Lecture 2
Risk and Return

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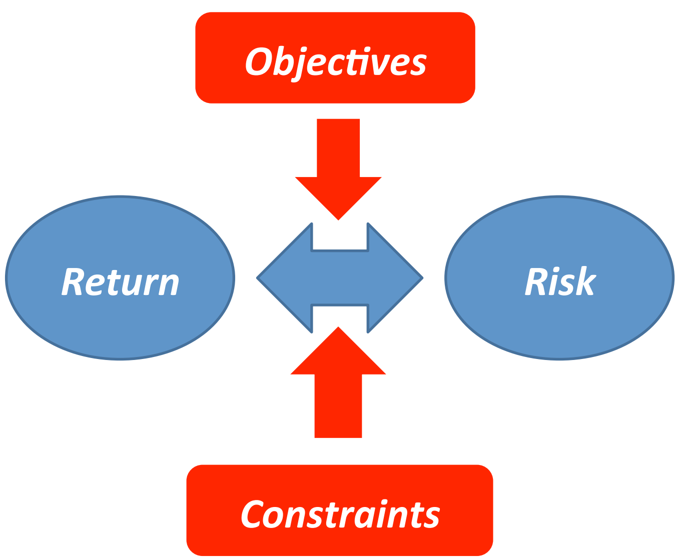
Conceptual framework of investment



How do we estimate risk and return in the presence of …

Real versus nominal returns

- The Fisher relation

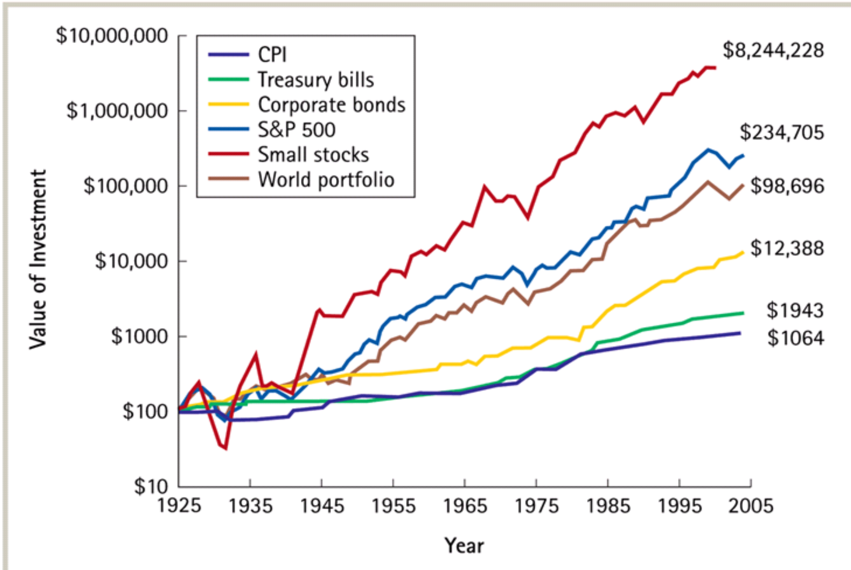
  Real = Nominal – Expected inflation

  (The relationship is in fact a linear approximation, but usually treated as an equality – see BKM)

Nominal returns influenced by:

- The supply of funds from savers (eg. households)
- The demand for funds from businesses
- Government and Central Bank actions
- Expected inflation

Value of $100 invested at the end of 1925



Source: Berk & DeMarzo (2007)

Simple rate of return

$$ROR = \frac{EMV - BMV + I}{BMV}$$

- BMV = Beginning market value
- EMV = Ending market value
- I = Income received during evaluation period
- ROR reports profitability of financial assets in percentage figures (rather than in $ amounts) which allows investors to compare the profitability across portfolios regardless of sizes or prices
- In this course, ‘return’ = ROR

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Example: Simple return

- You hold 200 shares of ABC stock at the beginning of this year
- P(0) = $100
- At year-end, you receive $8 DPS
- P(1) = $110
- Return = ?

Annualized Return

- Generally, longer horizons provide greater returns, so we need to express each as ROR for a <u>common period</u>, usually over a 1-year horizon
- Effective annual rate (EAR)

  Assumes compounded interest, i.e. you calculate interest on interest too, so your "effective principal" increases

- Annual percentage rate (APR)

  Rates on short-term investments (T<1) often are annualised using simple interest.

Annualized Variance

- Variance is proportional to time

  Annualized Variance =

- Standard deviation is proportional to the square root of time

  Annualized Standard Deviation =

Example: Historical Returns

Date	Price ($)	Dividend ($)	Return	Date	Price ($)	Dividend ($)	Return
12/31/1998	58.69			12/31/2007	6.73	0	
1/31/1999	61.44	0.26	5.13%	3/31/2008	5.72	0	-15.01%
4/30/1999	63.94	0.26	4.49%	6/30/2008	4.81	0	-15.91%
7/31/1999	48.5	0.26	-23.74%	9/30/2008	5.2	0	8.11%
10/31/1999	54.88	0.29	13.75%	12/21/2008	2.29	0	-55.96%
12/31/1999	53.31		-2.86%				

Returns and Risk are Uncertain

- Under uncertainty, we measure "reward" by using the expected (or average) return

$$\mu_X = E(X) = p_1X_1 + p_2X_2 + \cdots + p_NX_N = \sum_{i=1}^{N} p_iX_i$$

$$E(r) = \sum_s p(s)r(s)$$

$p(s)$ = probability of a state
$r(s)$ = return if a state occurs
s = state

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- We measure "risk" by using the variance of returns
- A measure of dispersion (around the mean), i.e. how observations can possibly deviate from the central tendency

$$Var(X) = \sigma_X^2 = \sum_{i=1}^{N} p_i[X_i - E(X)]^2$$

- Volatility or risk is measured by standard deviation

$$\sigma = \sqrt{\sigma^2}$$

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Other measures

- Risk premium
- Average absolute deviation
- Average of the squared deviations below the mean (semi variance)
- Value at risk measure

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Example: Expected return

$$E(r) = \sum_{s} p(s) r(s)$$

$p(s)$ = probability
$r(s)$ = return in s
s = state

State	Prob. of State	r in State
Excellent	.25	0.3100
Good	.45	0.1400
Poor	.25	-0.0675
Crash	.05	-0.5200

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Example - Calculating Risk

State	Prob. of State	r in State
Excellent	.25	0.3100
Good	.45	0.1400
Poor	.25	-0.0675
Crash	.05	-0.5200

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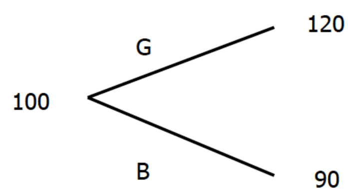
Another Example: Risky prospects

The stock price of ABC is currently $100. Assume the stock price is either going to increase to $120 or decrease to $90 over the next year. In both cases the firm will pay a dividend of $5.



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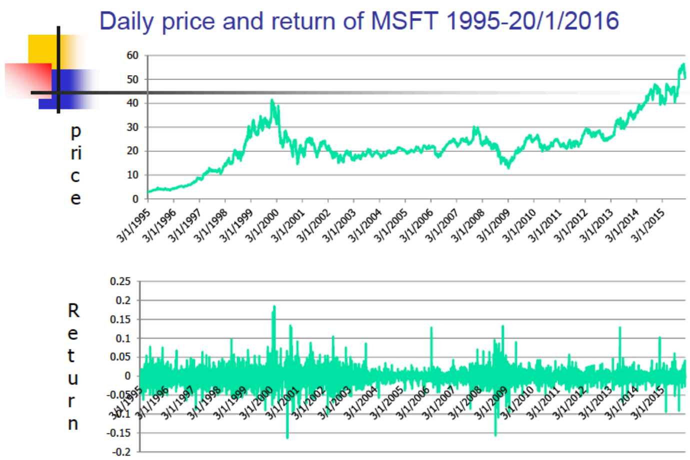
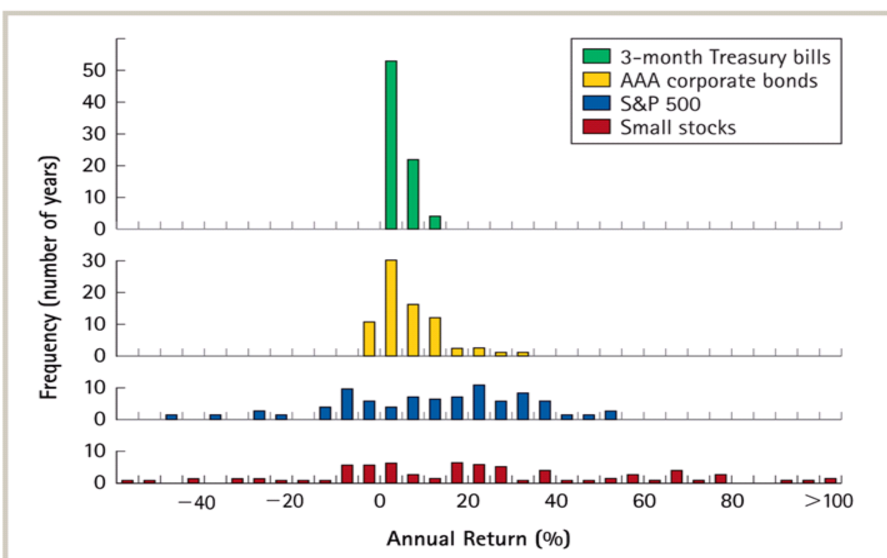
Times series analysis of past rate of returns



Historical distributions of US returns



Source: Berk & DeMarzo (2007)

Arithmetic Return

- When using historical data to estimated expected return we assume that each data point has equal probability

- Expected returns (arithmetic average)

$$E(r) = \sum_{s=1}^{n} p(s)r(s) = \frac{1}{n}\sum_{s=1}^{n} r(s)$$

Geometric return

- Time-weighted average return

Variance and standard deviations

- Variance = expected value of squared deviations

$$\sigma^2 = \frac{1}{n}\sum_{s=1}^{n}\left[r(s)-\bar{r}\right]^2$$

- For sample data (not population data) when eliminating the bias because we use estimated expected return, Standard Deviation becomes:

$$\sigma = \sqrt{\frac{1}{n-1}\sum_{j=1}^{n}\left[r(s)-\bar{r}\right]^2}$$

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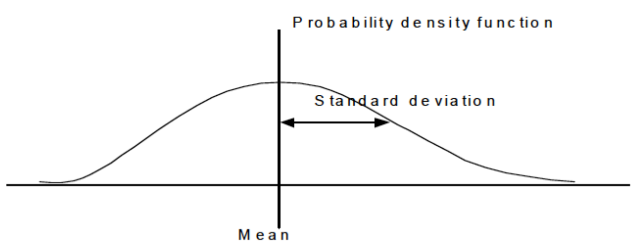
Distribution of returns



Mean = $E[\tilde{r}_i] = 1/N\sum \tilde{r}_i$

Variance of returns = $\sigma^2[\tilde{r}_i] = 1/(N-1)\sum (\tilde{r}_i - E[\tilde{r}_i])^2$

Standard deviation = square root of variance

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The Normal Distribution

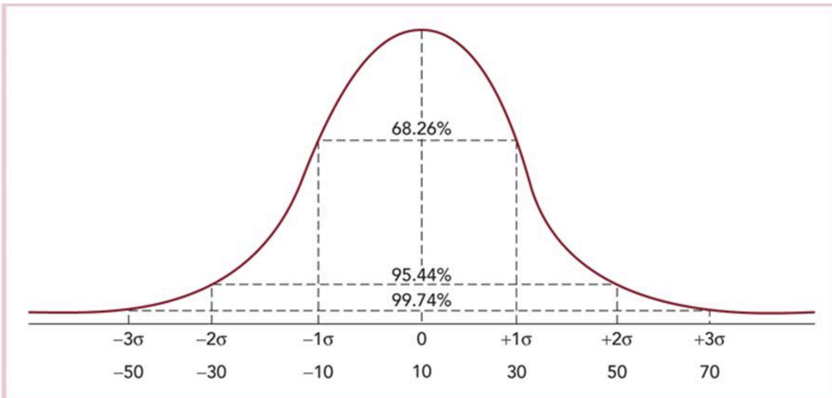


FIGURE 5.4 The normal distribution

Non-normality and risk measures

- When returns are not normally distributed, volatility (standard deviation) is no longer a complete measure of risk
- We then need to consider 'higher moments'

$$skew = average\left[\frac{\left(R - \bar{R}\right)^3}{\hat{\sigma}^3}\right] \qquad kurtosis = average\left[\frac{\left(R - \bar{R}\right)^4}{\hat{\sigma}^4}\right] - 3$$

- Skewness measures symmetry, and kurtosis 'peakedness'
- For normal distributions
- Stock returns are usually

Normal and Skewed Distributions

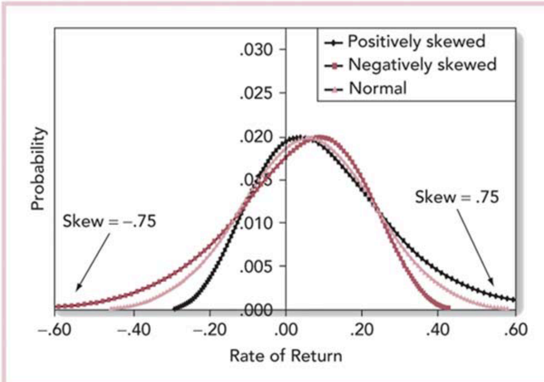


FIGURE 5.5A Normal and skewed distributions (mean = 6%, SD = 17%)

Normal and Fat-tailed distributions

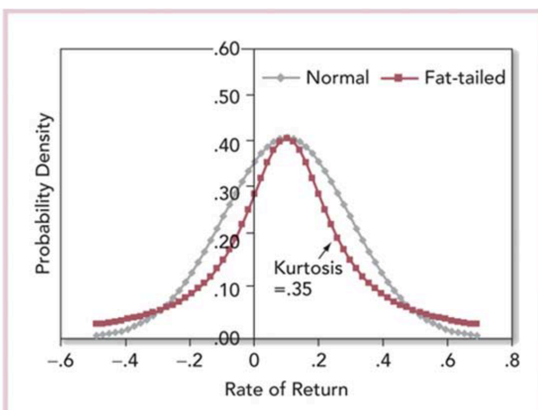
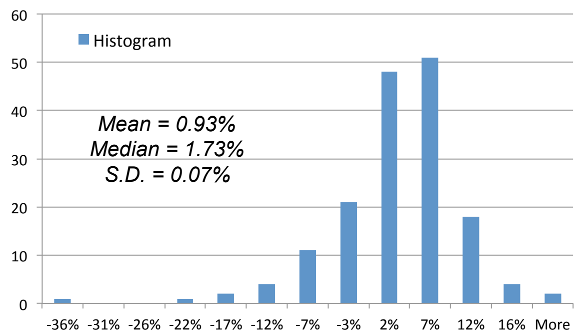
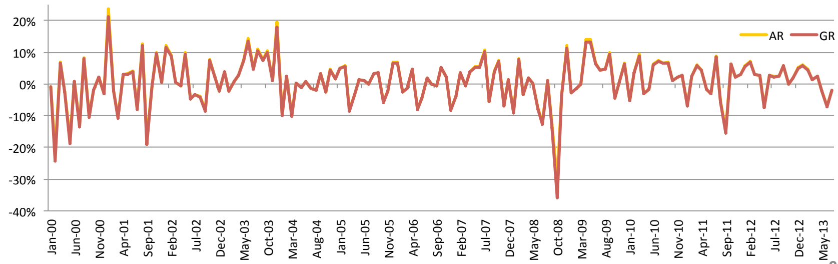


FIGURE 5.5B Normal and fat-tailed distributions (mean = .1, SD = .2)

Distribution of returns on SET

Date	SET Index	AR	GR
07/12	1,199.30	2.32%	2.29%
08/12	1,227.48	2.35%	2.32%
09/12	1,298.79	5.81%	5.65%
10/12	1,298.87	0.01%	0.01%
11/12	1,324.04	1.94%	1.92%
12/12	1,391.93	5.13%	5.00%
01/13	1,474.20	5.91%	5.74%
02/13	1,541.58	4.57%	4.47%
03/13	1,561.06	1.26%	1.26%
04/13	1,597.86	2.36%	2.33%
05/13	1,562.07	-2.24%	-2.27%
06/13	1,451.90	-7.05%	-7.31%
07/13	1,423.14	-1.98%	-2.00%





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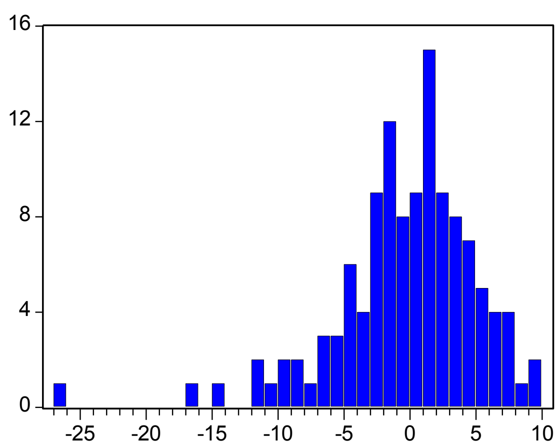
Data source: *CEIC*

Example: Returns on S&P Global 100



Series: Return on S&P Global 100
Sample 2000M05 2010M05
Observations 120

Mean	-0.299859
Median	0.351000
Maximum	9.698172
Minimum	-26.78273
Std. Dev.	5.438831
Skewness	-1.381392
Kurtosis	7.122558
Jarque-Bera	123.1423
Probability	0.000000

-28- ***Downside risk***

Homework

- Problem Set

BKM Ch 5# 4, 7, 8, 9, 12, 15

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