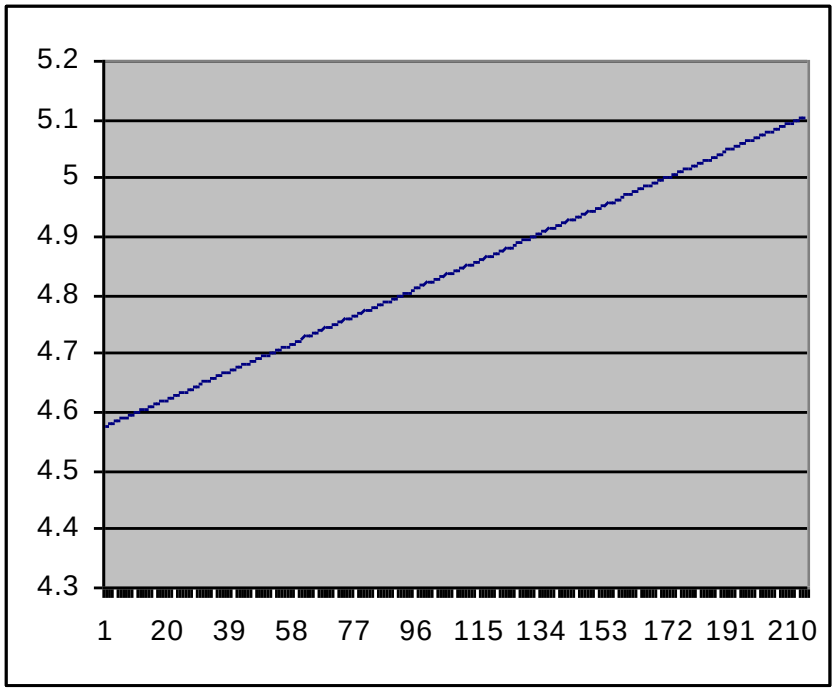
FN 201
BUSINESS FINANCE

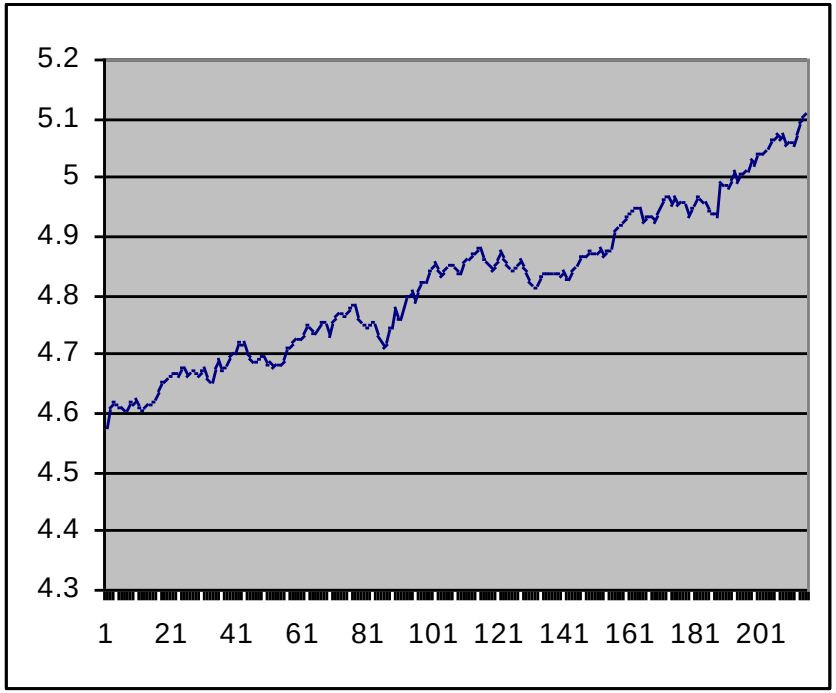
Lecture 11

Risk and Return

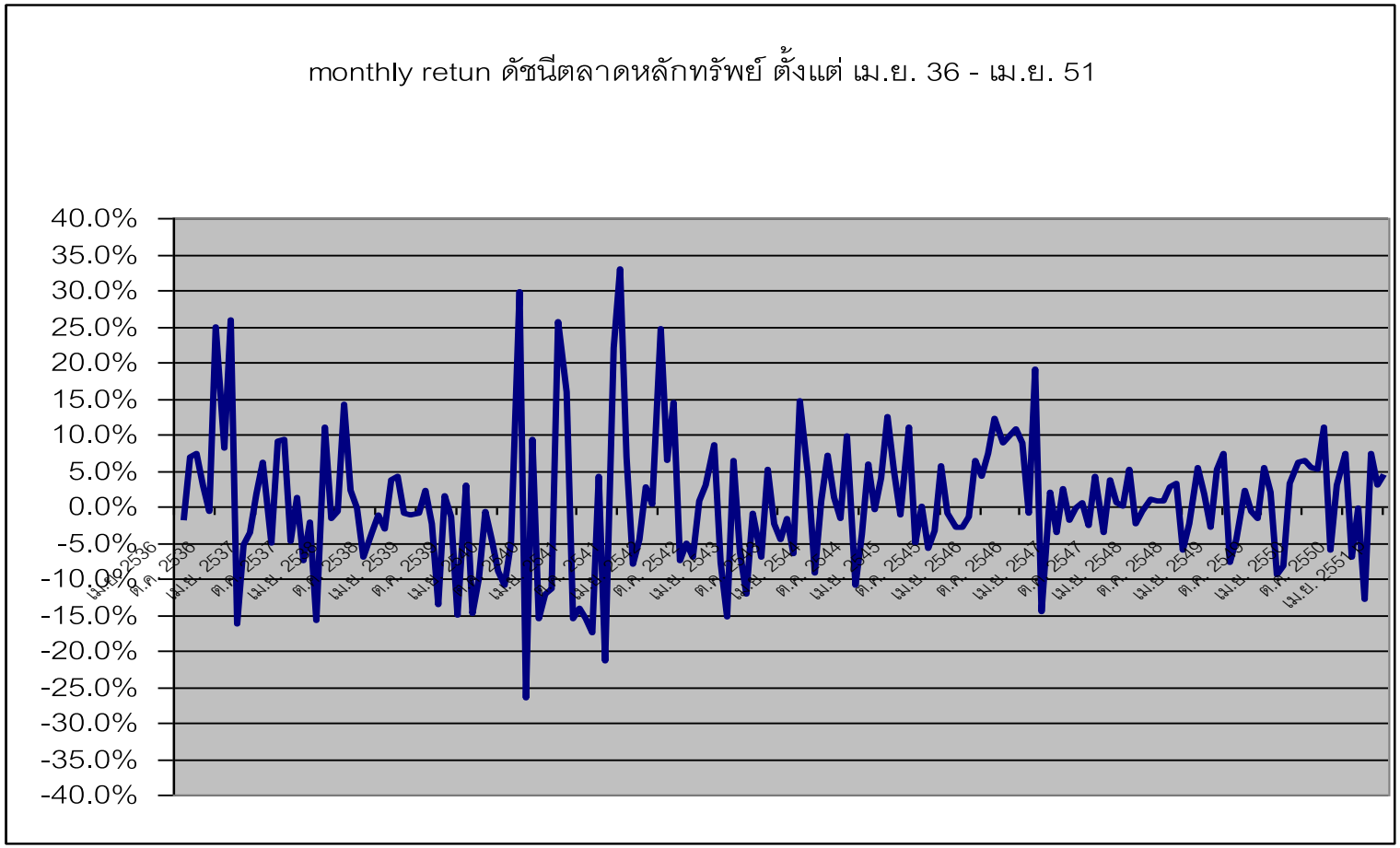
What is Risk?

- Risk is not “danger of losses” but rather “dispersion of unexpected outcome
  - Lose more or less than “expected” -> risk
  - Gain more or less than “expected” -> risk
- Good Risk vs Bad Risk





This is Risk

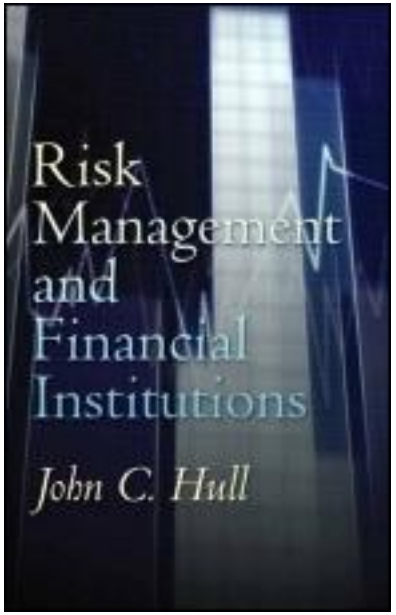

monthly retun ดัชนีตลาดหลักทรัพย์ ตั้งแต่ เม.ย. 36 - เม.ย. 51
40.0%
35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
-5.0%
-10.0%
-15.0%
-20.0%
-25.0%
-30.0%
-35.0%
-40.0%

What is Risk?

- In statistics -> Risk is Standard Deviation around the expected result
- High risk -> There is a wider range of possible outcome around the expected result
- Low risk -> There is a narrower range of possible outcome around the expected result
- So Risk and Return are the two sides of the coin
  - If you expect high return -> you need to take high risk -> there is a trade-off

Reference

- Excerpt from John C. Hull, Risk Management and Financial Institutions, Pearson International Edition, 2007



- Concerned with the way risks are managed by banks and other Fis, but many of the ideas and approaches are equally applicable to other types of firms

Agenda

- Quantify risk
- Portfolio Risk and Return
- Efficient Frontier
- Diversification
- Risk Preference
- Quantify expected return given risk of asset
  - CAPM Model

Key Concepts

- Risk and (expected) Return trade-off
  - Expected return defined as weighted average of possible return
    - Weights being probability of the return occurring
  - Risk defined as standard deviation of return over one year
    - Risk = sqrt($E(R^2) - [E(R)]^2$)
    - Now we can "quantify" the risk

Ex1. Cal E(r) and Risk

- Return in 1 year from investing 100k in equities

Probability	Return
0.05	+50%
0.25	+30%
0.40	+10%
0.25	-10%
0.05	-30%
Total = 1.00	

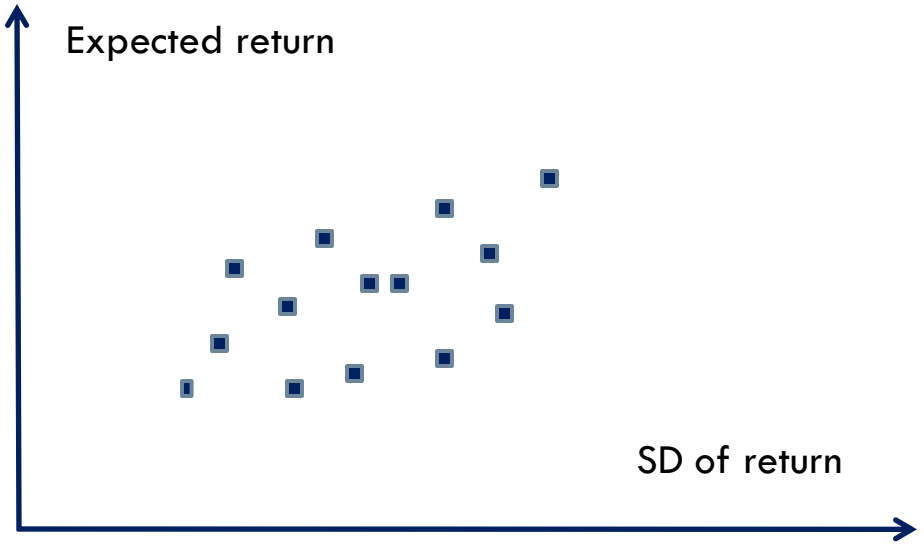
- $E(r) = 0.05*0.50 + 0.25*0.30 + 0.40*0.10 + 0.25*(-0.10) + 0.05*(-0.30) = \underline{0.10 \text{ or } 10\%}$
- risk or $SD(r) = \text{sqrt}(E(R^2) - [E(R)]^2)$
- $E(R^2) = 0.05*0.50^2 + 0.25*0.30^2 + 0.40*0.10^2 + 0.25*(-0.10)^2 + 0.05*(-0.30)^2 = 0.046$
- $SD(r) = \text{sqrt} (0.046 - 0.10^2) = \underline{0.1897 \text{ or } 18.97\%}$

Pioneer work in the area of risk & return tradeoff

- Markowitz (1952)
  - Quantifying risk
  - Portfolio risk
  - Efficient frontier
- Sharp(1964)
  - CAPM model – express relationship between expected return and risk in terms of (one) systematic risk
- Ross (1976)
  - Arbitrage pricing theory – an extension of CAPM- there are several sources of systematic risk
- All these works have had a profound effect on the way we think about risk today
- Key ideas will be recapped here

Investment Opportunities

- Given knowing how to "quantify" risk, we can characterize every investment opportunity by expected return and SD of return



- The most interesting question is <u>what will happen (in terms of risk and return) if we combine investment A & B to form a portfolio?</u>

What do you think?

Portfolio Risk and Return

- Expected returns $$E[r_p] = w_A \cdot E[r_A] + w_B \cdot E[r_B]$$

- Variance of return

$$Var(r_p) = w_A^2 Var(r_A) + w_B^2 Var(r_B) + 2 w_A w_B Cov(r_A, r_B)$$

- SD of return = sqrt(Var(r_p))
- Note:

$$\rho_{A,B} = \frac{\text{COV}_{A,B}}{\sigma_A \sigma_B}$$

Portfolio Risk

- The variance of a two stock portfolio is the sum of these four boxes from variance-covariance matrix

	Stock 1	Stock 2
Stock 1	$x_1^2\sigma_1^2$	$x_1x_2\sigma_{12} = x_1x_2\rho_{12}\sigma_1\sigma_2$
Stock 2	$x_1x_2\sigma_{12} = x_1x_2\rho_{12}\sigma_1\sigma_2$	$x_2^2\sigma_2^2$

How the risk of portfolio consisting of 3 stocks looks like?

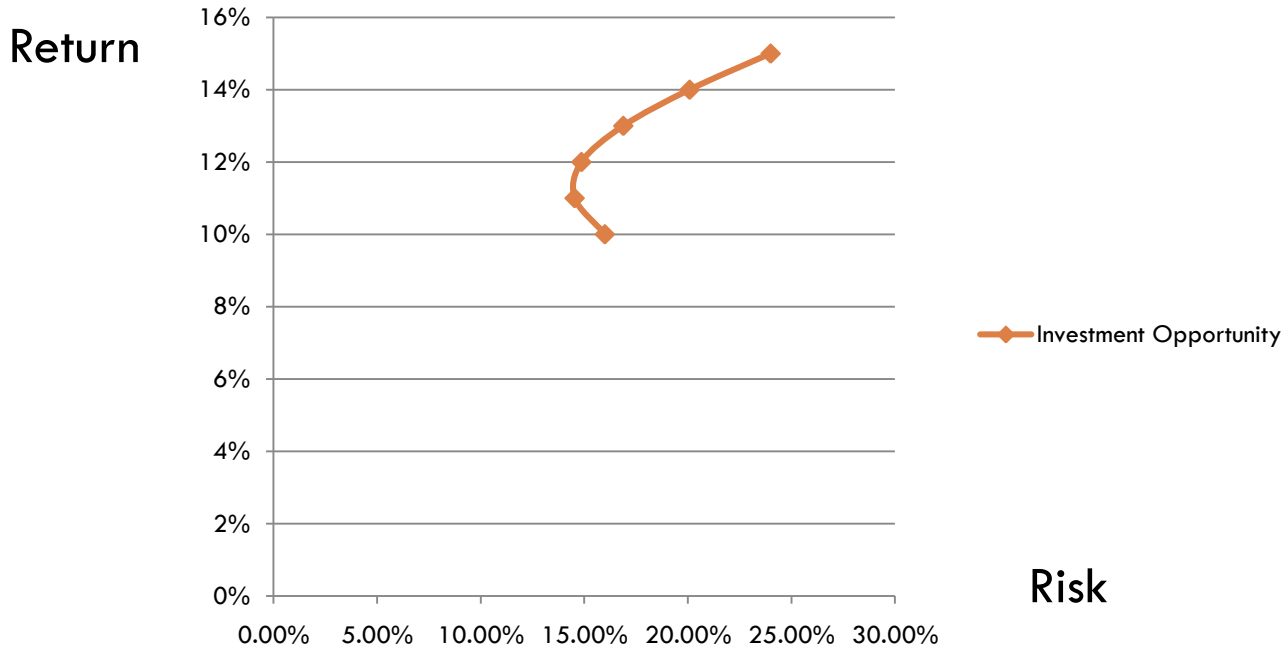
Ex2. Cal Portfolio risk and return

- Two assets have following characteristics
  - $E(r_A) = 10\%$, $SD(r_A) = 16\%$
  - $E(rB) = 15\%$, $SD(rB) = 24\%$
  - Correlation b/w the returns is 0.2

Weight A	Weight B	$E(r_p)$	$SD(r_p)$
0.0	1.0	15%	24.00%
0.2	0.8	14%	20.09%
0.4	0.6	13%	16.89%
0.6	0.4	12%	14.87%
0.8	0.2	11%	14.54%
1.0	0.0	10%	16.00%

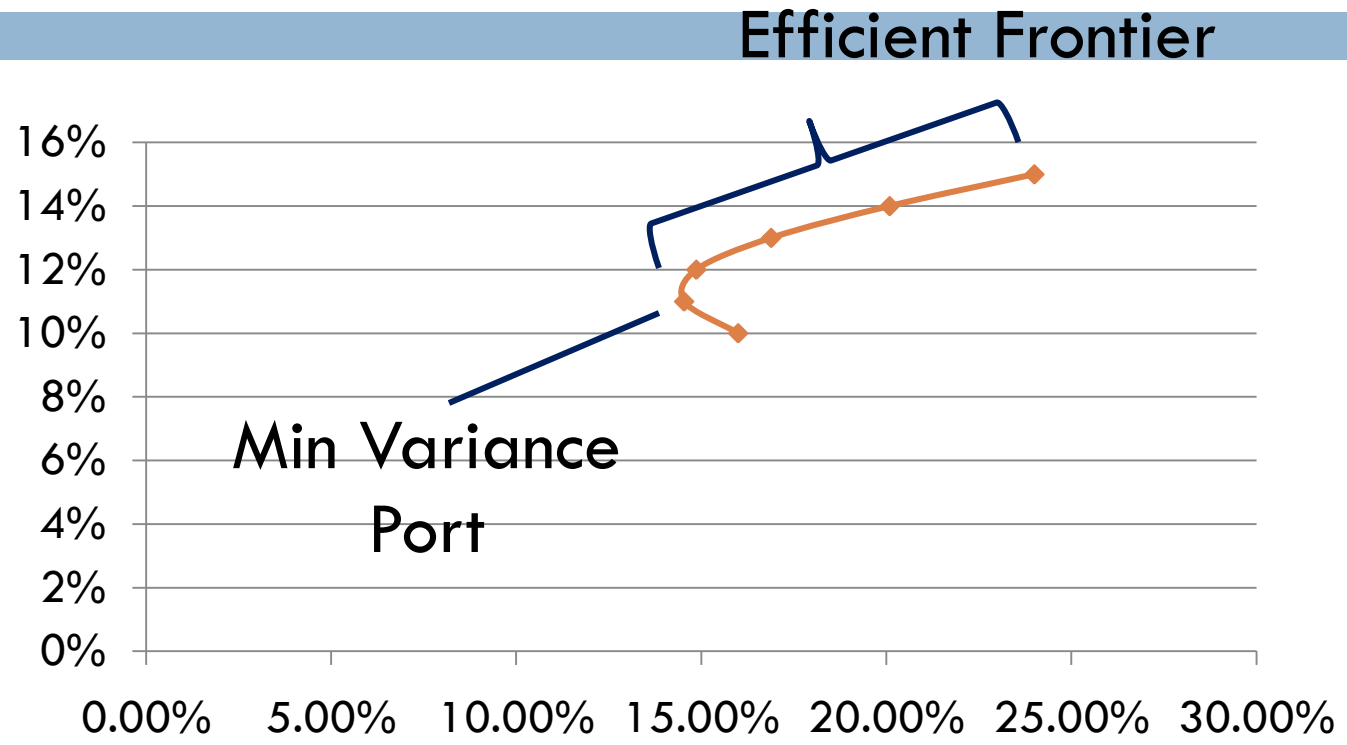
Ex2. Cal Portfolio risk and return (2)

- Make a plot



- Most investors are risk-averse
  - They want to increased expected return while reducing SD of return
  - Try to move as far as they can in a “north-west” direction

Efficient Frontier



- This represent how far we can move in a north-west direction
- Investor must invest on this efficient frontier
- There is no investment that dominates a point on the frontier in the sense that it has both a "higher expected return and lower risk
- It illustrate the best possible risk and return trade-off (in the world with only 2 assets)

Diversification

Ex3. Impact of Correlation

- What will happen if correlation between two assets is 1, 0 or -1?
- Suppose you invest 60% of your portfolio in Wal-Mart and 40% in IBM.
  - The expected return on Wal-Mart and IBM is 10% and 15%
  - The standard deviation of their annualized daily returns are 19.8% and 29.7%, respectively
  - Assume a correlation coefficient of 1.0 and calculate the portfolio risk
  - What will happen if correlation reduce to 0 and eventually reach -1?

rho	**1.00**
SD (Wal.)	**19.80%**
SD (IBM)	**29.70%**
w1	**0.60**
w2	**0.4**

Comp.1	0.014113
Comp.2	0.014113
Comp.3	0.028227
Port.Val	0.056454
SD	23.76%
Return	23.76%

rho	**0.75**
SD (Wal.)	**19.80%**
SD (IBM)	**29.70%**
w1	**0.60**
w2	**0.4**

Comp.1	0.014113
Comp.2	0.014113
Comp.3	0.02117
Port.Val	0.049397
SD	22.23%
Return	23.76%

rho	**0.50**
SD (Wal.)	**19.80%**
SD (IBM)	**29.70%**
w1	**0.60**
w2	**0.4**

Comp.1	0.014113
Comp.2	0.014113
Comp.3	0.014113
Port.Val	0.04234
SD	20.58%
Return	23.76%

rho	**0.25**
SD (Wal.)	**19.80%**
SD (IBM)	**29.70%**
w1	**0.60**
w2	**0.4**

Comp.1	0.014113
Comp.2	0.014113
Comp.3	0.007057
Port.Val	0.035284
SD	18.78%
Return	23.76%

rho	-1.00
SD (Wal.)	19.80%
SD (IBM)	29.70%
w1	0.60
w2	0.4

Comp.1	0.014113
Comp.2	0.014113
Comp.3	-0.02823
Port.Val	0
SD	0.00%
Return	23.76%

rho	-0.75
SD (Wal.)	19.80%
SD (IBM)	29.70%
w1	0.60
w2	0.4

Comp.1	0.014113
Comp.2	0.014113
Comp.3	-0.02117
Port.Val	0.007057
SD	8.40%
Return	23.76%

rho	-0.50
SD (Wal.)	19.80%
SD (IBM)	29.70%
w1	0.60
w2	0.4

Comp.1	0.014113
Comp.2	0.014113
Comp.3	-0.01411
Port.Val	0.014113
SD	11.88%
Return	23.76%

rho	-0.25
SD (Wal.)	19.80%
SD (IBM)	29.70%
w1	0.60
w2	0.4

Comp.1	0.014113
Comp.2	0.014113
Comp.3	-0.00706
Port.Val	0.02117
SD	14.55%
Return	23.76%

Ex. Try it in Excel

	Stock prices		Monthly Return	
Date	PNC	GS	PNC	GS
3/2/2000	34.16	80.22		
4/2/2000	33.46	79.57		
7/2/2000	33.13	80.57	4.665%	4.066%
8/2/2000	33.83	84.03	10.297%	6.097%
9/2/2000	33.08	81.51	9.109%	2.535%
10/2/2000	32.05	81.39	1.636%	2.905%
11/2/2000	31.63	79.98	-8.395%	1.005%
14/2/2000	31.25	81.27	-11.618%	1.288%
15/2/2000	32.38	81.27	-6.313%	-0.160%
16/2/2000	31.53	77.93	-7.601%	-5.152%
17/2/2000	31.35	77.16	-5.220%	-4.548%
18/2/2000	30.03	75.93	-9.249%	-5.857%
22/2/2000	29.66	76.64	-9.482%	-0.222%
24/2/2000	28.53	84.21	-14.797%	6.627%
25/2/2000	28.25	83.86	-18.321%	1.127%
28/2/2000	29.33	82.68	-17.816%	-1.130%
29/2/2000	29.05	86.91	-17.020%	6.133%
1/3/2000	29.09	89.03	-21.423%	3.358%
2/3/2000	29.19	90.44	-21.606%	5.337%
3/3/2000	29.23	96.31	-18.158%	11.765%
6/3/2000	28.62	97.42	-17.695%	19.426%
7/3/2000	27.54	98.54	-19.471%	21.383%

	PNC	GS
E[r]	0.675%	0.956%
SD[r]	6.669%	9.085%
var[r]	0.004447	0.008254
SD[r]	6.669%	9.085%
Covar Mat	PNC	GS
PNC	0.004447	0.001895
GS	0.001895	0.008254
Covar Mat	PNC	GS
PNC	0.004447	0.001895
GS	0.001895	0.008254

$$E[r_p] = w_A \cdot E[r_A] + w_B \cdot E[r_B]$$

$$Var(r_p) = w_A^2 Var(r_A) + w_B^2 Var(r_B) + 2 w_A w_B Cov(r_A, r_B)$$

W(PNC)	W(GS)	E[rp]	SD[rp]
-0.25	1.25	1.0%	11%
0	1	1.0%	9%
0.05	0.95	0.9%	9%
0.1	0.9	0.9%	8%
0.15	0.85	0.9%	8%
0.2	0.8	0.9%	8%
0.25	0.75	0.9%	8%
0.5	0.5	0.8%	6%
0.75	0.25	0.7%	6%
1	0	0.7%	7%

1-Steps Calculation	0.2855	=MMULT(MMULT(w,sigma),TRANSPOSE(w))

Diversification Benefit

- What is it exactly?
- In plain word,
  - It is unlikely that things will turn out badly at the same time
  - Or price of all stocks in your investment portfolio unlikely to drop at the same time, some firms will perform well while others may not
- In technical term,
  - idiosyncratic risk between firms get cancelled out

This is diversification benefit

The traditional theory on diversification "Don't put your eggs in one basket"
(Photo courtesy of www.moneywise.co.uk)

The Importance of Diversification

From year to year, there's no telling which asset classes will be the best performers—a strong argument for portfolio diversification. The chart below ranks the best to worst performing asset classes from top to bottom for the years 1999 to 2008.

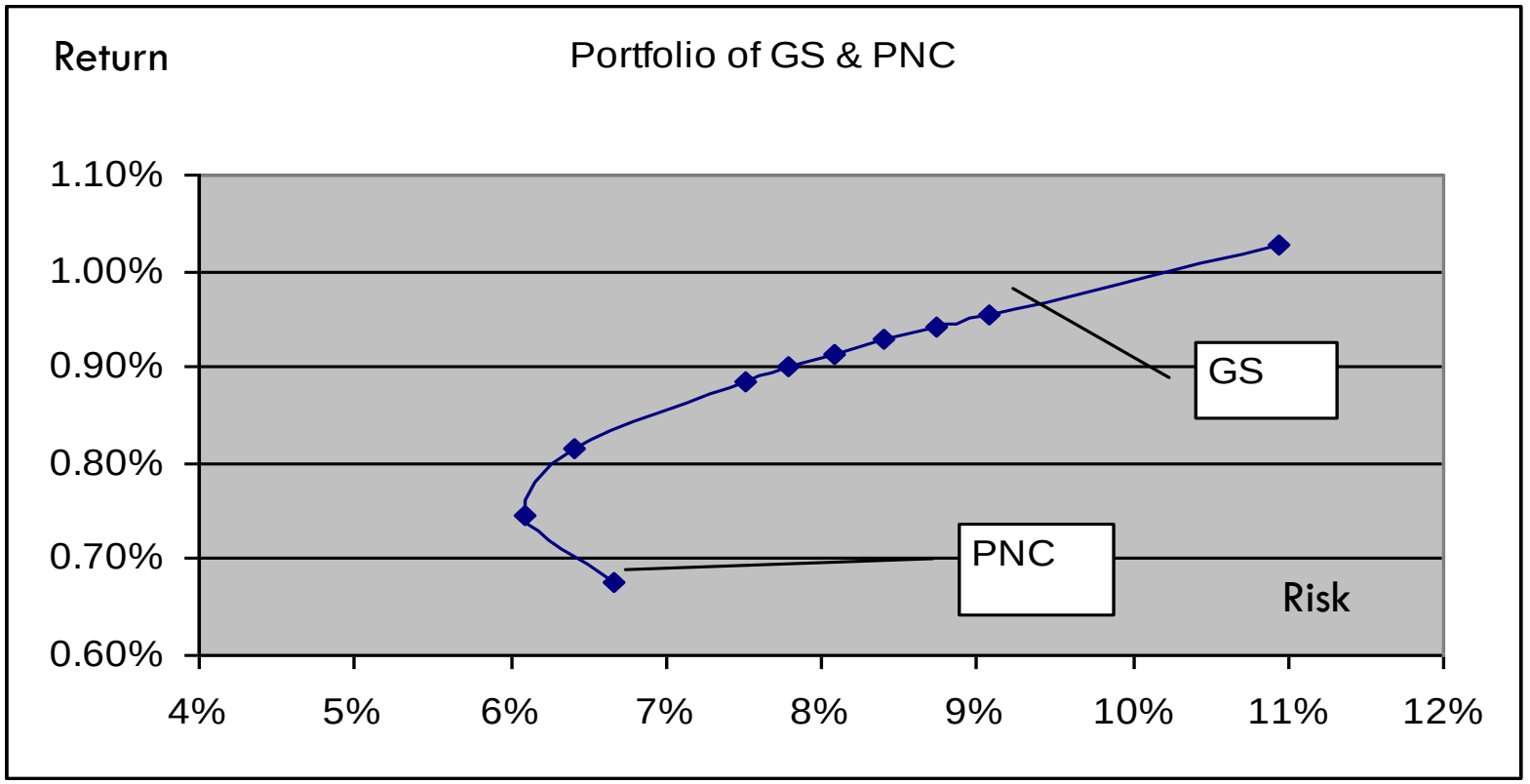
1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Small-Cap Growth 43.10%	Commodities 31.84%	Small-Cap Value 14.02%	Commodities 25.91%	Small-Cap Growth 48.54%	Real Estate 33.17%	Commodities 21.36%	Real Estate 36.14%	Commodities 16.23%	Long-Term Bonds 24.03%
Large-Cap Growth 33.16%	Real Estate 31.04%	Real Estate 12.36%	Unhedged Foreign Bonds 22.99%	Small-Cap Value 46.03%	Small-Cap Value 22.25%	International Stocks 14.01%	International Stocks 26.88%	Large-Cap Growth 11.82%	Unhedged Foreign Bonds 12.00%
International Stocks 27.31%	Small-Cap Value 22.80%	Interm-Term Bonds 8.44%	Long-Term Bonds 16.79%	International Stocks 39.17%	International Stocks 20.70%	Real Estate 13.99%	Small-Cap Value 23.48%	International Stocks 11.62%	Short-Term Bonds 6.61%
Commodities 24.35%	Long-Term Bonds 20.27%	Short-Term Bonds 8.30%	Interm-Term Bonds 10.26%	Large-Cap Value 30.03%	Large-Cap Value 16.49%	Large-Cap Value 7.05%	Large-Cap Value 22.21%	Unhedged Foreign Bonds 10.81%	Interm-Term Bonds 5.24%
Large-Cap Value 7.34%	Interm-Term Bonds 11.63%	High Yield Bonds 4.48%	Short-Term Bonds 5.76%	Large-Cap Growth 29.75%	Small-Cap Growth 14.31%	Long-Term Bonds 6.50%	Small-Cap Growth 13.35%	Long-Term Bonds 9.81%	Cash 1.80%
Cash 4.74%	Short-Term Bonds 8.00%	Long-Term Bonds 4.21%	Real Estate 3.60%	High Yield Bonds 28.15%	Unhedged Foreign Bonds 12.04%	Large-Cap Growth 5.27%	High Yield Bonds 11.77%	Short-Term Bonds 7.32%	High Yield Bonds -26.39%
Short-Term Bonds 3.06%	Large-Cap Value 7.02%	Cash 4.09%	Cash 1.70%	Real Estate 27.75%	High Yield Bonds 10.87%	Small-Cap Value 4.70%	Large-Cap Growth 9.09%	Small-Cap Growth 7.04%	Small-Cap Value -28.92%
High Yield Bonds 2.51%	Cash 5.95%	Unhedged Foreign Bonds -3.58%	High Yield Bonds -1.89%	Commodities 23.93%	Commodities 9.15%	Small-Cap Growth 4.15%	Unhedged Foreign Bonds 5.94%	Interm-Term Bonds 6.97%	Commodities -35.65%
Interm-Term Bonds -0.82%	Unhedged Foreign Bonds -2.48%	Large-Cap Value -5.59%	Small-Cap Value -11.42%	Unhedged Foreign Bonds 18.63%	Long-Term Bonds 7.70%	Cash 3.00%	Cash 4.76%	Cash 4.74%	Large-Cap Value -36.85
Small-Cap Value -1.49%	High Yield Bonds -5.12%	Small-Cap Growth -9.23%	Large-Cap Value -15.52%	Interm-Term Bonds 4.10%	Large-Cap Growth 6.30%	High Yield Bonds 2.74%	Interm-Term Bonds 4.33%	High Yield Bonds 2.19%	Large-Cap Growth -38.44%
Real Estate -2.57%	International Stocks -13.95%	Commodities -19.51%	International Stocks -15.64%	Long-Term Bonds 2.48%	Interm-Term Bonds 4.34%	Interm-Term Bonds 2.43%	Short-Term Bonds 3.96%	Large-Cap Value -0.17%	Small-Cap Growth -38.54%
Unhedged Foreign Bonds -6.19%	Large-Cap Growth -22.43%	Large-Cap Growth -20.42%	Large-Cap Growth -27.89%	Short-Term Bonds 1.90%	Cash 1.24%	Short-Term Bonds 1.67%	Commodities 2.07%	Small-Cap Value -9.77%	Real Estate -39.20%
Long-Term Bonds -8.74%	Small-Cap Growth -22.44%	International Stocks -21.21%	Small-Cap Growth -30.27%	Cash 1.07%	Short-Term Bonds 0.91%	Unhedged Foreign Bonds -9.24%	Long-Term Bonds 1.85%	Real Estate -17.88%	International Stocks -43.38%

Cash represented by the Citigroup 3-month T-Bill Index, an index of three-month Treasury bills. Commodities represented by the Dow Jones-AIG Commodity Total Return Index, which is composed of futures contracts on 19 physical commodities. Unhedged Foreign Bonds represented by the JPMorgan Non-U.S. Global Government Bond (Unhedged) Index, which is an unmanaged market index representative of the total return performance in U.S. dollars on an unhedged basis of major non-U.S. bond markets. High Yield Bonds represented by the Merrill Lynch US High Yield Master II Index, which tracks the performance of below investment grade (BBB), but not in default, US dollar-denominated corporate bonds publicly issued in the domestic market. Intermediate-Term Bonds represented by the Barclays Capital Aggregate Index, which is composed of securities from the Barclays Capital Government/Credit Bond Index, Mortgage-Backed Securities Index, and Asset-Backed Securities Index. It is representative of the domestic, investment-grade, fixed-rate, taxable bond market. Long-Term Bonds represented by the Barclays Capital Long Treasury Index, an index of US Treasury obligations with maturities greater than 10 years. Short-Term Bonds represented by the Merrill Lynch 1–3 Year Treasury Index, an index of US Treasury obligations with maturities from 1 to 2.99 years. International Stocks represented by the MSCI EAFE Index. The Morgan Stanley Capital International (MSCI) Europe, Australasia, Far East Index (EAFE) is an index of over 900 companies, and is a generally accepted benchmark for major overseas markets. Large-Cap Growth Stocks represented by the Russell 1000 Growth Index, which measures the performance of those Russell 1000 companies with higher price-to-book ratios and higher forecasted growth values. Large-Cap Value Stocks represented by the Russell 1000 Value Index, which measures the performance of those Russell 1000 companies with lower price-to-book ratios and lower forecasted growth values. Small-Cap Growth Stocks represented by the Russell 2000 Growth Index, which measures the performance of those Russell 2000 companies with higher price-to-book ratios and higher forecasted growth values. Small-Cap Value Stocks

Allianz Global Investors

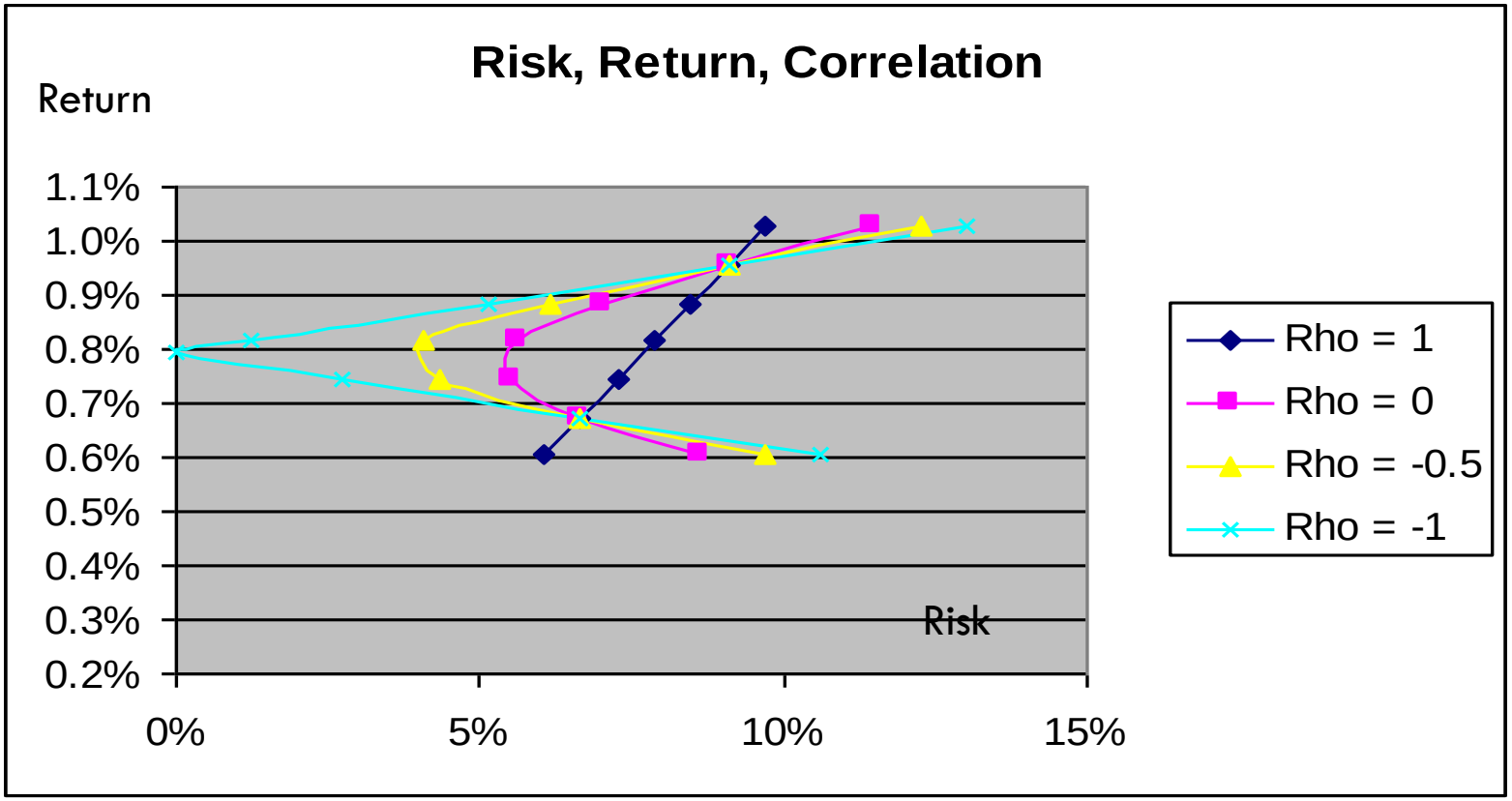
Ex4: Portfolio Risk and Correlation

- Using actual monthly data on GS and PNC



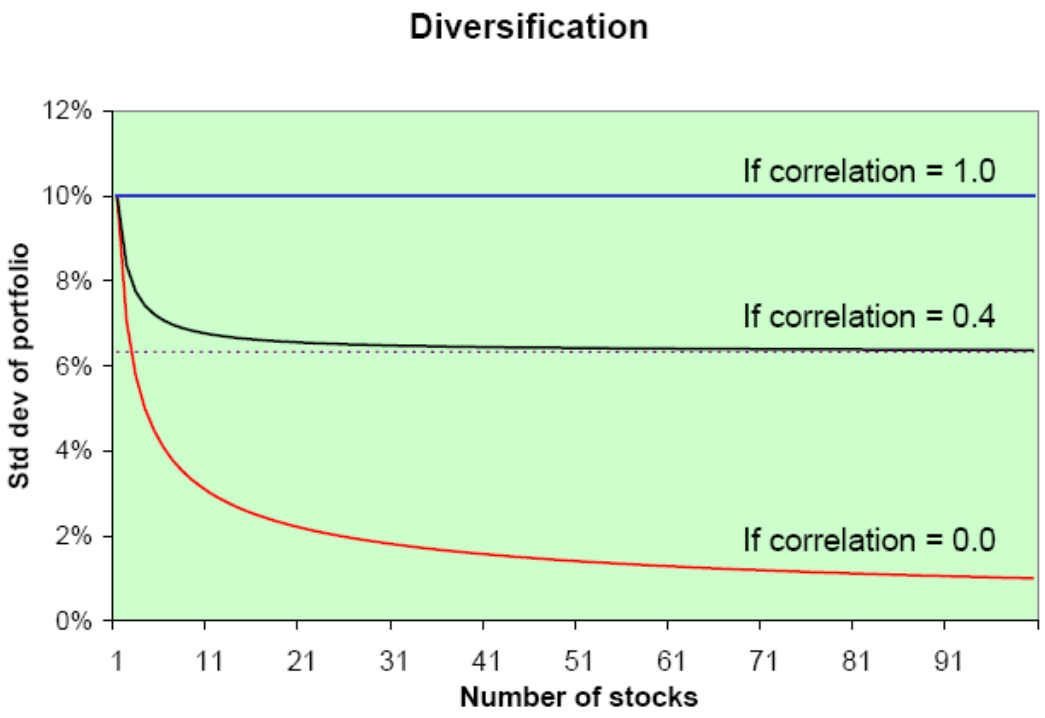
Ex4: Portfolio Risk and Correlation

- When correlation changes, this is how investment opportunities looks liked



Diversification-notes

- Diversification always reduces portfolio risk as long as correlation is not 1
- In well diversified portfolio, covariance among stocks are more important than individual variances.



Ex5: Only Covariance Matters

- Let's look at 3 stocks case
- $var(Rp) = 1/N^{2}*var_1 + 1/N^{2}*var_2 + 1/N^{2}*var_3 + 2/N^{2}*cov(1,2) + 2/N^{2}*cov(1,3) + 2/N^{2}*cov(2,3)$
- $var(Rp) = 1/N^{2}(\text{ sum } var_1\ var_2\ var_3\ ) + 2/N^{2}*(\text{ sum } cov(1,2)\ cov(1,3)\ cov(2,3)\ )$
- $var(Rp) = 1/N$ (Avg.var) + $2/N$ (Avg.cov)
- Generally $var(Rp) = 1/N$ (Avg.var) + $N-1/N$ (Avg.cov)
  - As N increases, the first term tend to go to zero, only second term left
  - Hence, in the well-diversified portfolio, only covariance matters in the sense that it determines portfolio risk (variance)
  - Key idea in modern portfolio theory

The idea of portfolio theory can be applied to corporation as well

- Imagine this situation
  - You are CRO of a major corporation. CEO wants your views on a major new acquisition
  - You have been flooded with report showing that new acquisition has a positive NPV and will enhance shareholder value. But what sort of analysis and ideas can you give to the CEO?
  - Maybe you want to see
    - How the new acquisition fits into company's portfolio?
    - What is the correlation of the performance of the new acquisition with the rest of company's business?
    - When the rest of business turn bad, will the new acquisition also provide a poor returns – or will it have the effects of dampening the ups and downs in the rest of business?

Risk Preference

Risk Preference

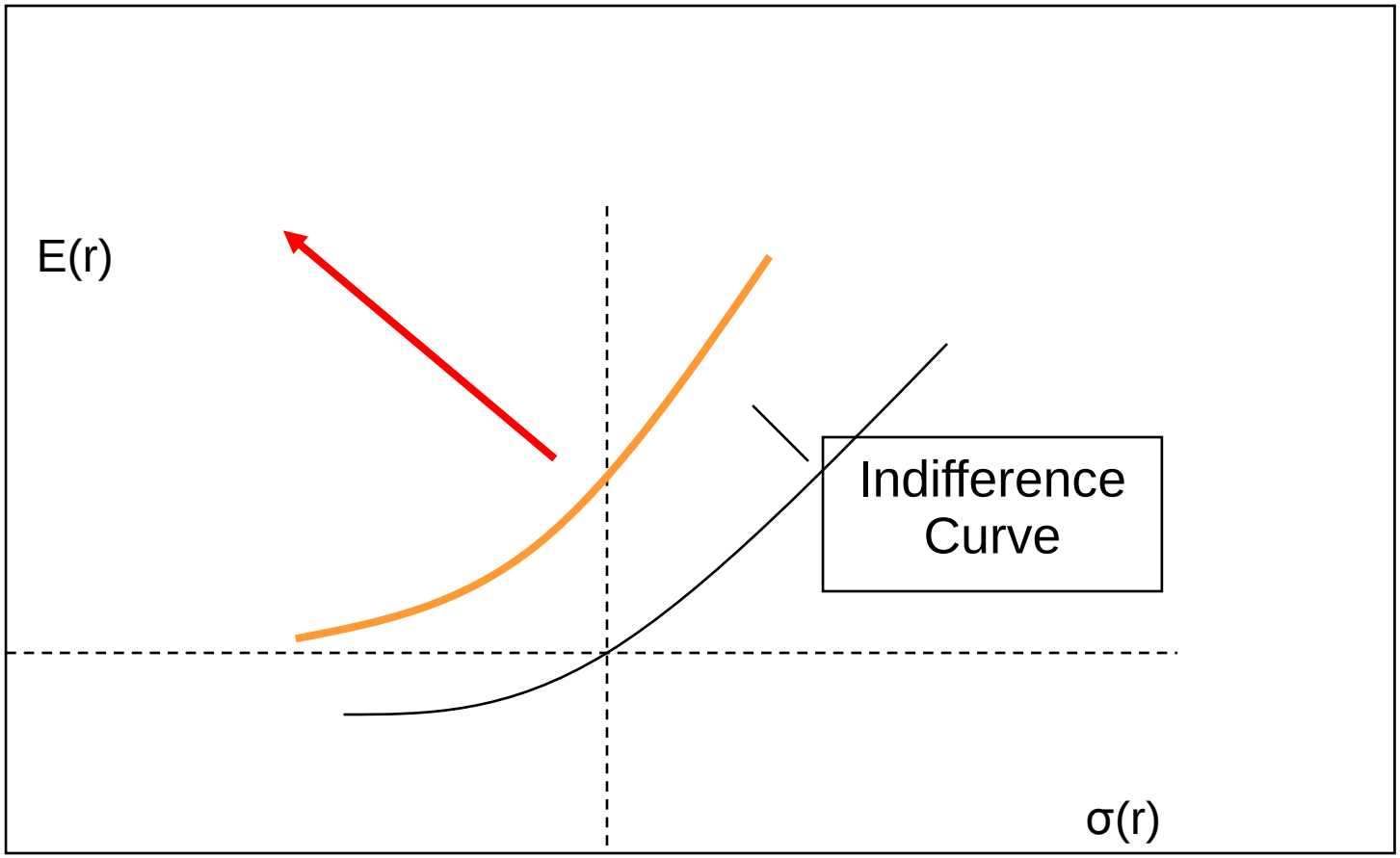
- At the end, individual chooses investment portfolio according to one's risk preference and objective

- 3 types of risk preferences
  - Risk averse
  - Risk neutral
  - Risk lover

- Suppose you can choose between 50 THB now with absolute certainty or equal chance of 100 or 0 THB, which one will you choose?

Risk Averse

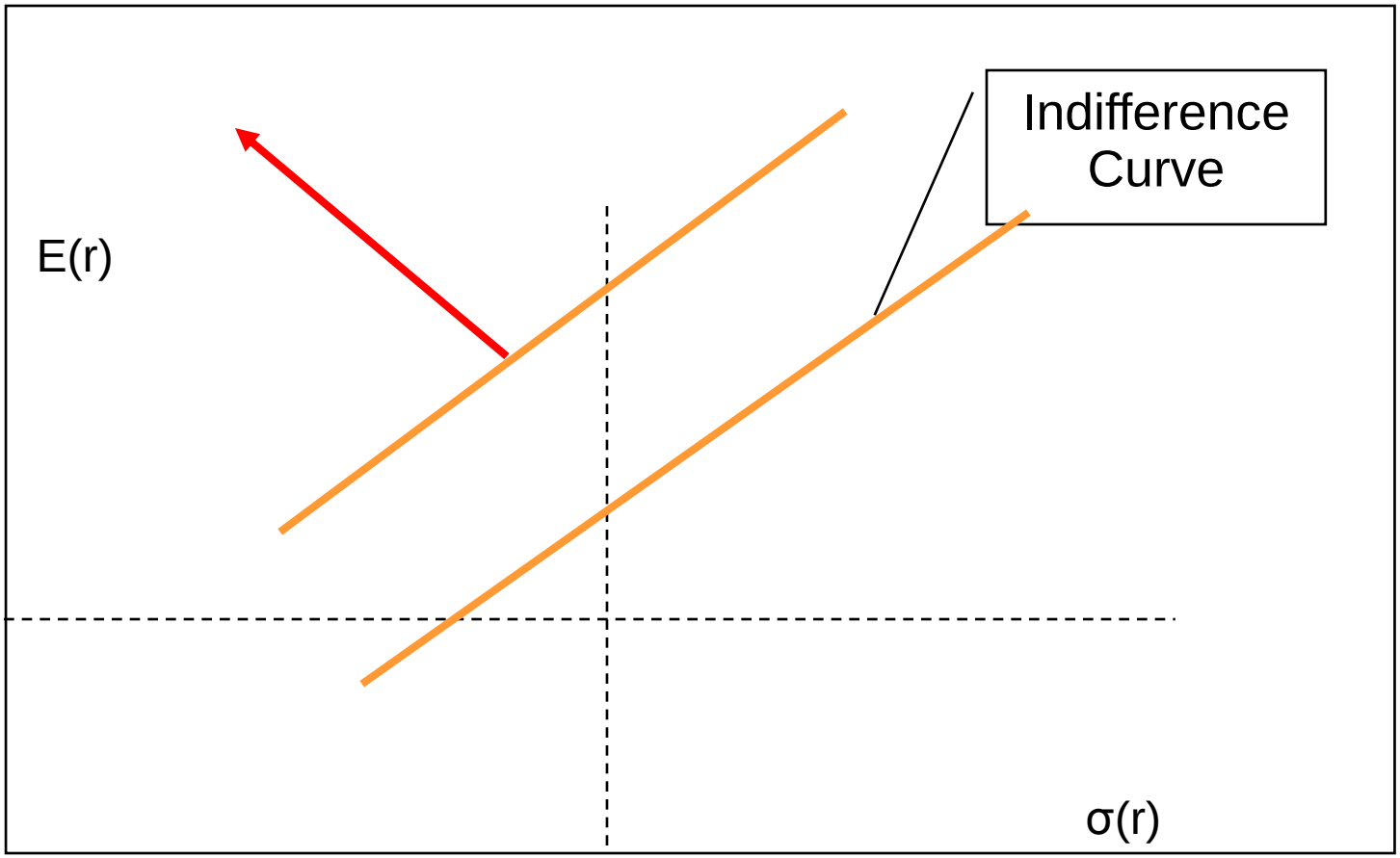
- Risk Averse
  - Prefer 50THB now than a 50% chance of 100 and 50% of 0
  - Penalize the expected rate of return of a risky portfolio by a certain %
  - The greater the risk, the larger the penalty
- To be on the same utility indifference curve, higher risk must be compensated by higher return
- Indifference curve is upward-sloping
- The more risk averse, the steeper an indifference curve

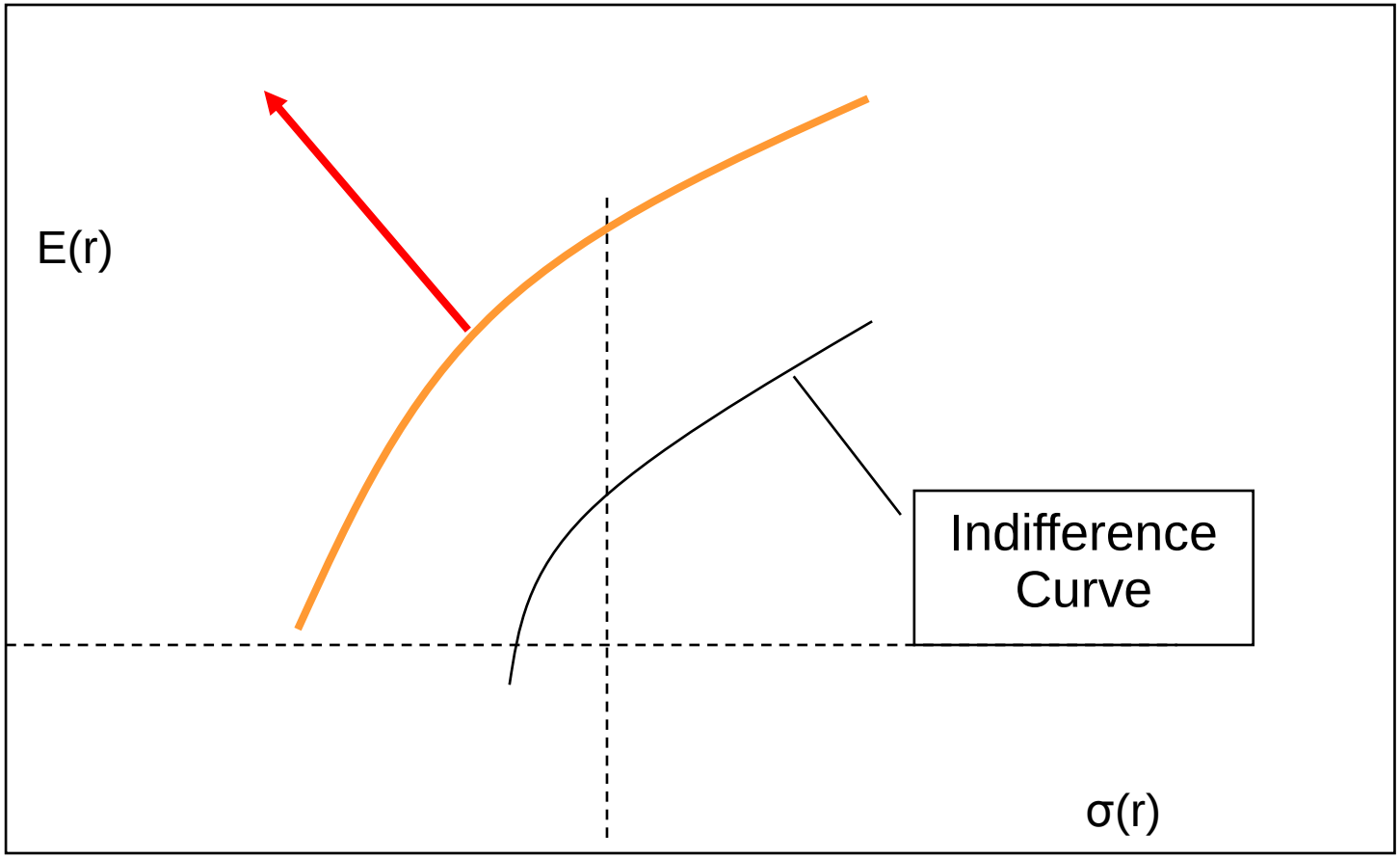

E(r)
Indifference Curve
σ(r)

Risk Neutral & Risk Lover

- Risk neutral
  - Judge risky prospects purely by expected return
  - Indifferent between 50THB now and 50% chance of 100
  - The level of risk is irrelevant to risk-neutral investors
  - Indifference curve is horizontal

- Risk lover
  - Adjusts the expected return upward to reflect utility from the "fun" from taking risks
  - Prefer 50% chance of 100 than 50THB now
  - Indifference curve is downward sloping
  - Less risky, must be compensated by higher expected return, since losing the "fun part"


Indifference Curve
E(r)
σ(r)


E(r)
Indifference Curve
σ(r)

Beta and CAPM
Risk and Return of Stock

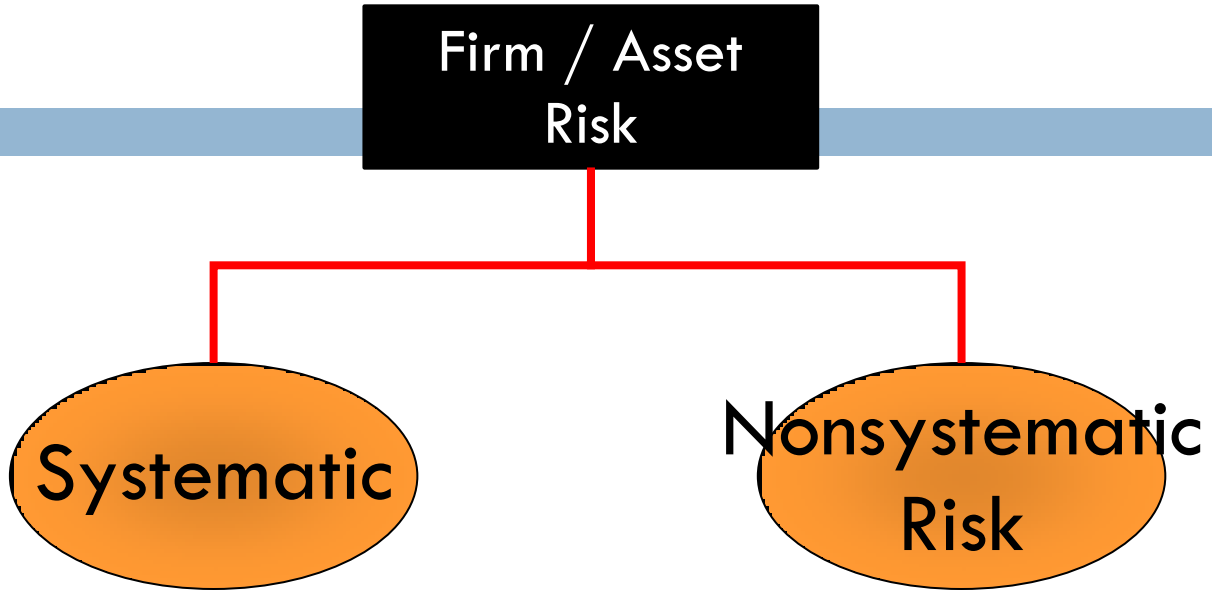
I know high risk high return trade-off but how do I know if trade-off is appropriate?

- How do investors decide on the expected return required for individual investments?
- Which of these is more attractive?
- Case I:
  - Stock A with expected return of 5% and SD of return of 10%
  - Stock B with expected return of 5% and SD of return of 20%
- Case II:
  - Stock A with expected return of 5% and SD of return of 10%
  - Stock B with expected return of 10% and SD of return of 20%
- Direct comparison can be difficult
  - Benchmark is needed

- As it turns out,
  - The expected return considered in relation to market portfolio -> "market benchmark"

- For example
  - If asset has "sensitivity" about the same as the market -> expected return should be the same
  - If asset has higher "sensitivity" (higher risk) compared market return, return should be higher

Two sources of risk



- "Risk from overall environment"
- Also call systemic risk
- Able to capture through risk modeling
- Different firm effected by market risk at different degree
- Cannot be eliminated
- Captured by "beta"

- Idiosyncratic risk
- "Risk from company themselves"
- Also called unique risk, diversifiable risk, firm specific risk
- Can be eliminated in a well-diversified portfolio

Non-Systematic Risk

- "Risk of price change due to unique circumstances of specific security or company, as opposed to the overall market"

- Risk can mean good and bad outcomes
- For examples: Bad Risk
  - New regulation affecting particular group of companies
  - Sudden strike by employees / sudden loss of key management persons
  - Possible losses from law cases against company
  - Fire on exploration platform
- For examples: Good Risk
  - New regulation benefiting particular group of companies
  - Recruitment of key management persons
  - Possible win from law cases of company
  - Discover of natural resources

Capital Asset Pricing Model

- Proposed by William Shrape, John Lintner, and Jack Treynor in the mid-1960s - all Noble price winner

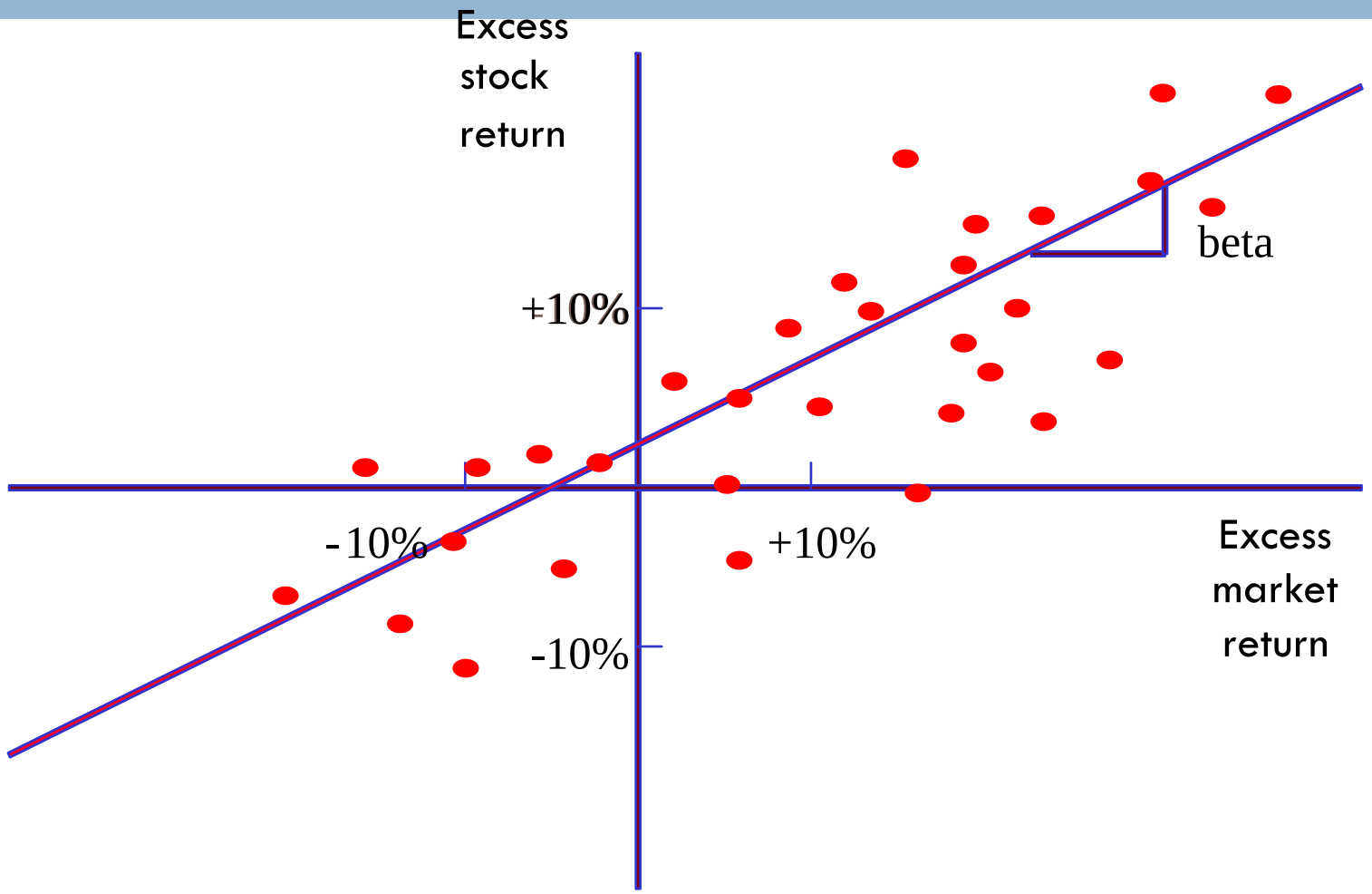
- "In the competitive market, the expected risk premium (return over risk free return) varies in direct proportional to beta"
- Beta is a "risk measure" in relative to market overall

- For example:
  - The expected risk premium on an investment with beta of 1 is, therefore, same as the expected risk premium on the market
  - The expected risk premium on an investment with beta of 0.5 is, therefore, half the expected risk premium on the market
  - The expected risk premium on an investment with beta of 2 is, therefore, twice the expected risk premium on the market

Beta β

- Beta is sensitivity / elasticity of asset return to market return
- Beta of market portfolio is 1
- Theoretically beta of stock ranges from negative infinity to positive infinity
- In actual world beta of stock is usually a small positive number around 1
- Beta >1 : asset tends to amplify overall market movements
- 0 > Beta > 1 : asset tends to move in the same direction as the market, but not as much

Estimating Beta from Historical Data



Estimating Beta from Historical Data (2)

$$B_i = \frac{\sigma_{im}}{\sigma_m^2}$$

Covariance with the market return

Variance of the market return

Capital Asset Pricing Model (2)

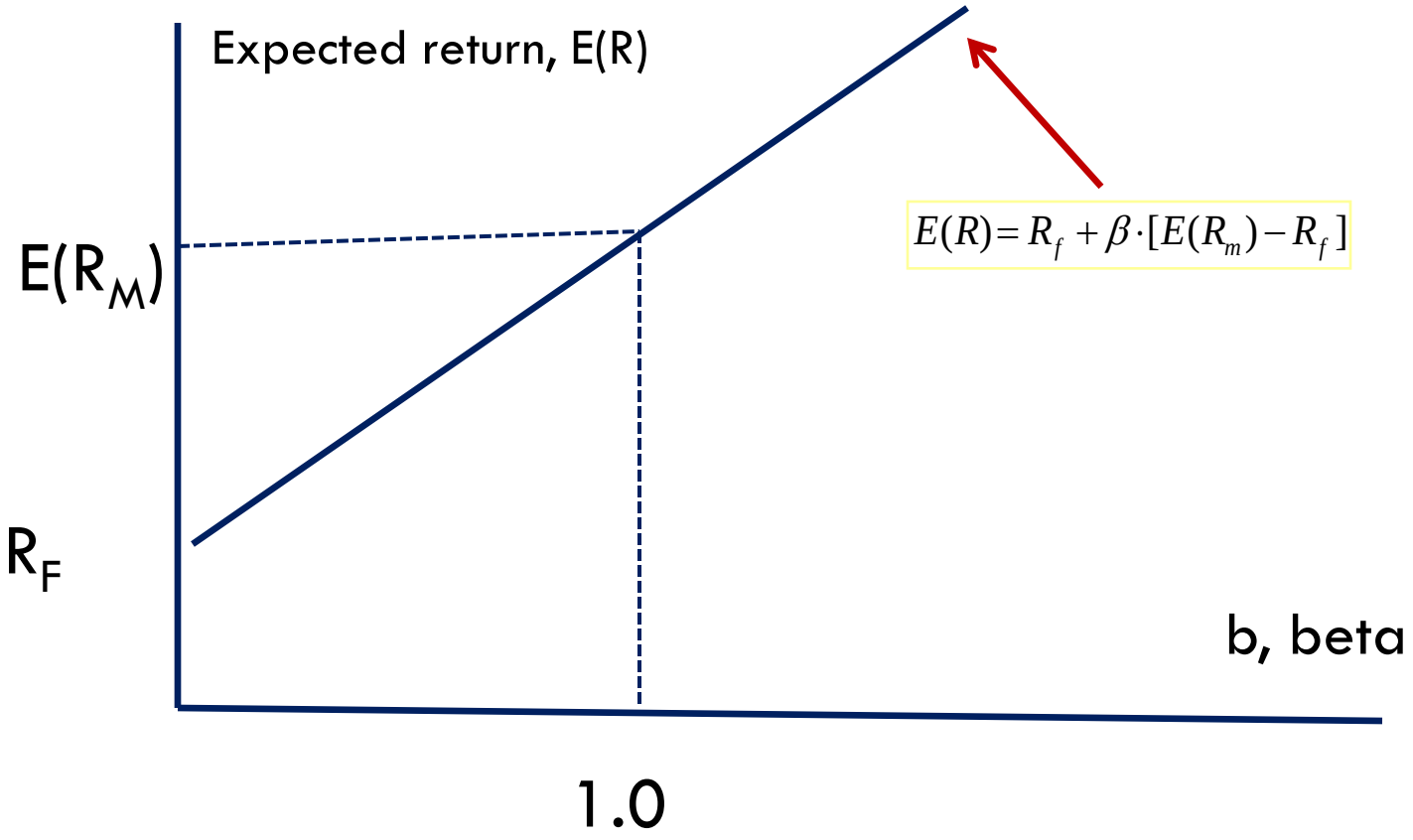
$$E(R - R_f) = \beta \cdot [E(R_m) - R_f]$$

$$\beta = \frac{\sigma_{im}}{\sigma_m^2}$$

$$E(R) = R_f + \beta \cdot [E(R_m) - R_f]$$

- Expected risk premium on asset = beta x expected risk premium on market
- Expected return on asset = risk free + (beta x expected risk premium on market)

Capital Asset Pricing Model (3)



Ex6: CAPM example

Stock	Beta	Expected Return rf = 5%, rm-rf=7%
Amazon	2.20	20.40
IBM	1.59	16.13
Disney	1.26	13.82
Microsoft	1.13	12.91
Boeing	1.09	12.63
Starbuck	0.69	9.83
ExxonMob	0.65	9.55
Wal-Mart	0.57	8.99
Pfizer	0.55	8.85
Heinz	0.56	8.92

Ex 7. Test of Concepts

- 1) The correlation between the efficient portfolio and the risk-free asset is:
  a. +1 b. -1 c. 0 d. Cannot be calculated

- 2) Beta of Treasury bills is:
  a. +1.0 b. +0.5 c. -1.0 d. 0

- 3) Beta of the market portfolio is:
  a. Zero b. +0.5 c. -1.0 d. +1.0

Ex 8. Test of Concepts

- 4) The correlation coefficient between stock A and the market portfolio is +0.6. The standard deviation of return of the stock is 30% and that of the market portfolio is 20%. Calculate the beta of the stock.

  a. 1.1 b. 1.0 c. 0.9 d. 0.6

- 5) The correlation coefficient between stock B and the market portfolio is 0.8. The standard deviation of the stock B is 35% and that of the market is 20%. Calculate the beta of the stock.

  a. 1.0 b. 1.4 c. 0.8 d. 0.7

Ex9. Beta of selected US companies

- July 2001 – June 2006

Stock	Beta	Stock	Beta
Amazon	2.20	Starbuck	0.69
IBM	1.59	ExxonMobil	0.65
Disney	1.26	Wal-Mart	0.57
Microsoft	1.13	Pfizer	0.55
Boeing	1.09	Heinz	0.56

Ex10. CAPM(1)

- 1) The capital asset pricing model (CAPM) states that:

  a. The expected risk premium on an investment is proportional to its beta

  b. The expected rate of return on an investment is proportional to its beta

  c. The expected rate of return on an investment depends on the risk-free rate and the market rate of return

  d. The expected rate of return on an investment is dependent on the risk-free rate

- 2) The main shortcoming of CAPM is that it

  a. Ignores the return on the market portfolio

  b. Uses too many factors

  c. Requires a single risk measure of systematic risk

  d. Ignores risk-free rate of return

Ex11. CAPM(2)

- 1) If the beta of Microsoft is 1.13, risk-free rate is 3% and the market risk premium is 8%, calculate the expected return for Microsoft.
  a. 12.04% b. 15.66% c. 13.94% d. 8.65%

- 2) If the beta of Amazon.com is 2.2, risk-free rate is 5.5% and the market risk premium is 8%, calculate the expected rate of return for Amazon.com stock:
  a. 15.8% b. 14.3% c. 35.2% d. 23.1%

- 3) A stock with a beta of 1. 25 would be expected to:
  a. Increase in returns 25% faster than the market in up markets
  b. Increase in returns 25% faster than the market in down markets
  c. Increase in returns 125% faster than the market in up markets
  d. Increase in returns 125% faster than the market in down markets

Underlying assumptions

1) Investors care only about the expected return and SD of return
2) The error term of one asset are independent
3) Investor focus on returns over just one period and this length is the same for all investors
4) Investor can borrow and lend at the same risk-free rate
5) There are no tax considerations
6) All investors make the same estimates of expected returns, SD of returns and correlation

How realistic can it be?

1) Investors have a complex set of risk preferences, involve more than the first two moments of return distribution. Satisfaction also depends on relative performance
2) Correlation between returns from two assets can not arise only from their correlations with market portfolio. Error term of firms in the same sector of the economy also tends to correlate
3) Investors have different time horizon
4) There is spread in borrowing
5) Tax do influence portfolio choices
6) Expectations are not homogeneous

CAPM in practice

- CAPM still proved to be a useful tool for portfolio manager
- Estimate of betas of stocks can be estimated and hence the expected return on a portfolio is commonly used benchmark for assessing performance of the portfolio manager

- A firm level, financial manager also use CAPM to estimate cost of equity in weighted average cost of capital (WACC)

CAPM in practice (2)

- From J.R. Graham and C.R. Harvey, "The Theory and Practice of Corporate Finance: Evidence from the Field", "Journal of Financial Economics 61 (2001), pp. 187-243.

- Financial managers use for more than one method to estimate cost of capital – expected rate of return on stock
  - 72% use CAPM
  - 39% use average historical stock return
  - 34% use CAPM model with some extra risk factors

Arbitrage Pricing Theory (APT)

- A more general analysis moves us away from the first two assumption is APT model
- It said "the return from asset is assumed to depend on several (more than one) factors
- Each factor is a separate source of systematic risk

- Model by E.F. Fama & K.R. French proposes more factors, namely
  - Size and Book-to-Market Factors

The idea of portfolio theory can be applied to corporation as well (2)

- Let's consider trade-off between risk and return made by a company
- How should a company decide whether expected return is sufficient compensation for its risks?
  - New project undertaken by company should be viewed as "additional asset" to its shareholder's portfolio
  - Company should calculate project beta, find required return from CAPM, use it as discount rate, if NPV is greater than zero -> it is a good deal for shareholders -> company should accept it
  - Non-systemic risks should not be considered
- In practice, companies are concerned about nonsystematic as well as systematic risk

The idea of portfolio theory can be applied to corporation as well (3)

- For example
  - Risk of building being burned down -> completely nonsystematic and can be diversified by shareholders thru capital market

- In practice, earning stability and survival of the company are important
- Shareholder prefer to invest in companies with solid growth and meeting earning forecast with low volatility
  - They like companies to manage risks carefully – both systematic and nonsystematic

Q&A