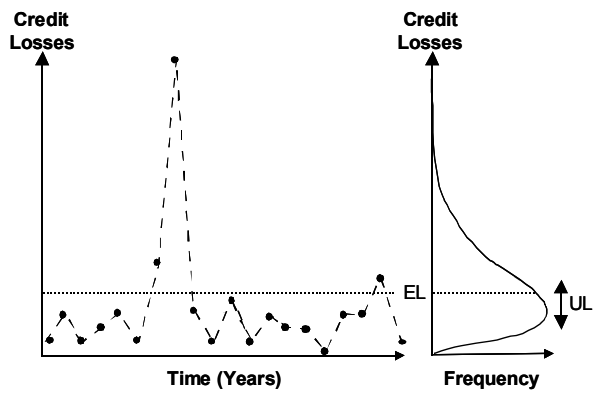
RISK GLOSSARY

Explain the risk measurement concepts for each source

1. Credit Risk

Credit risk can be calculated using two measures



*EXPECTED LOSS (EL)**
• Anticipated average annual loss rate
• Foreseeable 'cost' of doing business
• Not 'risk' as investors think of it, but rather charge which affects anticipated yield
• Equal to the mean (average) of losses over an economic cycle

UNEXPECTED LOSS (UL)
• Anticipated volatility of loss rate
• Results in volatility of return over time
• Unanticipated but inevitable
• Requires a balance sheet cushion of 'economic' capital
• Defined as one standard deviation of losses

Although loss levels fluctuate from month to month, there is an average, statistically anticipated, annual level of credit loss over time. This is called Expected Loss (EL) and should be viewed as the foreseeable cost of doing business.

Expected Loss does not by itself constitute risk-if losses always equalled their expected levels there would be no uncertainty. The risk arises from variations in loss levels which cannot be anticipated although are inevitable. These are due to Unexpected Loss (UL), which statistically speaking, can be thought of as the standard deviation of credit losses.

Banks hold two pools of funds to protect themselves against losses. Broadly, bad debt provisions provide against Expected Loss, while "economic" capital protects against Unexpected Loss.

The amount of capital a bank must hold to protect against Unexpected Loss is proportional to the risk it takes and is dependent upon its desired safety level (or target credit rating), ie for the same level of "underwritten risk", banks with more capital typically have stronger credit ratings

2. Market Risk (ALM & Trading risk)

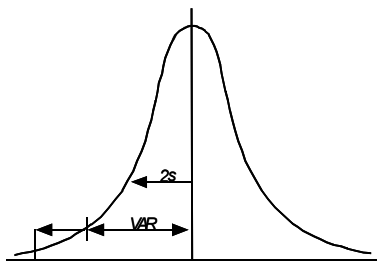
Market risk can be divided into two distinct categories

	TRADING	*ALM*
Purpose	• Positions to facilitate dealing • Proprietary trading positions	• Positions generated by customer business • Strategic "buy and hold" hedges
Liquidity	• Liquid, actively funded positions • Holding periods measured in days/weeks	• Illiquid or "buy and hold" positions • Holding periods measured in months/years
Option Characteristics	• Price-driven exchange-traded or OTC options • Short holding periods make linear approximations possible	• Customer-driven embedded options • Long holding period makes non-linearity material

The measurement approach is different for the two types of market risk

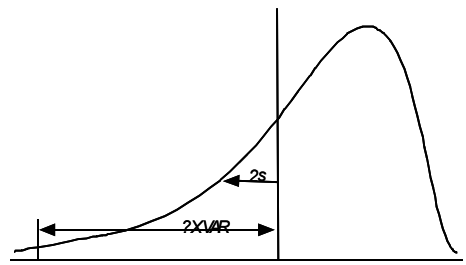
TRADING

'Worst case' loss is estimated as multiple of Value at Risk (VAR)
Short horizon
Ignores non-linearity of options



ALM

'Worst case' loss relative to VAR is a function of the skewness of the distribution
Long horizon
Non-linearity material



Market risk falls into two distinct categories – trading and ALM.
Trading risk results from volatility in the value of tradable securities held either as inventory to facilitate customer business, or as proprietary positions.

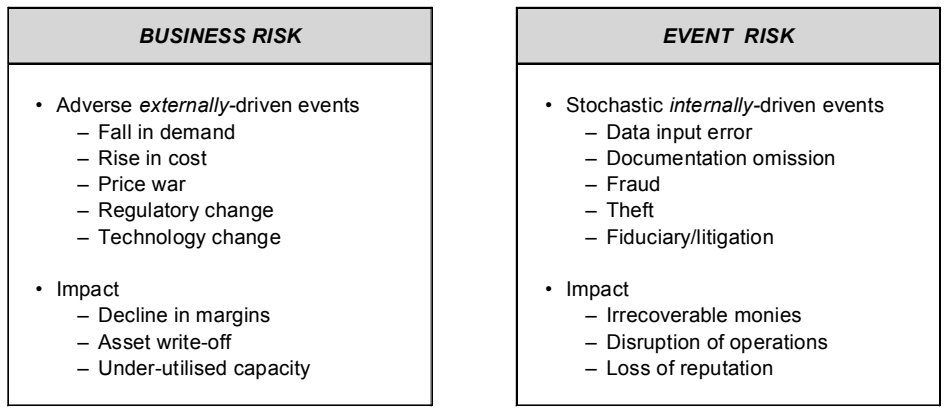
ALM risk results from structural interest rate mismatch between assets and liabilities, i.e. changes in interest rates affect the value of assets and liabilities differently, resulting in volatility in the economic value of the balance sheet.

Relatively short time horizons associated with the liquidity of trading positions enable economic capital to be estimated as a multiple of VaR. The nuance lies in determining the appropriate multiple that is driven by the liquidity of positions, as well as internal trading policies.

The long time horizons associated with ALM risk and the non-linearity that results from the embedded options inherent in many products have a significant impact on the level of economic required to achieve a given level of solvency

3. Operational Risk

We can identify two separate and independent components of operational risk



Capital is required to cover against non-financial operating risks which cause earnings/value volatility and hence the potential for loss.

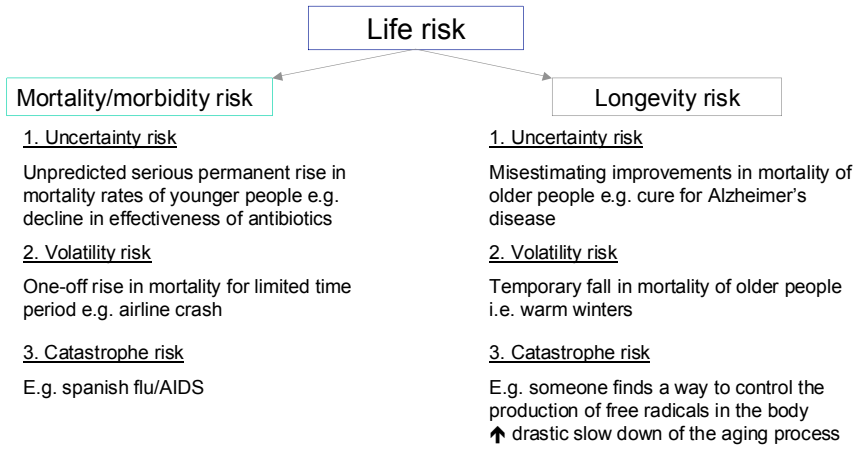
This capital is analogous to the need for equity in a non-financial company:

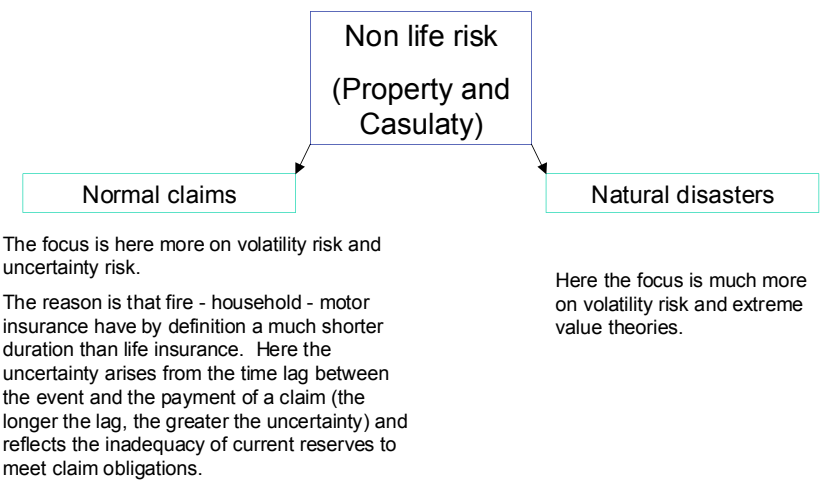
- To fund fixed assets
- To absorb swings in profitability
- To carry fixed costs when economic to do so

Operational risk capital provides the basis for consistent performance measurement, particularly of non-financial businesses.

Both regulators and investors see operational risk as a second order effect on solvency. This explains the focus on credit and market risk.

4. Insurance Risk (Life/ Non-Life)





Property and Casualty businesses also contribute to earnings value/volatility

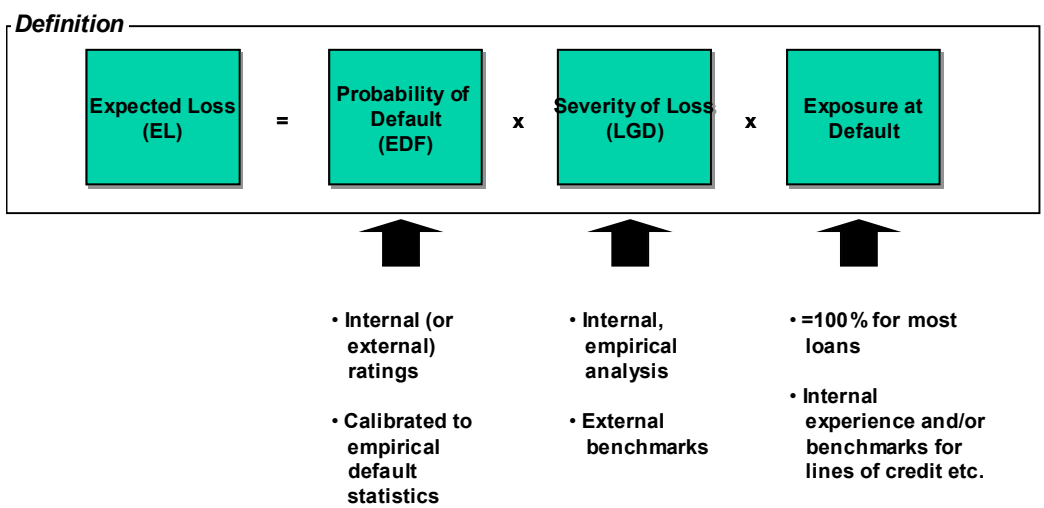
P&C	***LIFE***
• Underwriting risk for 'normal' events, eg theft, medical claims – Expected claims ~ EL – Unexpected claims ~ UL • Catastrophe risk from natural disasters	• ALM risk resulting from variable performance in investment portfolio but 'guaranteed' returns for with profits policy holders • Mortality risk resulting from changes in mortality rates – Term assurance – Annuities

CREDITS

5. Explain the concept of expected loss

The expected loss is the average annual loss rate which represent the foreseeable cost of doing business. It includes three factors that multiply each other: PD * LGD * EAD.

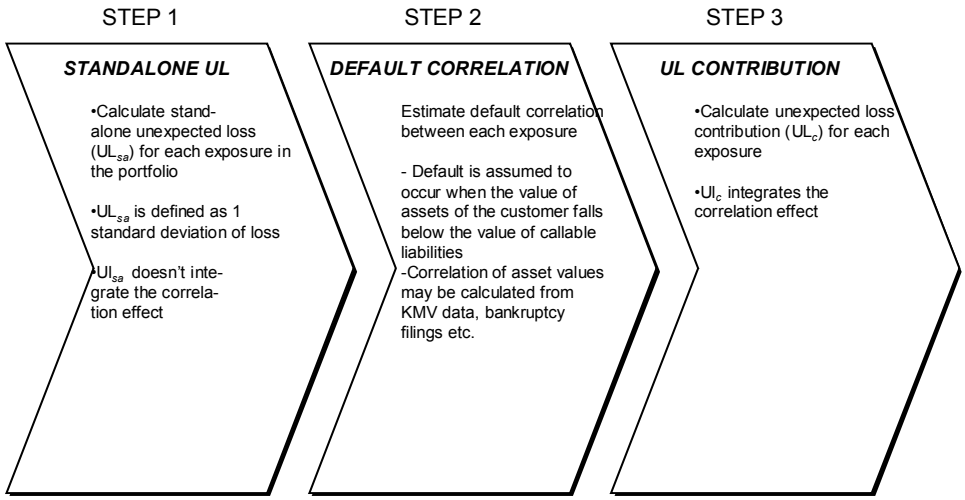
FACTOR	*QUANTIFICATION*
• Quality of the counterparty	Expected Default Frequency, or "EDF" - The statistical probability that a counterparty will default
• Quality of the security	Loss Given Default, or "LGD" - The percentage of the debt that the Bank is likely to lose once a counterparty has defaulted
• Amount at risk	Exposure at Default - The debt of the counterparty to the Bank at the point of default



6. Explain the concept of unexpected loss (up to the "standalone UL")

The unexpected loss is the main measure of earnings volatility resulting from credit risk. It corresponds to the anticipated volatility of the loss rate and is defined as one standard deviation of losses.

Estimating unexpected loss is a three stage process



The standalone unexpected loss is defined as one standard deviation of loss and can be estimated via a mathematical derivation from EDF (=PD) based on the standard deviation formula.

MEAN CAN BE DEFINED AS :

$E(x) = \mu$ (1)

VARIANCE CAN BE DEFINED AS:

$$VAR(x) = E(x-\mu)^2$$
$$= E\left(x^2 - 2\mu x + \mu^2\right)$$
$$= E\left(x^2\right) - 2\mu E(x) + \mu^2$$
(1) and (2) $\Rightarrow = E\left(x^2\right) - E(x)^2$

Since $J^2 = J = 1$ or $J^2 = J = 0$

$$VAR(J) = EDF - EDF^2$$
$$= EDF(1 - EDF)$$
$$\text{Volatility of Loss} = \sqrt{EDF(1-EDF)}$$
$$\text{Size of Loss (at Default)} = LGD \times Exposure at default$$

SUBSTITUTE X FOR BERNOULLI VARIABLE J

Where J 1 Default, 0 No Default

Where $E(J) = EDF$

$\Rightarrow VAR(J) = E(J^2) - E(J)^2$

$= E(J) - E(J)^2 = EDF - EDF^2$

SIZE OF VOLATILITY OF LOSS

$$UL_{sa} = \sqrt{EDF(1-EDF)} \times LGD \times Exposure at default$$

7. Explain the concept of unexpected loss (starting from "standalone UL")

To calculate the unexpected loss of a portfolio, the less than perfect correlation between the default of each loan must be taken into account.

CORRELATION (DENOTED BY RHO, ρ)

Definition

- Correlation is the degree to which two events happen at the same time
- ρ = 1 denotes perfect correlation (i.e. the two loans always default at exactly the same time)
- ρ = 0 denotes perfect independence (i.e. the two loans each default randomly, such that a default on one does not affect the other in any way)

$$UL_{portfolio} = \sqrt{\sum\sum UL_i UL_j \rho_{ij}}$$

where ρ_{ij} is the correlation between loan i and loan j

The correlation of the market value of assets may be calculated from publicly available data (eg. KMV, bankruptcy filings etc.).

The grading masterscale (calibrated to edf) is used to convert asset correlations to default correlations.

A UL_{sa} weighted average correlation for each product group to all product groups gives the segment to bank correlation.

The weighted average of the loan to bank correlation gives the average bank correlation.

The correlation benchmarks enable us to estimate the contribution that each portfolio makes to the total unexpected loss.

In our analysis of the portfolio, we will use the market-based approach to estimating correlation based on the Merton model of default.

Correlation of default can be derived from the probability that the asset value of both counterparties falls beneath the value of their callable liabilities.

	Rho	$\frac{\rho}{\sqrt{\rho_{bank}}}$		ULsa		ULc
Cons. Non-Mrtg	0.55%	4.63%	X	94.9	=	4.4
Cons. Mrtg	0.74%	6.18%	X	20.9	=	1.3
SME	1.50%	12.59%	X	128.6	=	16.2
Corp	2.47%	20.78%	X	79.6	=	16.5
Public Sector	1.19%	10.02%	X	24.1	=	2.4
Banks	1.36%	11.44%	X	27.8	=	3.2
Total	1.42%					44.0

EURO BN

$$\rho Bank = 1{,}42\% \Rightarrow \sqrt{\rho Bank} = 11{,}9\% \Rightarrow \frac{\rho}{\sqrt{\rho Bank}} = 4{,}63\%$$

ALM

12. Explain the concept of duration, modified duration

13. Compute the duration and the modified duration of a bond/portfolio of 2 bonds

The life span of a bond (ie. its maturity) does not take its intermediate cash-flows into account. Macaulay introduced the concept of duration to remedy this.

The duration measures the average time a bond older has to wait to receive the cash-flows of his bond, both interest and capital.

The duration is calculated by weighting the due dates of flows (of interest and capital) according to the current value of each flow.

$$D = \frac{\sum_{t=0}^{n} \frac{C_t \text{ x } t}{(1+i)^t}}{\sum_{t=0}^{n} \frac{C_t}{(1+i)^t}}$$

The duration of a portfolio is equal to

$$D_{Port.} = \frac{\sum_{j=1}^{m} \sum_{t} \frac{C_t^j \text{ x } t}{(1+i)^t}}{\sum_{j=1}^{m} PV_j} = \frac{\sum_{j=1}^{m} D_j \text{ x } PV_j}{\sum_{j=1}^{m} PV_j}$$

The sensitivity of a product's price P (of the PV) to the interest rate is given by the price's first derivative with respect to rate I (i.e. the slope of the curve).
Starting from the hypothesis that the PV is a continuous function of the rate,

$$\frac{dP}{di} = \frac{d}{di}\left[\sum_{t=0}^{n} \frac{C_t}{(1+i)^t}\right] = \sum_{t=1}^{n} -\frac{C_t.t}{(1+i)^{t+1}} \quad \text{and} \quad \frac{1}{P}.\frac{dP}{di} = \frac{\sum_{t=1}^{n} -\frac{C_t.t}{(1+i)^{t+1}}}{\sum_{t=0}^{n} \frac{C_t}{(1+i)^t}} = -\frac{D}{1+i} \quad \text{or} \quad \frac{dP}{P} = -\frac{D}{1+i}.di$$

The modified duration is given by $\boxed{\text{mod}\, D = \frac{D}{1+i}}$

It gives the relative sensibility of a product's price to a unitary yield shift. This is a sensitivity to the present because it depends on the present rate. It is thus not based on a sample taken from the past.