# Chapter 9
# Calculating Capital for Market Risk

# Introduction

- Three reasons for analyzing the capital consumed by market risks:
  - complying with industry regulations
  - calculating economic capital to control the bank's default probability
  - measuring risk-adjusted profitability

* VaR gives a solid foundation for assessing the amount of capital that should be held by a bank to protect it in the case of losses arising from market risks

# Complying with Industry Regulations

- In 1996, the Basel Committee on Banking Supervision recommended to national regulators that the minimum capital to be set for market risks based on VaR

$$\text{Capital} = 3 \times \sqrt{10} \times \text{VaR}_{99\%,1\text{day}}$$

(至少)

危機持續10天

一年發生3次

選定後還要作back testing，如第八章所說，如果exceptions過多，要增加capital

# Calculating Economic Capital to Control the Bank's Default Probability

- 不只是要維持不倒閉，可能要更多的EC來維持好的credit rating

$$\mathrm{EC} = \frac{W_P}{(1 + r_f)}$$

，where $W_P$ is the maximum probable loss such that there is only probability $P$ that the probability over a year will be worse than $W_P$

$$P = \text{prob}\left[\text{Annual profit} < W_P\right]$$

其中$P$通常設為$\underline{\underline{1\%}}$, $2.32\sigma_{1yr}$

$\Downarrow$

$BB$ or $BBB$

$\underline{\underline{0.1\%}}$, $3.1\sigma_{1yr}$

$\Downarrow$

$A$

$\underline{\underline{0.01\%}}$, $3.7\sigma_{1yr}$

$\Downarrow$

$AA$ or $AAA$

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$$\text{EC for A rating} \approx 3.1 \times \sigma_{1\,\text{yr}}$$

$$= 3.1 \times \sqrt{250} \times \sigma_{1\,\text{day}}$$

$$= \sqrt{250} \times \frac{3.1}{2.32} \times \text{VaR}_{99\%,1\,\text{day}}$$

$$= 6.68 \times \sqrt{10} \times \text{VaR}_{99\%,1\,\text{day}}$$

$$\approx 2\text{倍之regulatory capital}$$

- 與regulatory capital不同可能原因:
  - 銀行希望擁有比持有minimum regulatory capital 更好之債信
  - regulatory capital 可能同時考慮了market risk與其他的risks，而這些風險互相diversified後，整體的風險沒有那麼大，自然regulatory capital for market risk 也變得較小
  - 長期之影響未必等於短期相加 (但乘了 $\sqrt{T}$ 即表示為相加)，此外，通常長期的影響都有mean reversion的性質 (亦即有serial correlation)
  - 投資組合可能持有一天、兩天，但很少同樣投資組合持有一年
  - 考慮了公司之stop-loss policies and liquidity of the instrument 後，EC應該不需要那麼高，但要達到A rating，通常EC還是要為regulatory capital之1~2倍

- 某一個transaction or subportfolio所需之資本，可用VaRC的觀念得出：

$$\text{Allocated Capital}_{\text{subportfolio}} = \text{Capital}_{\text{portfolio}} \times \frac{\text{VaRC}_{\text{subportfolio}}}{\text{VaR}_{\text{portfolio}}}$$

其中 $\text{Capital}_{\text{portfolio}}$ 是為了整個銀行的portfolio考慮而建立的

# Measuring Risk-Adjusted Profitability

- 當我們知道某個交易所需的EC，則可以算出此交易的RAROC與SVA

$$\text{RAROC} = \frac{\text{Net Income}_{\text{transaction}}}{\text{Allocated Capital}_{\text{transaction}}}$$

$$\text{RAROC}_{\text{annual}} = \left(1 + \text{RAROC}_{\text{T}}\right)^{\frac{250}{\text{T}}} - 1$$

(不同之transaction持續不同之期間T，因此，要annualize才能比較RAROC)

$$\text{SVA} = \text{Net Income} - \text{Allocated Capital} \times \text{H}_{\text{T}}$$

其中 $\text{H}_{\text{T}}$是hurdle rate for T，$\text{H}_{\text{T}} = \left(1 + \text{H}_{\text{Annual}}\right)^{T/250} - 1$

# The use of VaR by Fund Companies

- For a fund company, there are two sets of risks to control:
  - Risks to their fund holders (dependent on the fund portfolio)
  - Risks to their shareholders (partially dependent the performance of the fund, and also dependent on costs and fees charged)