Portfolio Return and Risk
R2, Chapter 4

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Agenda

- First Half: Risk and Return Review
  - Single Asset Risk and Return
  - Portfolio Risk and Return
- Second Half: Application with Excel
  - Basic Excel Calculation
  - Manipulate Data with Excel Function
    - RANGE, VLOOKUP and etc..
  - **Basic Security Analysis**

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What are investment returns?

- Investment returns **measure the financial results** of an investment.
- Returns may be **historical** or **prospective**
- Returns can be expressed in:
  - Dollar terms.
  - Percentage terms.

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What is investment risk?

- Typically, investment returns are **not known with certainty**.
- Investment risk pertains to the probability of earning a return **less than that expected**.
- The greater the **chance of a return far below** the expected return, the greater the risk.
- Context
  - Single Asset Risk
  - Portfolio Risk

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Single Asset Return and Expected Return

- Simple Rate of Return of asset i^{th}

$$R_i = \frac{P_1 - P_0 + D}{P_0} \text{ or } R_i = \ln\left(\frac{P_1 + D}{P_0}\right)$$

- **Expected** Rate of Return of asset i^{th} at outcome j^{th}

$$E(R_i) = \overline{R}_i = \sum_{j=1}^{M} P_{ij} R_{ij}$$

Example

- IBM Stock have a return of 14%,10% and 6% in a good time, normal time and bad time respectively(1/3 probability in all time)

$$10\% = \left(\frac{1}{3}\right)(14\%) + \left(\frac{1}{3}\right)(10\%) + \left(\frac{1}{3}\right)(6\%)$$

- What if the probability changes to ¼, ½ ,¼ ?

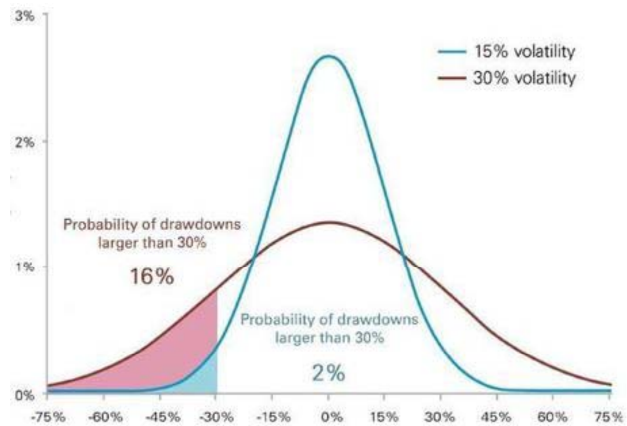
Single Asset Dispersion, or Risk

- Variance and Standard Deviation

$$\sigma_i^2 = \sum_{j=1}^{M} (R_{ij} - \overline{R}_i)^2 P_{ij}$$

$$\sigma_i = \sqrt{\sum_{j=1}^{M} (R_{ij} - \overline{R}_i)^2 P_{ij}}$$

Probability Distribution: Which Stock is Riskier? Why?



Sample Historical Return & Risk

- Historical Average Return

Excel's fnc.
=AVERAGE()
=STDEV()

$$\bar{r}_{avg} = \frac{\sum_{t=1}^{n} r_t}{n}$$

- Historical Standard Deviation

$$s = \sqrt{\frac{\sum_{t=1}^{n} (r_t - \bar{r}_{avg})^2}{n-1}}$$

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Exercise

- Single Asset Return & Risk

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Portfolio Expected Return and Risk

- Expected Portfolio Return

Excel's fnc.
=SUMPRODUCT()
=CORREL()

$$E(R_p) = \bar{R}_p = \sum_{i=1}^{N} X_i \bar{R}_i$$

- Correlation Coefficient Between 2 Assets

covariance

$$\rho_{12} = \frac{\sum_{j=1}^{M} (R_{1j} - \bar{R}_1)(R_{2j} - \bar{R}_2)}{\sqrt{\sum_{j=1}^{M} (R_{1j} - \bar{R}_1)^2 \sum_{j=1}^{M} (R_{2j} - \bar{R}_2)^2}} = \frac{\sigma_{12}}{\sigma_1 \sigma_2}$$

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Portfolio Expected Return and Risk

- Portfolio Risk
  - Two-Asset Portfolio

$$\sigma_p^2 = X_1^2 \sigma_1^2 + X_2^2 \sigma_2^2 + 2X_1X_2\sigma_{12}$$

$$\sigma_p^2 = X_1^2 \sigma_1^2 + X_2^2 \sigma_2^2 + 2X_1X_1\rho_{12}\sigma_1\sigma_2$$

  - How about 3,4 or 5 assets?
  - Write down a general form

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Portfolio
Expected Return and Risk - **Matrix**

- Consider a matrix form, let **X** be a column vector of asset weight, **R** be a column vector of expected return and Σ be variance covariance matrix

$$\mu_p = X'R$$

$$\sigma_p^2 = X'\Sigma X$$

- 2 Assets Portfolio Variance

$$\mu_p = \begin{pmatrix} X_1 & X_2 \end{pmatrix} \begin{pmatrix} E(R_1) \\ E(R_2) \end{pmatrix} \qquad \sigma_p = \begin{pmatrix} X_1 & X_2 \end{pmatrix} \begin{pmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{21} & \sigma_2^2 \end{pmatrix} \begin{pmatrix} X_1 \\ X_2 \end{pmatrix}$$

Exercise

- Portfolio Return & Risk

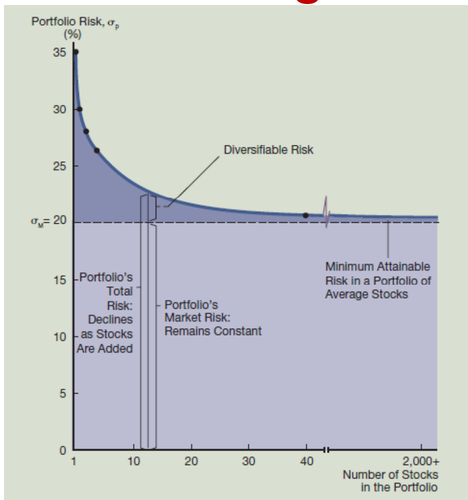
Consider Theoretical Two-Stock Portfolios

- Two stocks can be combined to form a riskless portfolio if ρ = -1.0.
- Risk is not reduced at all if the two stocks have ρ = +1.0.
- In general, stocks have $\rho \approx 0.35$, so risk is lowered but **not completely** eliminated.
- Investors typically hold many stocks.
  - By adding more stocks, σ_p would decrease but it would not be completely σ_p=0

Effects of Portfolio Size on Portfolio Risk for Average Stocks

$\sigma_{1\ stock} \approx 35\%$

$\sigma_{Many\ stocks} \approx 20\%$



…Look Closely…

- **Single Asset Risk** = Diversification Risk + Market Risk
- **Diversification Risk**
  - A risk that can be avoided by diversification at **no cost**
  - A random event: lawsuits, strikes, successful and unsuccessful marketing programs, winning or losing a major contract and etc…
- **Market Risk, β**
  - A risk that is inevitable, to bear such risk, a premium **must** be given
  - Factors that systematically affect most firms: war, inflation, recessions, and high interest rates.

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What Can We Learn From The Picture?

- As more stocks are added, each new stock has a smaller risk-reducing impact on the portfolio.
- σ_p falls very slowly after about 40 stocks are included. The lower limit for σ_p is about 20% = σ_M .
- By forming **well-diversified** portfolios, investors can eliminate about **half** the risk of owning a single stock.

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Conclusion

- Risks are typically decreased when we add more stocks into a portfolio
- Risks can be managed but not virtually eliminated
- Not only ρ plays important role in risk reduction, proportion of investment also plays a crucial part
  - Up coming **"Minimum Variance Portfolio"**
- **Homework**
  - R2, Ch4, Q1-2

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