

---

## **Chapter 2**

# Risk Measurement at the Corporate Level: Economic Capital and RAROC

---

---

- Risk adjusted Return on Capital (RAROC)

$$\text{RAROC} = \frac{\text{Expected net risk-adjusted profit (ENP)}}{\text{Economic capital (EC)}}$$

- \* RAROC was developed by Bankers Trust in the late 1970s, which is designed to solve the problem of evaluating the performance of traders with different risk profiles
- \* RAROC has become the industry's standard way of measuring risk-adjusted profitability

- 
- Economic Capital: the net value the bank must have at the beginning of the year to ensure that there is a small **probability of defaulting** within the year (Table 2-5 default prob.)
    - Net value = Asset – Liability (equity can be viewed as being a cushion against default)
    - EC for Credit Risk
    - EC for Market Risk
    - EC for Operating Risk
  - \* Economic Capital is also called Risk Capital, which is basically a value-at-risk measure
-

# 1. 資本、風險與破產機率

- Examples

$$ROE = \frac{E_1 - E_0}{E_0}$$

$A_0=100$ , $r_A=6\%$ (預計 $t=1$ 賺回106)	$D_0=95$ , $r_D=5\%$ ( $t=1$ 預計要付99.8)
	$E_0=5$

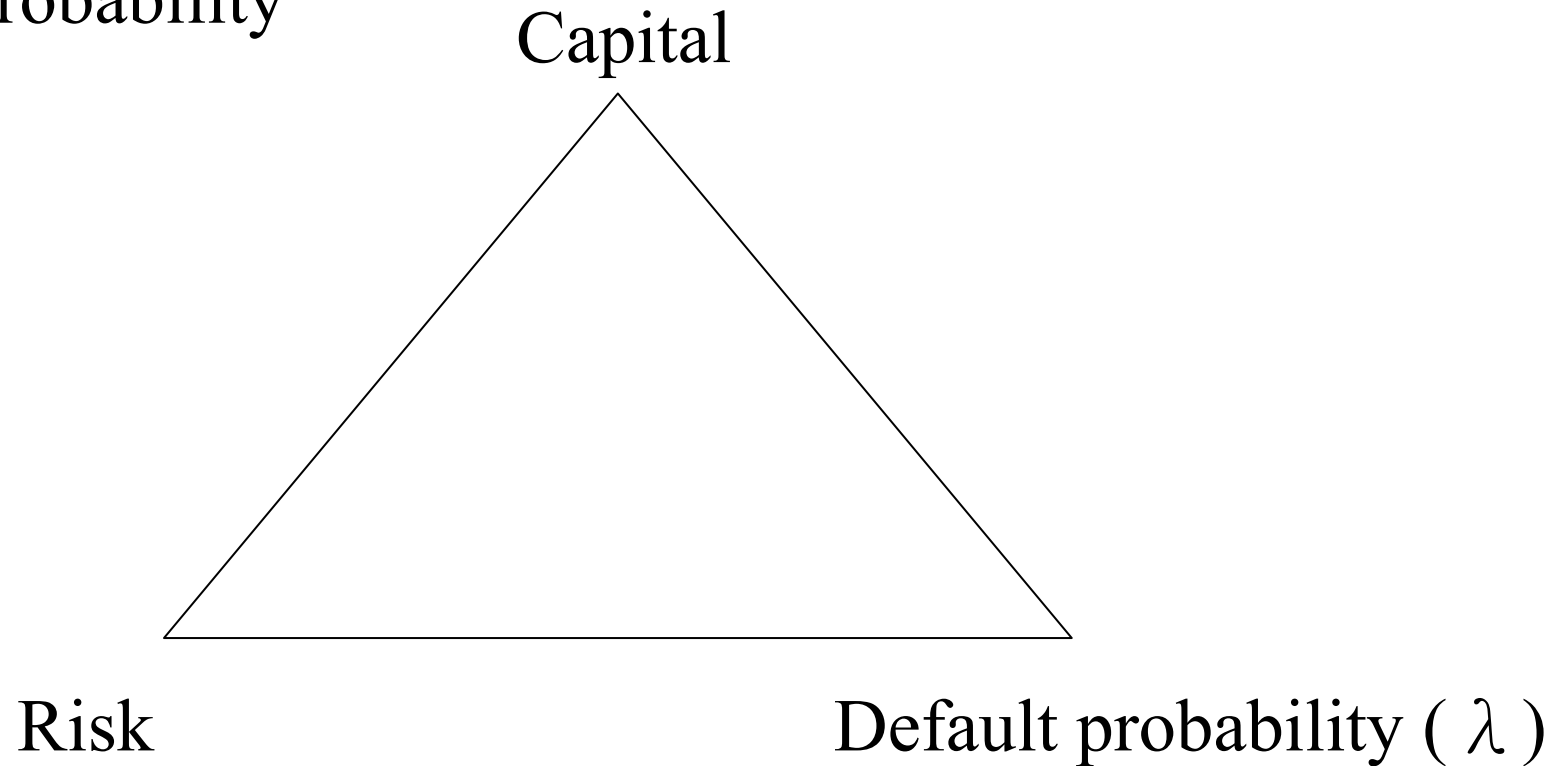
## Base Case

$\lambda$	0%	4%	8%	16% (extra risk)
$A_1$	106	101.8	97.5	89
$D_1$	99.8	99.8	97.5	89
$E_1$	6.3	2	0	0
ROE	25%	-60%	-100%	-100%

## Extra Capital

$A_0=100$ , $r_A=6\%$		$D_0=90$ , $r_D=5\%$			
		$E_0=10$			
$\lambda$	0%	4%	8%	16%	
$A_1$	106	101.8	97.5	89	
$D_1$	94.5	94.5	94.5	89	
$E_1$	11.5	7.3	3	0	
ROE	15%	-27%	-70%	-100%	

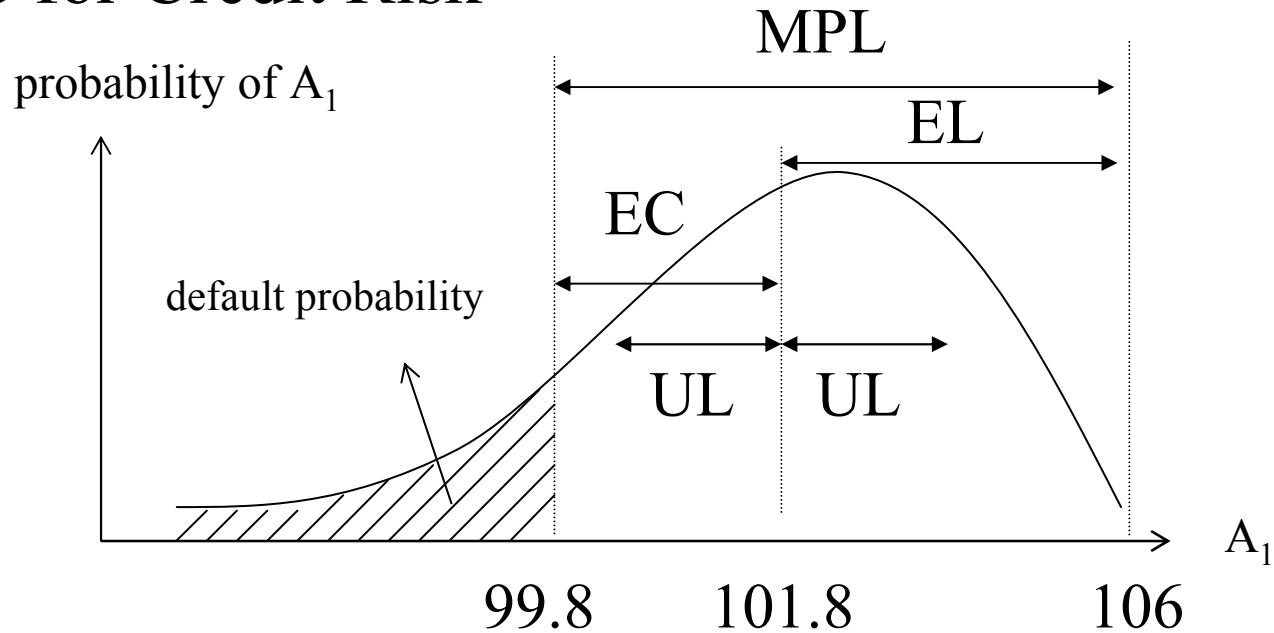
- 
- The Relation between Capital, Risk, and Default Probability



\* Table 2-4 and Figure 2-1 (Credit-Loss Scenarios)

~~\* Figure 2-2, 2-3, and 2-4 (Prob. Dist. of the payoff of assets)~~

- EC for Credit Risk



$$=106*(1-4\%)$$

MPL : maximum probable loss

EL : expected loss

UL : unexpected loss

EC : economic capital



- 證明  $EC \approx MPL - EL$

$$EC_0 = A_0 - D_0$$

$$A_0 = D_0 + EC_0$$

$$D_1 = (1 + r_D)D_0$$

$$A_1 = (1 + r_A)(1 - \lambda)A_0$$

$$EC_1 = A_1 - D_1 = (1 + r_A)(1 - \lambda)A_0 - (1 + r_D)D_0$$

$$\Rightarrow 0 = (1 + r_A)(1 - \lambda_p)A_0 - (1 + r_D)D_0$$

其中  $\lambda_p$  指能承受最大的破產風險 (worse case of the lose of principal)

$$\Rightarrow D_0 = A_0 \frac{(1 + r_A)(1 - \lambda_p)}{1 + r_D}$$

$$\begin{aligned}
&= A_0 \left( \frac{(r_D - r_A) + \lambda_P + \lambda_P r_A}{1 + r_D} \right) \\
&= A_0 \lambda_P \frac{1 + r_A}{1 + r_D} - A_0 \frac{r_A - r_D}{1 + r_D} \\
&= \text{MPL} \frac{1}{1 + r_D} - A_0 \frac{\text{EL} / A_0}{1 + r_D} \\
&\approx \text{MPL} - \text{EL}
\end{aligned}$$

其中  $\text{MPL} = A_0(1 + r_A)\lambda_P$

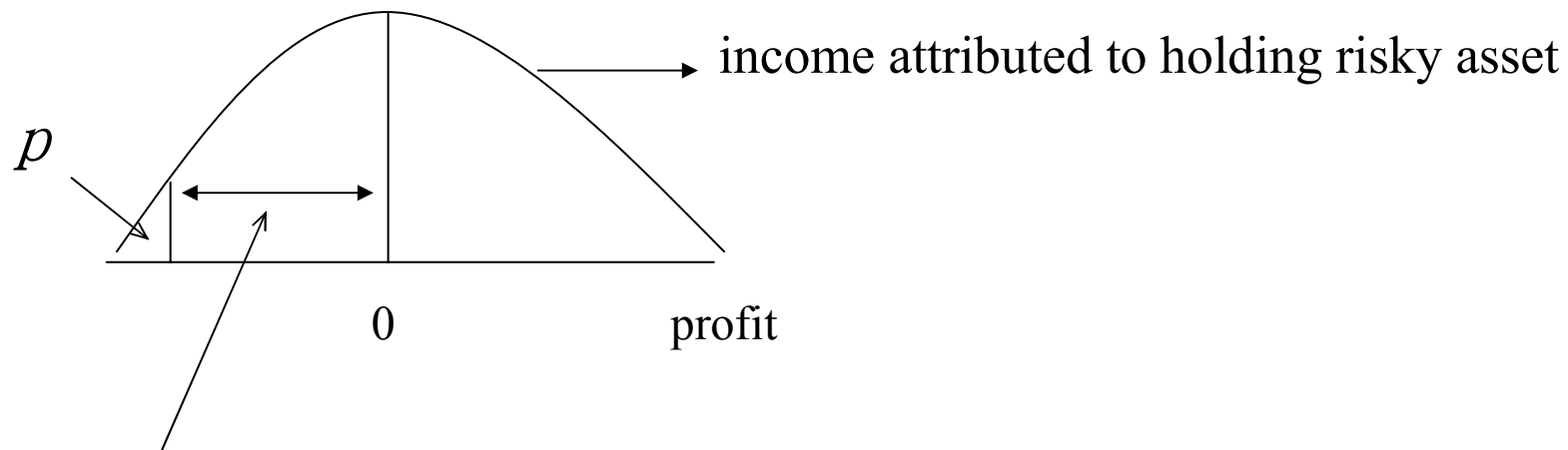
$$r_A = \frac{(A_0 - \text{EC}_0)r_D + \text{OC} + \text{EL} + \text{H} \times \text{EC} - \text{F}}{A_0} \quad (A_0 - \text{EC}_0 \approx A_0, \text{OC} = \text{F} = 0, \text{H} = 0)$$

$$\approx \frac{A_0 r_D + \text{EL}}{A_0} = r_D + \frac{\text{EL}}{A_0}$$

$\left(\frac{\text{EL}}{A_0} = \mu, \text{期望壞帳機率}\right)$

- EC for Market Risk (假設投資在無風險資產)

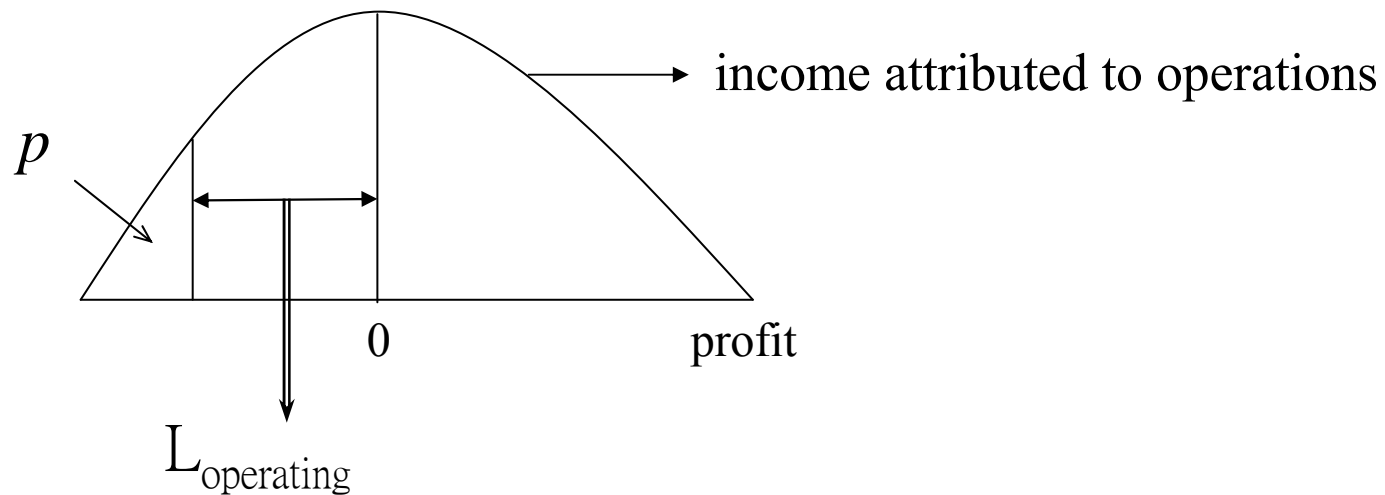
$$EC = \frac{W_P}{(1 + r_f)}$$



$W_P$  : maximum probable loss

- EC for Operating Risk

$$EC = \frac{L_{\text{operating}}}{(1 + r_f)}$$



## 2. RAROC

- 之前銀行業，都用較不精確的ROA，ROE來做performance的比較，這些都沒考慮risk，無論是credit risk，market risk，或是operating risk，所以比較的結果較沒有意義
  - ROE之E可以是
    - ◆ book capital
    - ◆ Regulatory capital (政府規定的，目前與風險大小無關，但其實應該與風險有關，所以在新的巴塞爾協定中，建議所需的資本，應該與承擔的風險相關)

- 若用了EC之觀念來做調整，會好很多
  - Risk-adjusted Return on Capital (RAROC)
    - ◆ For a loan asset

$$\text{RAROC} = \frac{\text{ENP}}{\text{EC}} = \frac{A_0 r_A + F - D_0 r_D - \text{OC} - L}{\text{EC}}$$

ENP: expected net risk-adjusted profit

F : fee

$D_0$  :  $A_0 - \text{EC}$

OC : Operating Cost

L : Expected Loss

- ◆ For a trading transaction

$$\text{RAROC} = \frac{\text{ENP}}{\text{EC}} = \frac{\Delta\text{V}-\text{OC}}{\text{EC}}$$

$\Delta\text{V}$  : Net Change of Portfolio Value

OC : Operating Cost

- ◆ If RAROC is calculated on a prospective basis

$$L \rightarrow E[L]$$

$$\Delta\text{V} \rightarrow E[\Delta\text{V}]$$

- ◆ The minimum required value for RAROC is called the hurdle rate, and the actual value chosen is around 12 to 20%

---

- Shareholder value added (SVA)

SVA gives a dollar-based measure of performance

SVA = actual or expected profitability – required profitability to meet the hurdle rate

- ◆ For a loan asset

$$SVA = (A_0 r_A + F - (A_0 - EC) r_D - OC - E[L]) - H \times EC$$

- ◆ For a trading transaction

$$SVA = (E[\Delta V] - OC) - H \times EC$$