

# Economic Capital for Life Insurers

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Southeastern Actuaries Conference

Spring Meeting

Ritz Carlton, Amelia Island – June 20, 2003

# RAROC

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## Economic Capital...

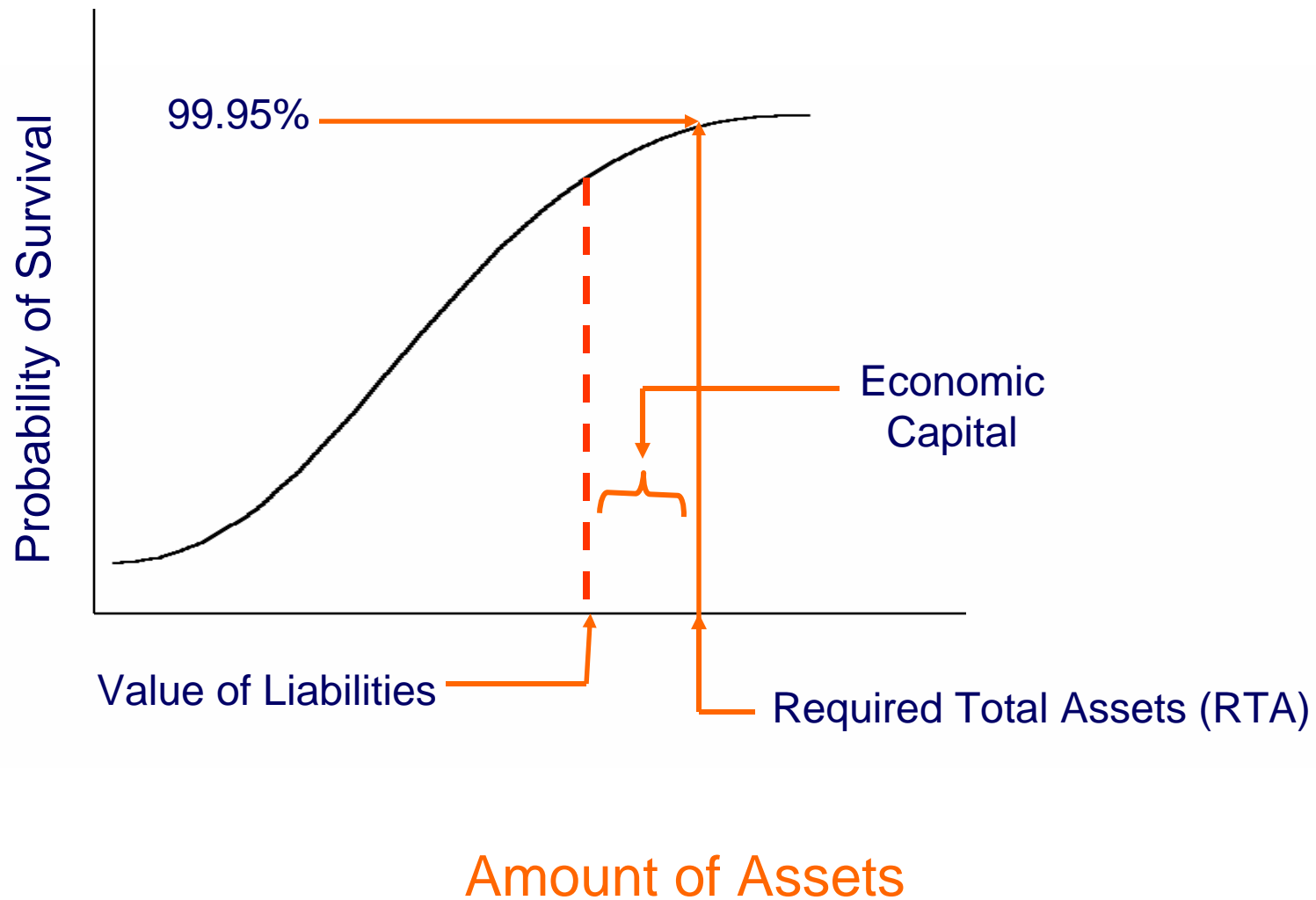
- How is it defined?
- What are its components?
- How are the components calculated?
- How is diversification taken into account?

## Definition of Economic Capital

Economic Capital (EC)...

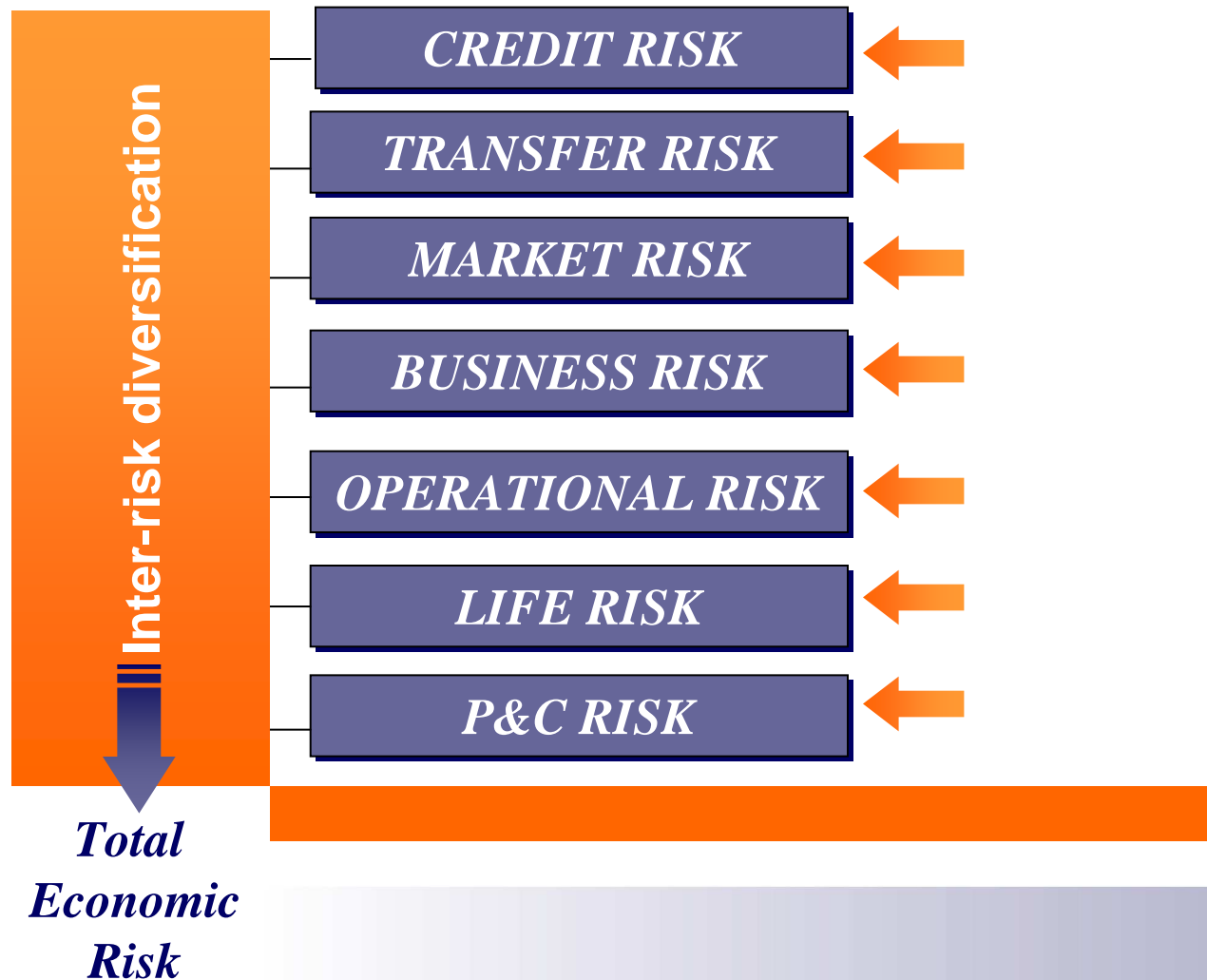
- EC equals Required Total Assets (RTA) less Value of Liabilities (VL)
- RTA is the value of assets required to assure that the NPV of net cash flows is positive with a given probability (e.g., 99.95%) for a set of scenarios
- Both RTA and VL may change with the scenario – and so will EC

# Ruin Theory Approach































# Components of Economic Capital

Economic Capital covers 7 different risk types



## Risks for A Diversified Financial Services Firm

Management of a diversified financial services firm wants to know the risks and returns of all its businesses

| <b>RISK MAP</b>              | <b>CREDIT</b>                                                                       | <b>TRANSFER</b>                                                                     | <b>MARKET*</b>                                                                        | <b>BUSINESS</b>                                                                       | <b>OPERATIONAL</b>                                                                    | <b>LIFE</b>                                                                           | <b>P&amp;C</b>                                                                        |
|------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| <b>Banking</b>               |    |    |    |    |    |    |    |
| <b>Life insurance</b>        |    |    |    |    |    |    |    |
| <b>P&amp;C insurance</b>     |  |  |  |  |  |  |  |
| <b>Investment activities</b> |  |  |  |  |  |  |  |

## Value of Liabilities

**Economic Return** = change in **market value** of assets less change in **market value** of liabilities

**Market Value** is an estimate of price – easy to determine if **complete markets** with readily available and observable values exist. This holds for example for trading, treasury and investment banking businesses. More difficult for **incomplete markets** such as insurance.

For a block of life insurance, **market value of liabilities** is taken to be the present value of cash flows equal to best estimate cash flows increased by a **Market Value Margin (MVM)** for each of the risks; e.g., an actuarial proxy of market value of the cash flows.

## What is Market Value Margin (MVM)?

- MVM reflects the **market estimate** of the price a willing buyer would pay **above the best estimate** of liability cash flows e.g., the risk premium for uncertainty (systematic, undiversifiable)



## Value of Liabilities

### Economic Capital...

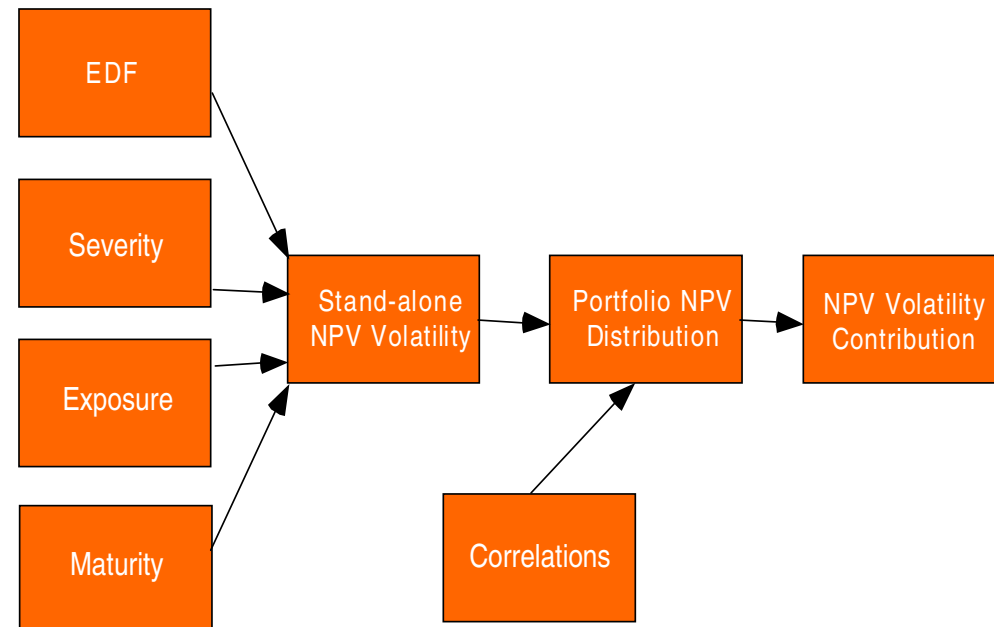
- Is usually based on market value of liabilities
- Could theoretically be calculated based on other liability valuations
- Calculations would be different
- Following assumes Market Value of Liabilities (MVL)

# Seven Risk Types – Credit Risk

## 1. Credit Risk

Credit Risk is driven by 5 factors

- Expected default frequency: issuer/counterpart creditworthiness
- Severity: offset by collateral
- Exposure: size of exposure at default
- Maturity: contract & cash flow maturity
- Correlations: diversification



## **Seven Risk Types – Transfer Risk**

### **2. Transfer Risk – Inconvertibility Risk**

- Local book capital can in some emerging countries not be repatriated when required
- Solvent foreign partners cannot meet their obligations because of emerging government restrictions

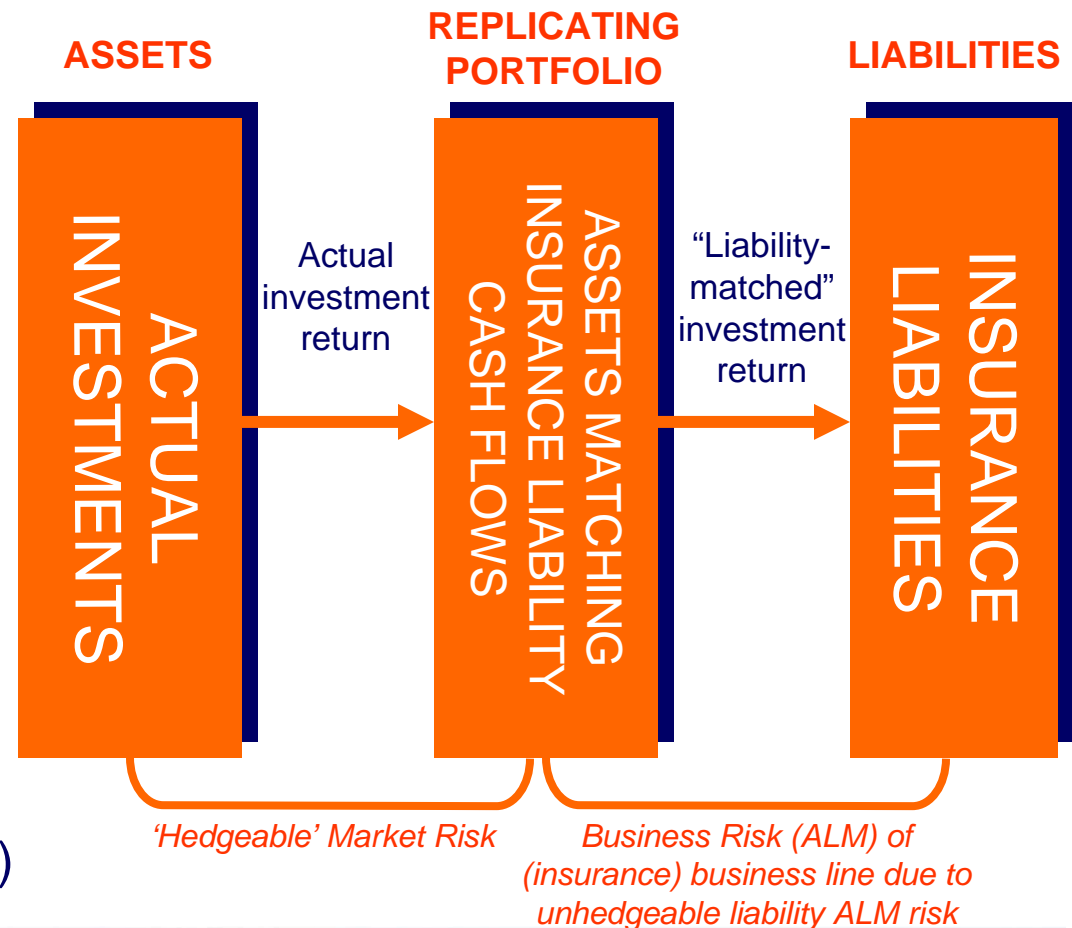
## ALM Risk

- ALM risk is the uncertainty in economic value caused by uncertainty/volatility in interest rates, equity prices, real estate prices, foreign exchange rates and other factors
- ALM risk cannot always be fully diversified/hedged due to, for example, complexity of embedded options and long-term structure of some businesses
- ALM risk involves both **market risk** (hedgeable) and **business risk** (unhedgeable)

# ALM Risk

## ALM Risk – Replicating Portfolio

- Replicating portfolio contains assets which match the liability cash flows as closely as possible
- Actual asset portfolio versus replicating portfolio performance is attributable to investment activity
- Replicating portfolio versus liability portfolio performance is attributable to (insurance) business line



## Seven Risk Types – Market Risk

### 3. Market Risk

- Market risk is defined as hedgeable market price or rate changes on open positions
- Responsibility of investment area

## ALM Market Risk – Practical Method

- Method only applicable where there is no ALM Business Risk
- Asset cash flows will come from existing assets
- Select a set of stochastically-generated scenarios (say 100)
- Project asset cash flows without reinvestment and solve for an option adjusted spread (OAS) over the 90-day Treasuries such that the average of the present value of these cash flows over the 100 scenarios equals the (known) market value of the existing assets
- Use the 90-day Treasuries from each scenario increased by the OAS to discount the liability cash flows (including the MVM). The PV is the value of the replicating portfolio
- Rank each scenario by the excess (or deficiency) of the PV of the existing asset cash flows over the PV of the liability cash flows for that scenario
- RTA will be the average of the market values of the assets that must be added to the existing assets to avoid ruin for the 99<sup>th</sup> and 100<sup>th</sup> scenarios
- The Economic Capital for the ALM market risk is the excess of the RTA over the market value of the existing assets

## **Seven Risk Types – Business Risk**

### **4. Business Risk**

*Business risk consists of two parts:*

**ALM Business Risk**

**Non-ALM Business Risk**



## **Seven Risk Types – Business Risk**

### **4. Business Risk *continued***

*Business risk consists of two parts:*

#### **ALM Business Risk**

- Unhedgeable (price or interest rate) mismatch risk due to product design and/or market
  - Life policies with interest guarantees with maturities which cannot be closed out or hedged in the financial markets
  - Insurance liabilities sold in emerging market countries with maturities which are not traded

#### **Non-ALM Business Risk**

## **Seven Risk Types – Business Risk**

### **4. Business Risk *continued***

*Business risk consists of two parts:*

#### **ALM Business Risk**

#### **Non-ALM Business Risk**

- New business variations from plan (usually as a result of regulatory or fiscal changes)
- Existing business variations from plan (lapses and renewals)
- Expense risk
- Moral hazard

## Seven Risk Types – Operational Risk

### 5. Operational Risk

Operational risk is the risk of loss due to one-off events

- System failures
- Processing & control failure
- Litigation mis-advice
- Unplanned litigation
- Regulatory breach
- Fraud
- External disruption

## Seven Risk Types – Operational Risk

### 5. Operational Risk *continued*

Operational risk can be traded off for lower return

- Company decides on protection, but protection has a price (reduced return)
- A safer company needs lower capital (buffer) – again, a “risk versus reward” decision
- Expansion of internal control procedures implies quantified operational risk capital savings are factored into (financial) performance measurement (higher costs with simultaneous decrease in operational risk capital)

## Capital for Insurance Risks

- **Volatility capital** – To provide for random fluctuations where risk probability distribution is known
- **Uncertainty capital** – To provide for incorrect estimates of risk probability distribution
- **Calamity capital** – To provide for short-term increases in claims due to extreme conditions

## Seven Risk Types – P&C Risk

### 6. P&C Risk

- **Volatility risk** Major windstorm
- **Uncertainty risk** Mis-estimation of the period between storms
- **Calamity risk** Windstorm of size that occurs once in 2000 years

Often short term contracts, possibly with long tail

## **Seven Risk Types – Life Risks**

### **7. Life (Morality and Morbidity) Risks**

Longer term contracts

# Life Risk Factors

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Needed

Practical methods to determine economic capital for life risk and life market value margins



# Life Risk Factors

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## Reinsurance Advantage

- Data from a collection of independent sources
- Knowledge of deals done at market value

# Life Risk Factors

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## Market Value Margin (MVM)

Look at pure mortality reinsurance deals in the marketplace

## Life Risk Factors

Determine MVM to equalize present values of expected cash flows

- With pricing discount rate and pricing (expected) mortality
- With risk-free discount rates and pricing mortality multiplied by  $(1+\text{MVM})$

# Life Risk Factors

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## Volatility Capital

Can be calculated from expected mortality rates

## Life Risk Factors

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Uncertainty Capital – *First Try*

Calculate sample standard deviation of A/E ratios  
for collection of client companies

# Life Risk Factors

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## Problems

- Unweighted result: very high – unrealistic
- Weighted by exposure: still unrealistic
- Surmise: should weight by credibility and discount for diversification across ceding companies

## Life Risk Factors

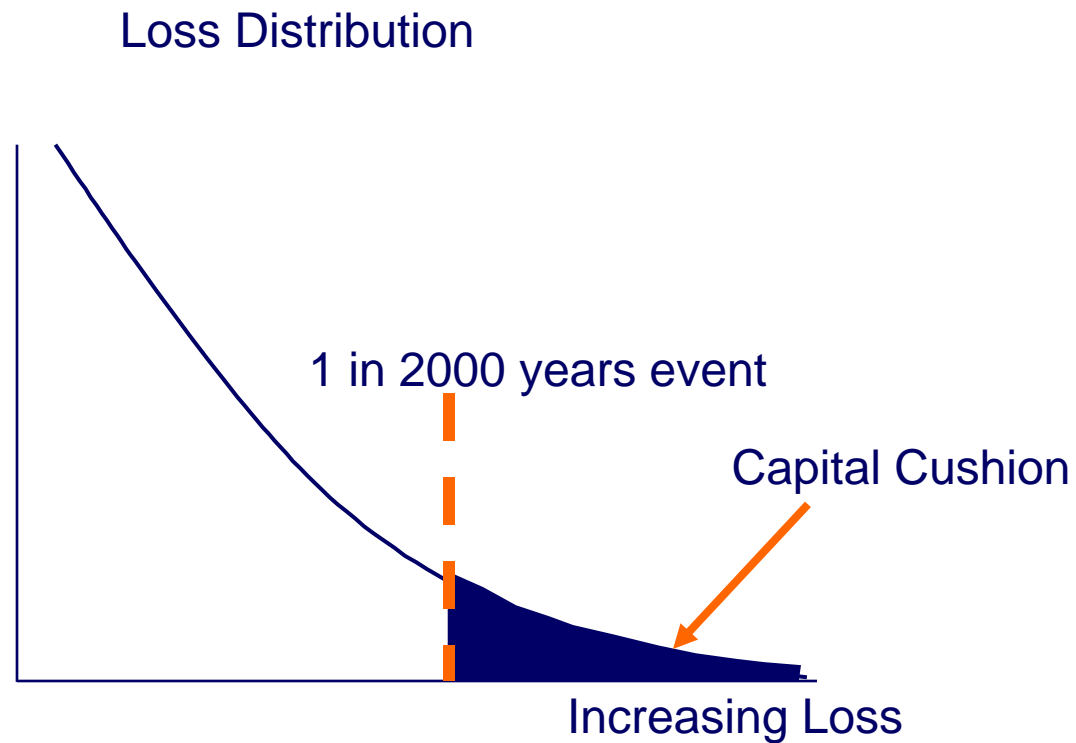
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Uncertainty Capital – *Second Try*

Calculate sample standard deviation of A/E time series for entire block

# Life Risk Factors

## Calamity Risk – Conditional Tail Expectation





## Life Risk Factors

### Calamity Capital – *Example 1918 Influenza*

- 500,000 deaths in US (would be more than 1,000,000 today)
- 20,000,000 deaths worldwide
- W-shaped age distribution
- 9-month lead time for vaccine
- Estimate 50% increase in mortality for the year
- Frequency? Black Plague (1400s) was longer lasting; less intense

## Life Risk Factors

### Calamity Capital – *MRC “Delphi” study*

- Earthquake
- Infectious diseases
- Bioterrorism
  - Mortality increase <<50%

# Life Risk Factors

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## Life Economic Capital

|             |     |
|-------------|-----|
| Volatility  | 5%  |
| Uncertainty | 75% |
| Calamity    | 20% |

- Would vary significantly by book of business
- Diversification impact can be large

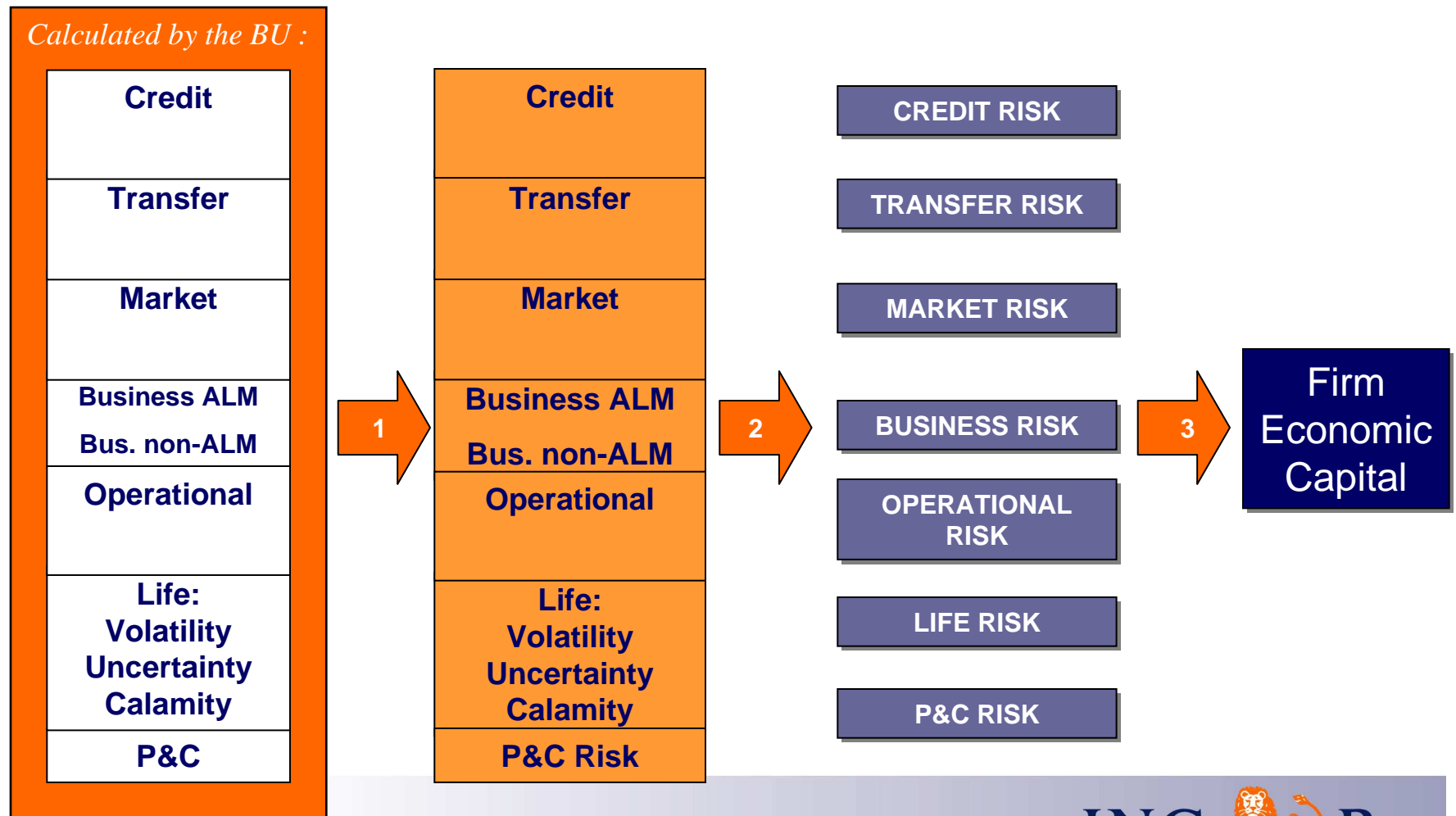
## Credit for Diversification

### Diversification and Economic Capital

- Risks are not always fully correlated
- Total risk is therefore not the same as the sum of the risks
- This is called diversification and reduces the economic capital buffer
- However, for a 99.95% probability of ruin (AA-rating starting-point), the diversification tends to break down and many correlations move to 1 again
- Can distinguish 3 diversification levels
  - 1 = within a risk, within a BU
  - 2 = within a risk, between BU's
  - 3 = between risks, between BU's

# Credit for Diversification

## Three Diversification Levels – Many Correlation-Matrices

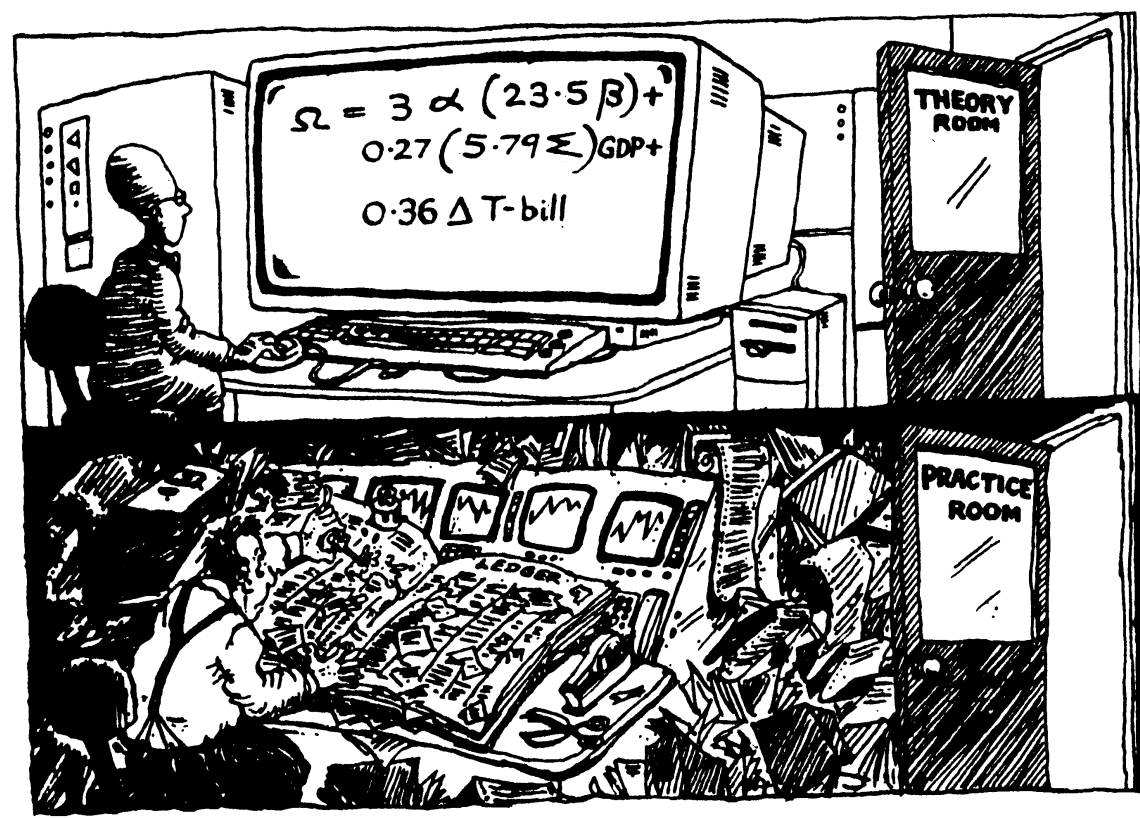


## Use of EC for Pricing

In pricing (or embedded value accounting), Economic Capital is needed for all years, so must be based on a formula

# Practicality

How do we calculate Economic Capital?



Very carefully!