Chapter4

Background on Traded Instruments

Introduction

- Market Risk

  Arising from the possibility of losses resulting from unfavorable market movements

- Financial Instruments
  - Fixed income (Bonds)
  - Forward rate agreements
  - Stocks
  - Foreign exchange
  - Forwards and Futures
  - Swaps
  - Options

  * Valuation of each instrument is important in risk measurement because risk is all about potential changes in value

Bonds Structure

- Maturity
  - > 5 years => bonds
  - 1 ~ 5 years => notes
  - < 1 year => bills or money market instruments
- Issuer Credit Ratings
  - Credit spread (Investment grade bonds must be rated BBB or better)
  - The capital requirement of different credit quality of the bonds suggested by the Basel committee (p.52 Table 4-1)
- Payment Structure
  - Fixed-rate vs. Floating-rate
- Currency

Bonds Valuation

- $\text{Value} = \sum_t \frac{C_t}{(1+r_t)^t}$, where r_t is the discount interest rate

- Yield Curve (Term Structure) (p. 55 Figure 4-1)

  "Bootstrap" p.56 Table 4-2 的例子

- Yield to Maturity (IRR of a bond)

  $$\text{Market Price} = \sum_t \frac{C_t}{(1+y)^t}$$

  y: 代表平均的discount rate

Duration

- if $B = \sum_t \frac{C_t}{(1+r)^t}$
  - Macauley Duration $= \sum_t t \cdot \frac{\frac{C_t}{(1+r)^t}}{B}$ （單位是年）, $\frac{\frac{C_t}{(1+r)^t}}{B}$ is the weight of time
  - Modified Duration $= -\frac{\frac{dB}{B}}{dr}$ $\left(\frac{\%}{\%/\text{yr}}\right)$ (比較精準)

$$= \frac{1}{B} \cdot \left(-\frac{dB}{dr}\right)$$

$$= \frac{1}{B} \cdot \left(-\sum_t \frac{(-t)C_t}{(1+r)^{t+1}}\right)$$

$$= \frac{1}{B} \cdot \left(\sum_t \frac{t \cdot C_t}{(1+r)^t} \cdot \frac{1}{1+r}\right)$$

$$= \frac{1}{1+r} \cdot \sum_t t \cdot \frac{\frac{C_t}{(1+r)^t}}{B} = \frac{1}{1+r} \cdot \text{Macauley Duration}$$

Effective Interest Rates

Period per year (m)	Final Sum	EAR
1	\$1.06	6.0000%
2	$\$1.03^{2}=1.0609$	6.0900%
4	$\$1.015^{4}=1.061364$	6.1364%
12	$\$1.005^{12}=1.061678$	6.1678%
365	$\$1.0001644^{365}=1.061831$	6.1831%
∞	$e^{0.06}=1.061837$	6.1837%

- if $B = \sum_t C_t \cdot e^{-rt}$
  - $\text{Macauley Duration} = \sum_t t \cdot \frac{C_t \cdot e^{-rt}}{B}$
  - $\text{Modified Duration} = -\frac{\frac{dB}{B}}{dr}$

$$= \frac{1}{B} \cdot \left(-\sum_t C_t \cdot e^{-rt} \right)$$

$$= \frac{1}{B} \cdot \left(-\sum_t C_t \cdot e^{-rt} \cdot (-t) \right)$$

$$= \frac{1}{B} \cdot \left(\sum_t t \cdot C_t \cdot e^{-rt} \right)$$

$$= \sum_t t \cdot \frac{C_t \cdot e^{-rt}}{B}$$

$$= \text{Macauley Duration}$$

- Duration dollars $= -\dfrac{dB}{dr}\ \left(\$/\%\right)$

*Duration 只有用一次線性來預估，只能考慮parallel shift in the yield curve，當yield curve的convexity有變化時，並無法由Duration看出 (p.59 Figure 4-2, 4-3)

*之前都是在Fixed-rate bonds的情況下，如果是Floating-rate bonds的情況時，Duration 等於現在到下一次付息日的時間，一般來說，此時間可能是三個月~六個月，會遠小於Time to maturity

- Effective Duration

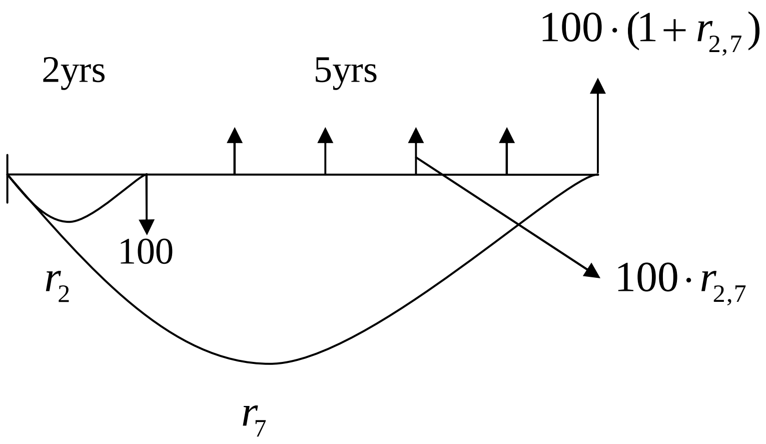
$$D^E = \frac{B(r-\Delta r) - B(r+\Delta r)}{(2\Delta r)B}$$

- Coupon Curve Duration

$$D^{CC} = \frac{B(r;c+\Delta c) - B(r;c-\Delta c)}{(2\Delta c)B}$$

* This approach is useful for securities that are difficult to price under various yield scenarios because only the market prices of securities with different coupons are required

- # Forward Rate Agreements



$$100 \cdot (1 + r_7)^7 = 100 \cdot (1 + r_2)^2 \cdot (1 + f_{2,7})^5$$

$$\Rightarrow f_{2,7} = \left[\frac{(1 + r_7)^7}{(1 + r_2)^2} \right]^{\frac{1}{5}} - 1$$

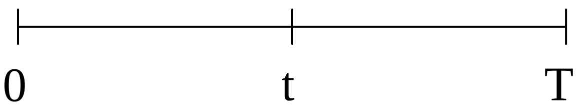
- Equity
  - Systemic risk→ β
  - Idiosyncratic risk→ ε (個股風險)

$$\Delta V = V \cdot r_s = V(\alpha + \beta \cdot r_m + \varepsilon)$$

- Foreign Exchange
  - 外匯市場交易量最大，流動性也好
  - 包括外匯現貨與期貨、外國的有價證券等都有匯率風險
  - For example, consider a U.S. bank holding a bond issued by a Mexican Company. The bank could lose money if the company defaults, if the peso interest rates increase, or if the peso devalues compares with the US$.

- Forwards
  - an agreement to buy a security or commodity at a point in the future
  - delivery price (contract price)
  - delivery date

$$\text{contract value at } t = \frac{N}{\left(1+r_f\right)^{T-t}}\left(D_t - D_0\right)$$



delivery Price D_0 D_t

Contract Value 0 $\frac{N}{\left(1+r_f\right)^{T-t}}\cdot\left(D_t - D_0\right)$

- A more complex example for a forward (interest and exchange rates parity)

* Futures: standardized amounts and delivery dates, daily settlement

- SWAP
  - Interest-Rates Swap $\tilde{r} \leftrightarrow \bar{r}$
  - Currency Swap = FX spot + FX forward
  - Basis Swap $\tilde{r}_{U.S} \leftrightarrow \tilde{r}_{LIBOR}$
  - Equity Swap equity index $\leftrightarrow \tilde{r}_{\text{LIBOR}}$

- Options
  - Vanilla options
  - Packages of vanilla options
  - Exotic options

  - Puts
  - Calls

  - European-style
  - Bermudan-style
  - Asian-style

- P.68 ~ 72, BS formula
- P.73 ~ 75, Figure 4-6 ~ 4-10, Greek Letters
- P.76 ~ 78, Figure 4-12 ~ 4-13, Volatility Smile and Skew
- P.77 ~ 79, Binomial Tree and Monte Carlo Simulation
- P.81 ~ 83, Trade Strategies of Options
- P.84, Exotic Options
  - Forward Start Options
  - Binary Options
  - Lookback Options
  - Barrier Options
  - Asian Options
  - Chooser Options

- Risk Measurement for Options

$$\Delta = \frac{\partial P}{\partial S} \quad \Gamma = \frac{\partial^2 P}{\partial S^2} \quad \upsilon = \frac{\partial P}{\partial \sigma} \quad \rho = \frac{\partial P}{\partial r} \quad \theta = \frac{\partial P}{\partial T}$$

$$\delta V = \Delta \times \delta S + \frac{1}{2}\Gamma \times (\delta S)^2 + \upsilon \times \delta\sigma + \rho \times \delta r + \theta \times \delta T$$