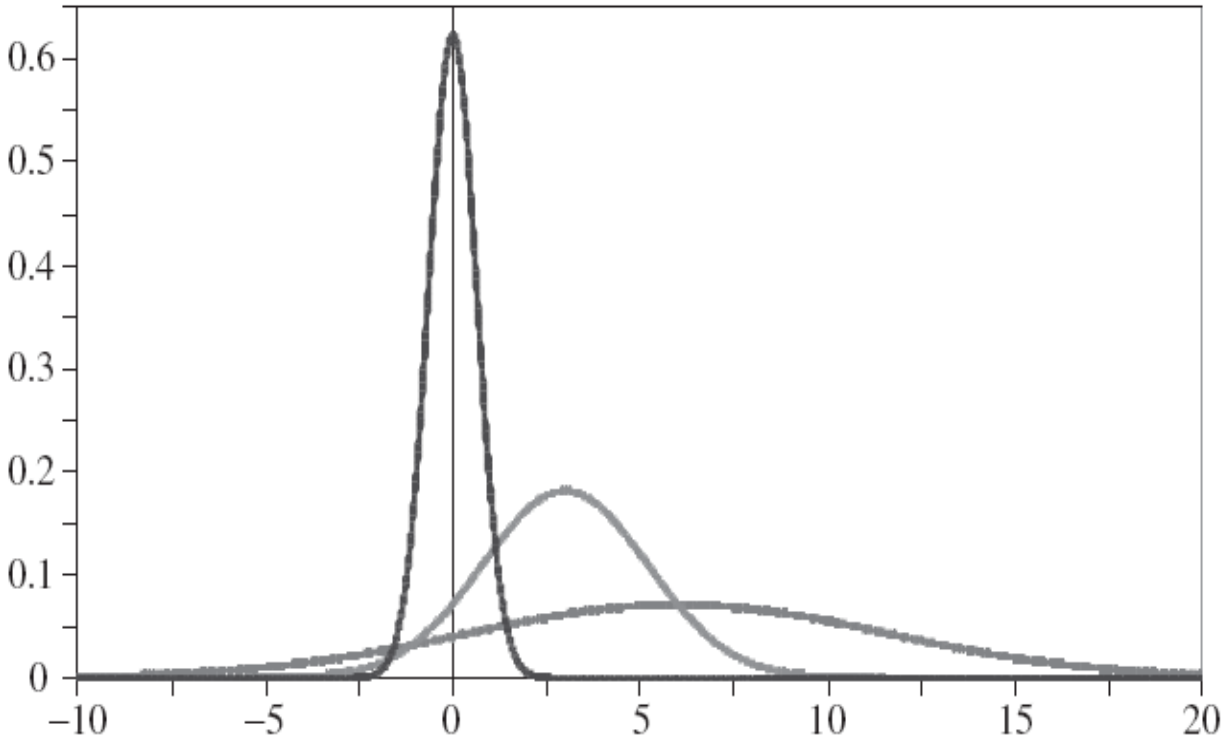
5. Making Choices

- Figure 5.7. The return distributions from a position in two-, five-, and ten-year bonds. In these simulations, the trend from the interest rate data has been subtracted.



5. Making Choices

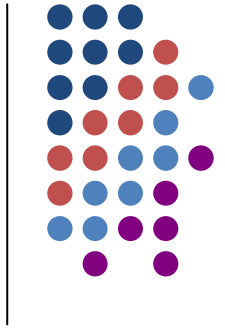
- Figure 5.8. More crucial is to estimate future return , not to measure risk!



5. Making Choices

- Human has two systems to cognize the risk (probability)
  - ✓ System 2: By reflective cognition, we know the correct risk slowly.
  - ✓ →Frequency (objective) probability
  - ✓ System 1: Depending on “heuristic” analysis, we react to the risk quickly.
  - ✓ →Bayesian (subjective) probability

5. Making Choices



- Q11. Which type of probability we should use in our risk management?
  - ✓ Market Risk v.s Credit Risk , ALM Risk

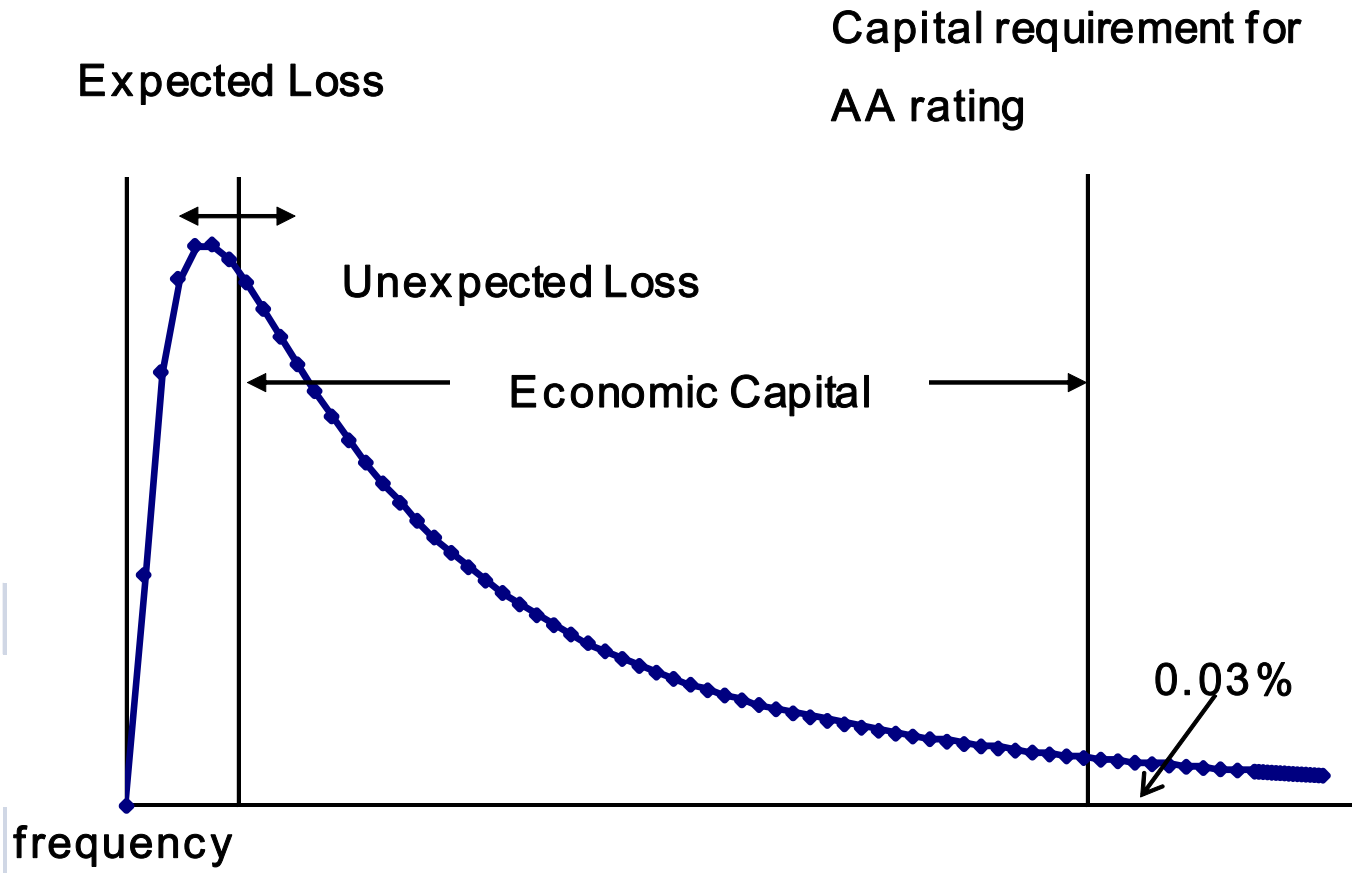
Type of probability	Bayesian	Frequentist
Frequency of data collection	Long interval	Short interval
Time horizon of our prediction	Long term	Short term
Time homogeneity of the phenomenon	Time varying	Constancy
Rarity of the event	Rare	Very often

6. ERM

- It is an inclusive, integrated frame that administers the various risks (credit risk, market risk, operational risk and insurance risk) , the economic capital, and the risk transfer to maximize the corporate value.
  - ✓ ①Centralized risk-management function
  - ✓ ②Integrated risk transfer strategy
  - ✓ ③Optimization of the business performance by supporting the decision making of pricing and the resource allocation, etc.

6. ERM

- Economic Capital（⇔Regulatory Capital）
  - ✓ The capital that covers the unexpected loss



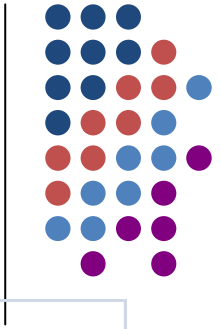
6. ERM

- Economic Capital Approach
  - The profitability of the business or trades is evaluated based on RORAC
  - RORAC（Return On Risk Adjusted Capital）

    = Return ／ （ Risk Adjusted Capital ）

    = Return ／ Economic Capital
- Stress Testing
  - The loss when an extreme event occurs is measured by scenario-analysis

6. ERM

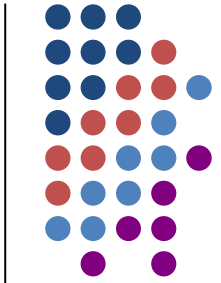


Business Unit	Credit Risk	Market Risk	Op Risk	Other Risk	Sum
Retail	EC / RORAC	$ / %	$ / %	$ / %	$ / %
Whole sale					
Asset Managemen					
Admini					
Sum	$ / %	$ / %	$ / %	$ / %	$ / %

6. ERM

				Credit	Market (ALM)		Ope	P&C	Life
					Stock	Interest			
Bank	*OWC*			53%		21%	26%		
	CMRA	38 banks		62%		19%	19%		
		6 banks		48%		21%	31%		
	BOJ	Mega	2002	61%	30%	6%	3%		
			2007	35%	56%	6%	3%		
		Regional	2002	56%	20%	18%	6%		
			2007	36%	32%	25%	7%		
Insurance	*Steven et al*	Life		10%		55%	30%		5%
	Nakada et al	P&C		2%		37%	10%	51%	
	Ward=Lee	Composite		19%	17%	27%	5%	28%	4%
	FSA	Life		14%	63%	16%	2%		21%
		P&C		4%	44%	0.6%	2%	60%	

6. ERM



Seven Lessons from Past Experience

1. Know your business
2. Establish internal check system
3. Set Limit and Restraint
4. Watch cash flow
5. Use an adequate measure for evaluation
6. Create a desirable relationship between compensation and incentive

6. ERM

7. Keep a balance between yin and yang

Hardware (yin):Process, System and Reporting

Risk Management Committee, Risk management policy and process, Risk Measurement and Reporting, Risk Limit Control

→Suppression factor for risk-taking

Software(yang):Human, Culture, Value and Incentive

Leadership of management, Risk Culture, Communication, Education and Training Program

→ Promotion factor for risk-taking

7. Reference

- Michel Crouhy. “The Essentials of Risk Management: The Definitive Guide for the Non-risk Professional ”
- James Lam . “ Enterprise Risk Management: From Incentives to Controls ”
- Riccardo Rebonato, “ Plight of the Fortune Tellers: Why We Need to Manage Financial Risk Differently ”