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9-12th Nov 2008
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Solvency II and Internal Models

Philipp Keller



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Content

- **Current State of Solvency II**
- **Types of Internal Models**
- **Epistemology**
- **Requirements on Internal Models**
- **Scenarios**
- **Group Models**



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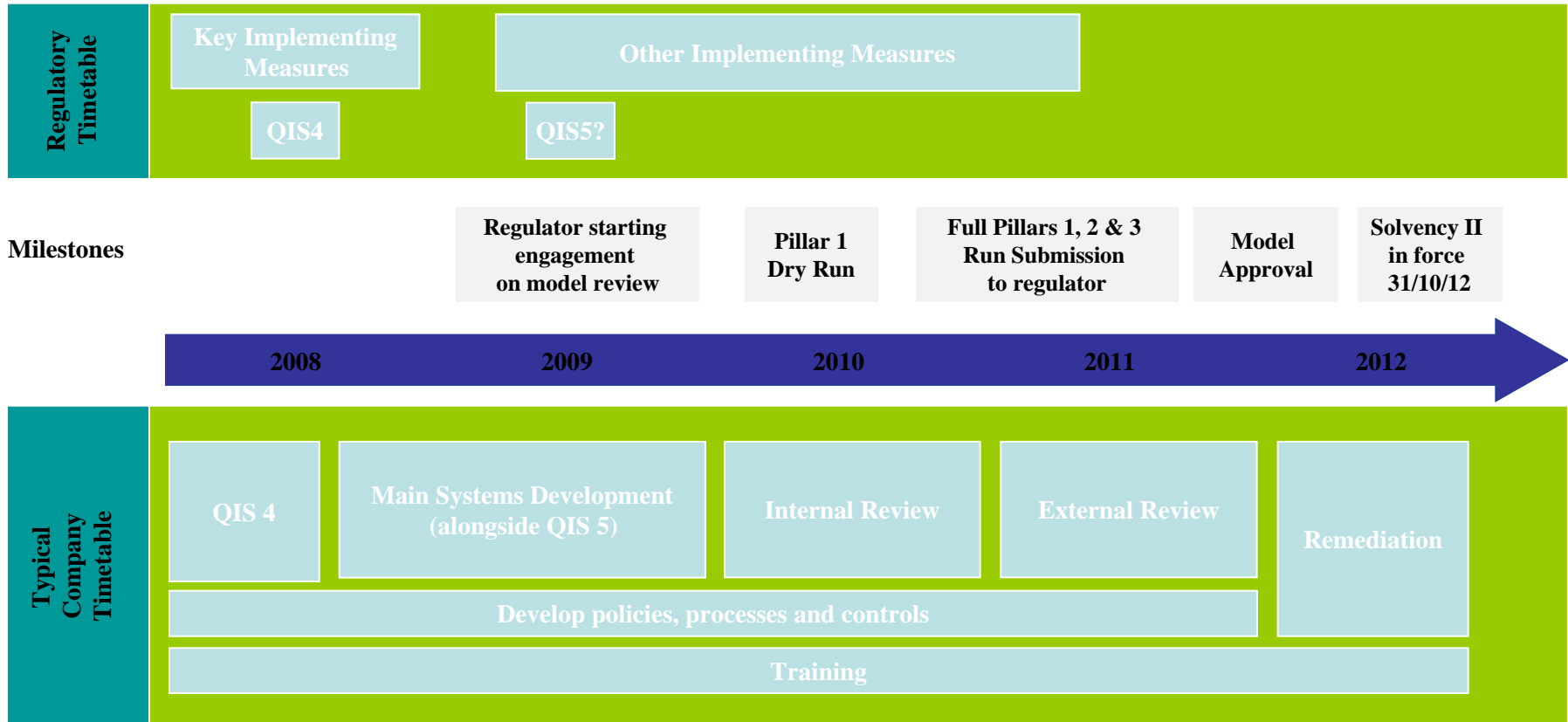
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Solvency II: Expected Timetable





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Solvency II: Expected Timetable

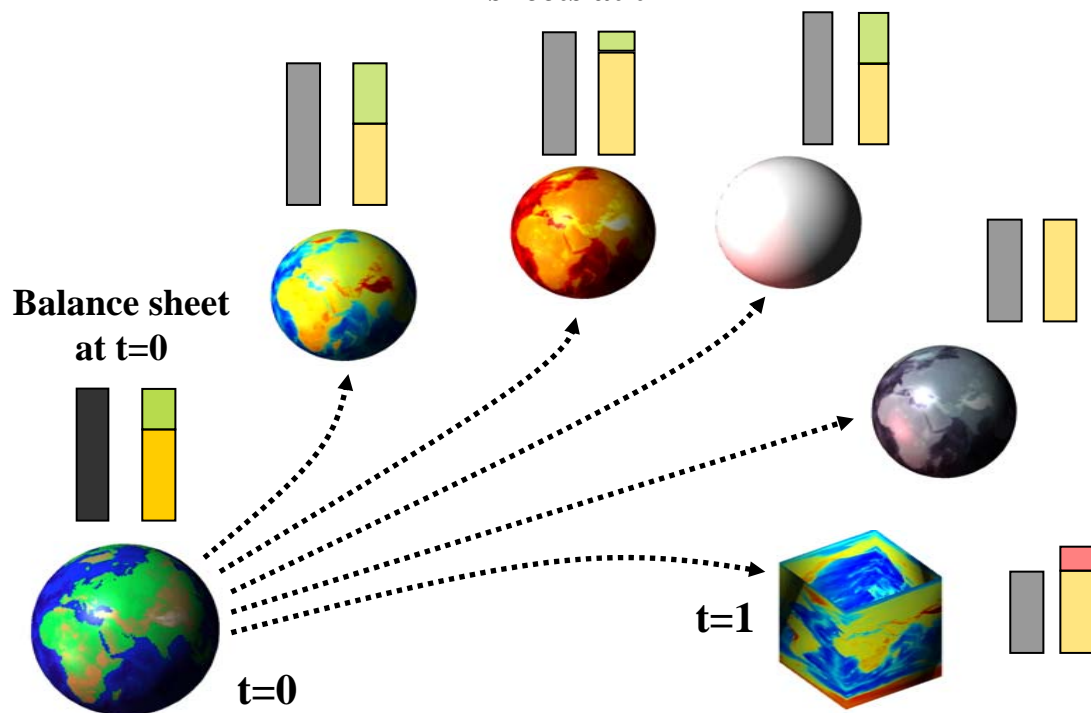
- Currently the Council of Finance Ministers ECOFIN has to achieve agreement on the Solvency II draft directives
- However, the Solvency II approach to group requirements is contentious and might lead to slippage in the time-table
- If no agreement can be reached, the new elections of the EU parliament in Spring 2009 might lead to a postponement of the introduction of Solvency II of 1 - 2 years
- Currently CEIOPS is developing more detailed guidelines, e.g. on
 - risk management and governance
 - Internal model requirements
 - transparency requirements



What is Solvency II?

Solvency II defines the required capital SCR to be sufficient to buffer risks emanating during a one year time horizon and impacting the insurer's economic balance sheet. SCR has to be sufficient to buffer 1 in 200 year events

Hypothetical balance sheets at t=1



The economic balance sheet at t=1 differs from the one at t=0 due to:

- ▶ Changes in the financial markets (interest rates, real estate prices, ...)
- ▶ Losses and catastrophes
- ▶ New information leading to a revaluation of the liabilities (e.g. asbestos)
- ▶ Capital received from or transferred to the group, reinsurers, ...
- ▶ Hybrid instruments switching from liabilities to equity
- ▶ Dividends paid, profit participation for policyholders
- ▶ ...



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Quantitative Impact Study 4: Learnings

- Market Consistent Valuation widely accepted (best estimate + risk margin)
- Standard Formula:
 - Equity shock might have been too low
 - Equity dampener approach (i.e. treating equities as bond-like) is contested by a majority of industry and only accepted by one supervisory authority
 - Credit risk calculation seen as too complex
 - Internal Models:
 - Over 60% of QIS4 participants have plans to use at least partial internal models due mainly to better capital and risk management and more transparent decision making process
 - Over 30% intend to use full economic capital models
 - Groups:
 - More thought needed to model impact of restrictions of capital mobility
- More information in '*Quantitative Impact Study 4: Summary Results and Main Messages*', Stakeholder Meeting, Frankfurt, 20 October 2008



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Internal Models

Abstractly, a model can be seen as a framework within which to ask questions and have a dialog on that part of nature which the model intends to capture. A model is a simplified picture which allows the quantitative and qualitative exploration or investigation of that part of nature

Mapping of reality to a conceptual framework

Mathematization of the conceptual framework

Simplification and approximations for the implementation of the model

Translation of the mathematical model in an algorithmic form and IT implementation

Reality



Conceptual Framework



Mathematical Framework



Model Implementation
Framework



Software Implementation

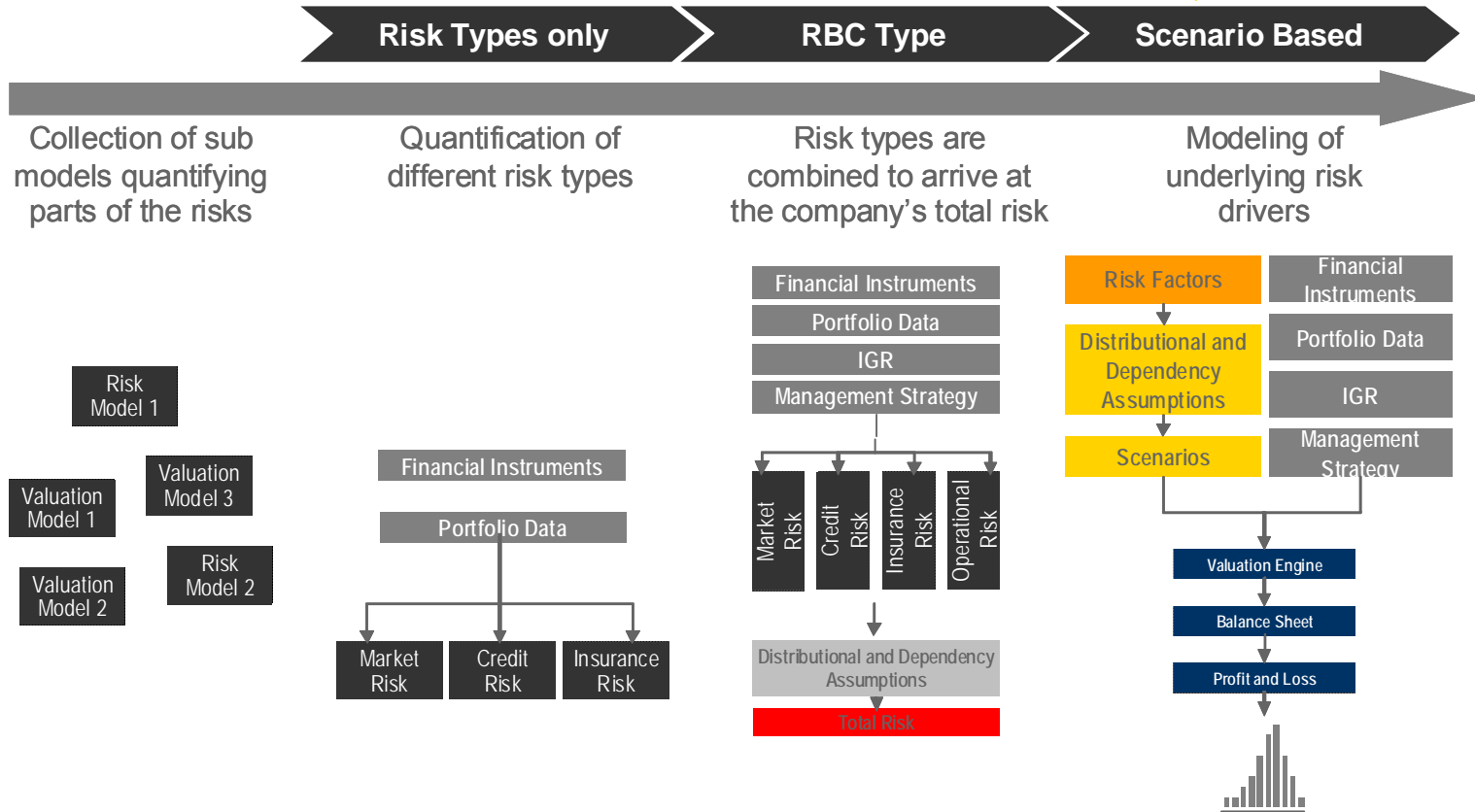


The Model



Internal Models - Evolution

Some companies go over from RBC type models to full scenario based model

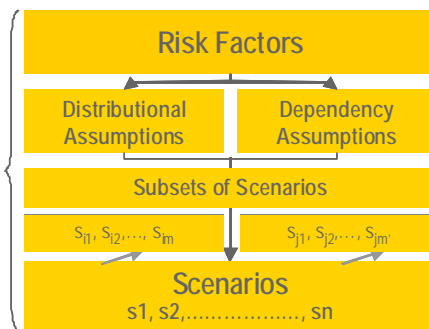




Fully Scenario Based Model

Risk Engine:

- ? Scenarios modeling time evolution of risk factors
- ? Subset of scenarios capturing risk of different BU / legal entities

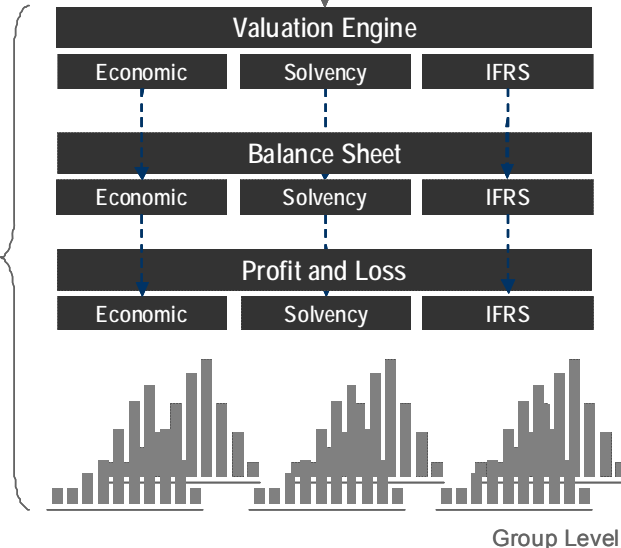


Input Data

- ? Position data
- ? Reinsurance programs
- ? Assumptions
- ? Capital and risk transfer instruments

Valuation Engine:

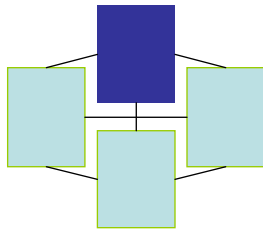
- ? Calculating different balance sheets for different subsets of the group



- ? The risk engine and the valuation engine are conceptually separate
- ? Improvements and enhancements of the model are simplified
- ? The consistent set of scenarios allows down-streaming of the model to BU and legal entities, allowing specific risk assessment and local fine-tuning of models
- ? Local models can be tailored to specific regulatory requirements

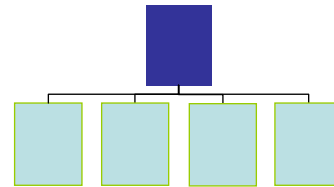


Typology of Economic Capital Models



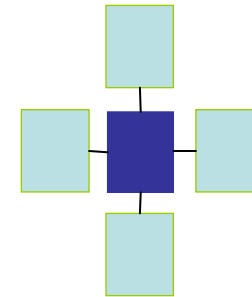
Federal

- Business units choose model and control the process
- Business units set all assumptions
- Business unit responsibility for results
- Group only reviews locally produced results that are required for consolidated group reporting



Controlled

- Group provides guidance and standards
- Group may provide a common platform and some assumptions (e.g., ESG)
- Business unit responsibility for results
- Group has a role as independent reviewer



Centralized

- Group controls all or part of the modeling process
- Key assumptions set at group level, with business unit consultation
- Joint responsibility for results

For more information, refer to Phil Vermeulen, E&Y Zurich



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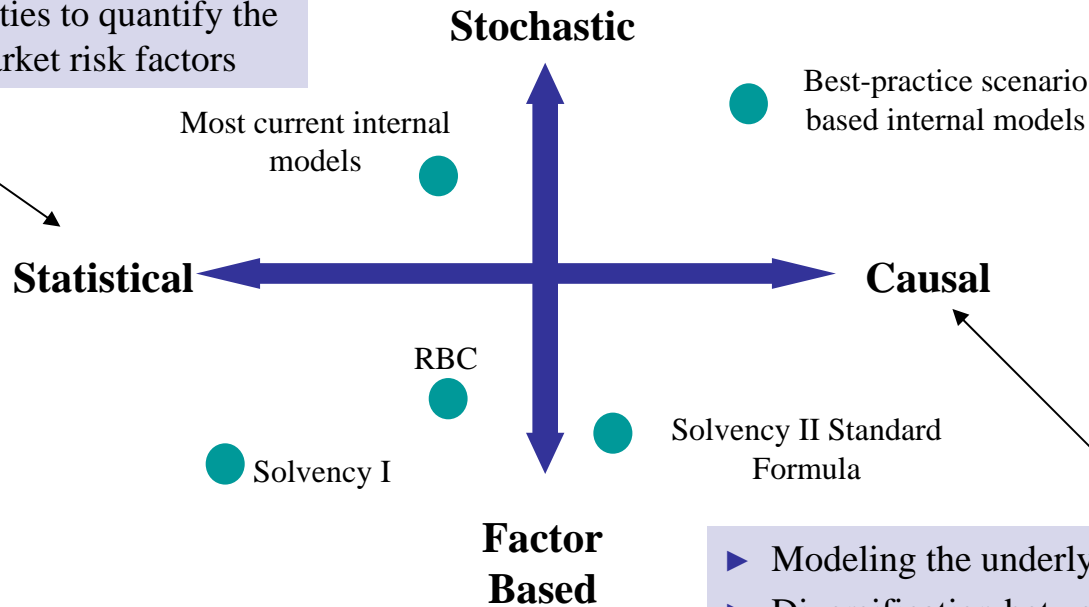


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Typology of Economic Capital Models

- ▶ Using correlation matrices between risk classes (e.g. market, credit and insurance risk) for aggregation
- ▶ Using historical volatilities to quantify the changes of financial market risk factors



- ▶ Modeling the underlying risk drivers
- ▶ Diversification between risk classes emerges from dependency structure between underlying risk drivers
- ▶ Full scenario approaches



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Internal Models: Epistemology

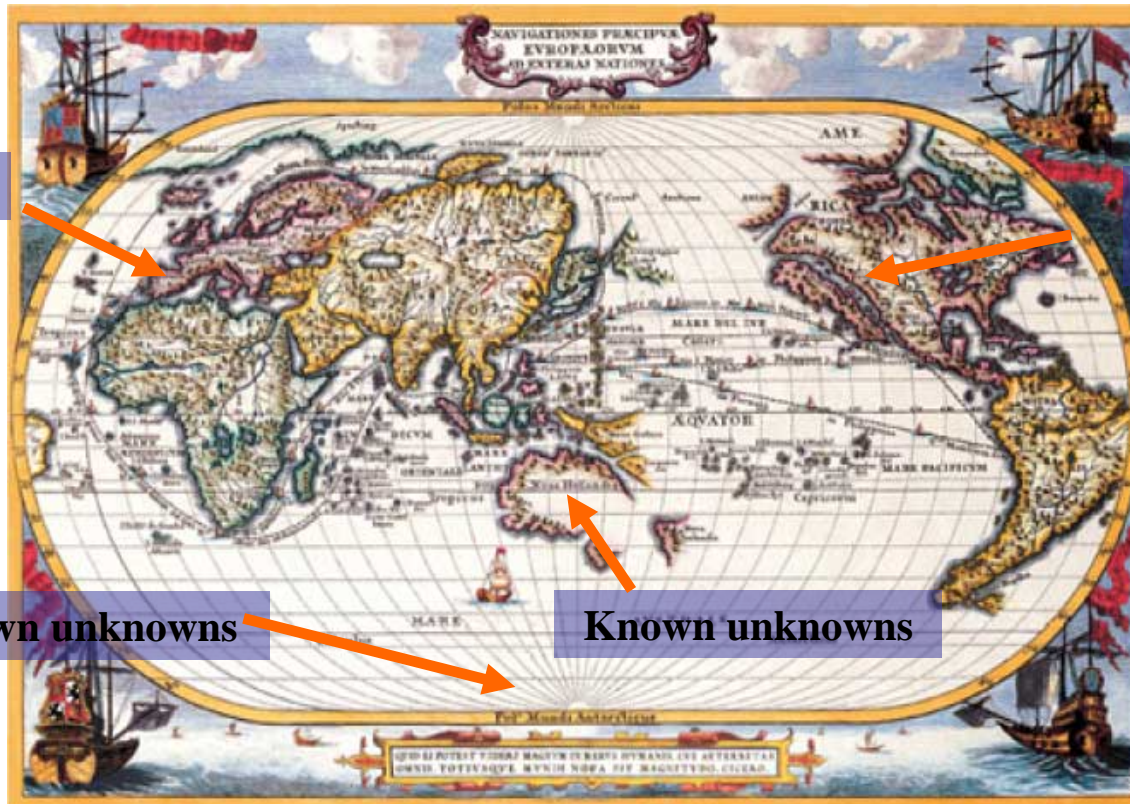
“There are known knowns. These are things that we know. There are known unknowns. That is to say, there are things that we know we don't know. But there are also unknown unknowns. There are things that we don't know we don't know.” Donald Rumsfeld

Known knowns

**Wrongly believed
to be known**

Unknown unknowns

Known unknowns



Map by Heinrich Scherer



Internal Models: Epistemology

- 1. things that are known:** e.g. high frequency - low impact risk
 - 2. things that are known to be unknown:** e.g. the impact of the next financial market bubble, natural catastrophes, terror events, ...
 - 3. things that are believed to be known but are actually unknown:** e.g. operational risks, financial market risks
 - 4. things that are preferred to stay unknown:** company dependent; often risks that would force a change in the business model
 - 5. things that are unknown to be unknown:** unknown by definition
- In practice, often the main focus of risk management and supervision is on **1** and **2**.
 - However, in many cases, companies become financially distressed by **3**, **4** and **5**.
 - Most dangerous are actually situations **3** and **4**:
 - **3** leads to over-confidence and a belief that risks are controlled
 - **4** is the sign of an inappropriate risk culture and likely the cause of most financial problems



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Internal Models: Epistemology

“Ignorance is power”, George Orwell,
Nineteen Eighty-Four

- In some cases, senior management prefers that certain risks stay unknown and not quantified
- Not knowing about risks can allow management to continue with its existing business strategy (e.g. investing heavily in sub-prime risks or selling long-duration performance guarantees)
- Also, not knowing about risks leaves management free in its strategy setting
- The CRO and actuaries might be pressured or replaced with a more pliant ones who conform to the wishes of management
- The board and supervisors have to be able to identify instances when management behaves in such a way and take remedial action
- Actuaries and CROs need to have the courage to confront senior management also with unpalatable truths



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Internal Models: Best Practice

There are a number of essential criteria for best practice internal models. They are

- based on a **consistent** methodology
- treat all quantifiable material risks
- are **explanatory** rather than purely statistical and backward looking
- commensurate with the firms complexity and business model
- based on **realistic** assumptions rather than on wishful thinking
- well understood by the modelers and users
- clear on their simplifications and assumptions
- clear on their **limits of applicability**
- adequately **documented**
- continuously questioned, peer reviewed and improved
- implemented appropriately



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Internal Models: Consistency

- Internal models need to be based on a **consistent methodological framework**
- Inconsistent internal models are often a hodgepodge of different models with different definitions and time-horizons for risks, different underlying assumptions etc and results are impossible to interpret
- Consistency requires:
 - Clear definitions and terminology
 - A sound mathematical basis
- Essential requirements are consistency between:
 - valuation of assets and liabilities
 - valuation and risk quantification
 - time horizons for risks
 - different legal entities, business units, LoBs, etc.



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Internal Models: Consistency of Valuation and Risk

- In economic capital models, risk is defined as the potential change in firm economic net worth e over a given time horizon T
- The value V of the firm is given by the value of its (allowable) assets less the value of the liabilities
- To this risk is then applied a risk measure ρ to arrive at a currency amount for the required capital ($SCR(0)$) to be held at $t=0$ to buffer the risk during the time interval $[0, T)$

$$E(t) = V(A(t)) - V(L(t)),$$

$A(t)$: assets at time t , $L(t)$: liabilities at time t ,
 $E(t)$: economic net worth at time t

$$SCR(0) = - \rho(E(T) - E(0))$$

- In addition, some valuation standards, e.g. market consistent valuation for Solvency II, also depend on the liabilities underlying risk, resulting in an implicit system of equations for $SCR(0)$



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Internal Models: The Need for Realism

- In some cases, implicit and explicit assumptions and parameterization are less based on a realistic assessment but on wishful thinking
- Calibration to the 'expected case' only
 - Use of correlations and disregarding that in financial stress dependencies increase
 - Policyholder behavior calibrated to historical observations only
- Implicit assumptions:
 - Using consolidated balance sheet for the group and assuming unhindered capital flows based on normal going concern situation
 - Using analytical solutions for some financial market options and assuming perfect replication and deep and liquid markets
- Wishful thinking
 - Assuming equity is bond-like
 - Changing parameters such that the result corresponds to the expectations, e.g. a low required capital number



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Thinking in Scenarios

“It is hard for us, without being flippant, to even see a scenario within any kind of realm of reason that would see us losing one dollar in any of those transactions.”,
Joseph J. Cassano, a former A.I.G. executive, August 2007

“Almost no one expected what was coming. It’s not fair to blame us for not predicting the unthinkable.”, Daniel H. Mudd, former chief executive, Fannie Mae



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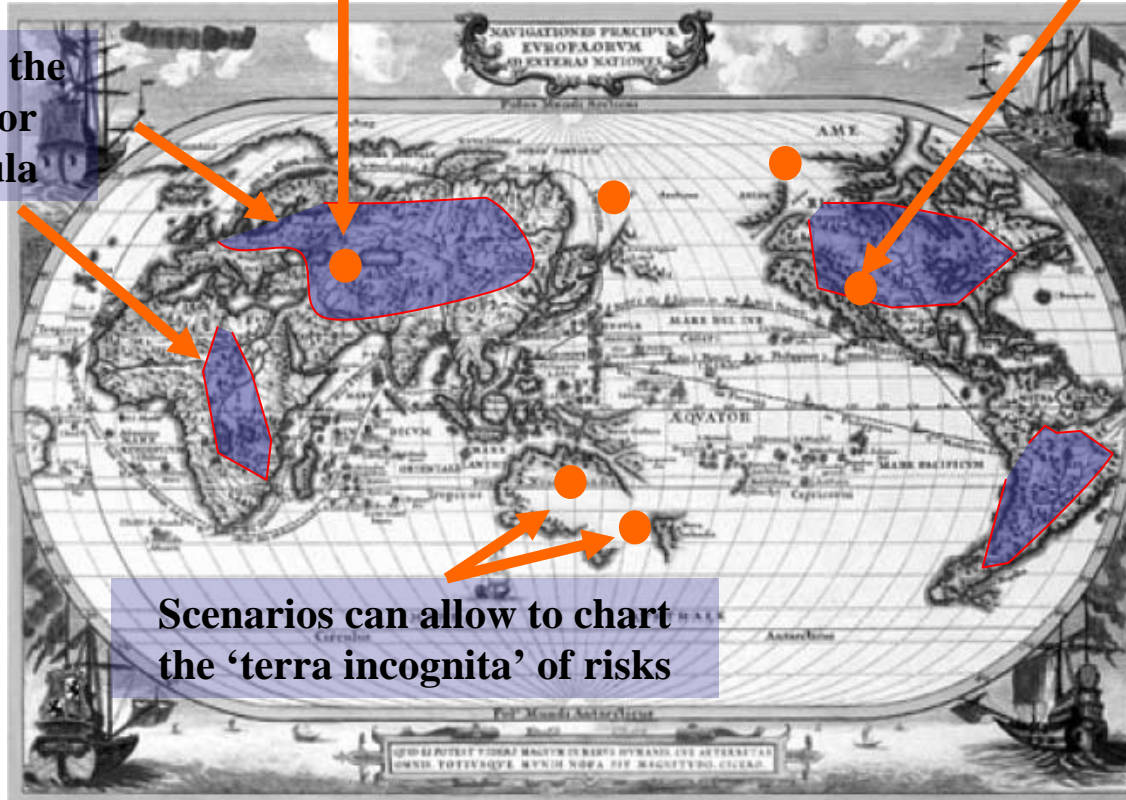
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Uses of Scenarios

Scenarios can be used as a sanity check for an internal model

Scenarios as a check to validate internal models to identify wrongly believed known knowns

Risks covered by the internal model or standard formula



Scenarios can allow to chart the 'terra incognita' of risks

Map by Heinrich Scherer

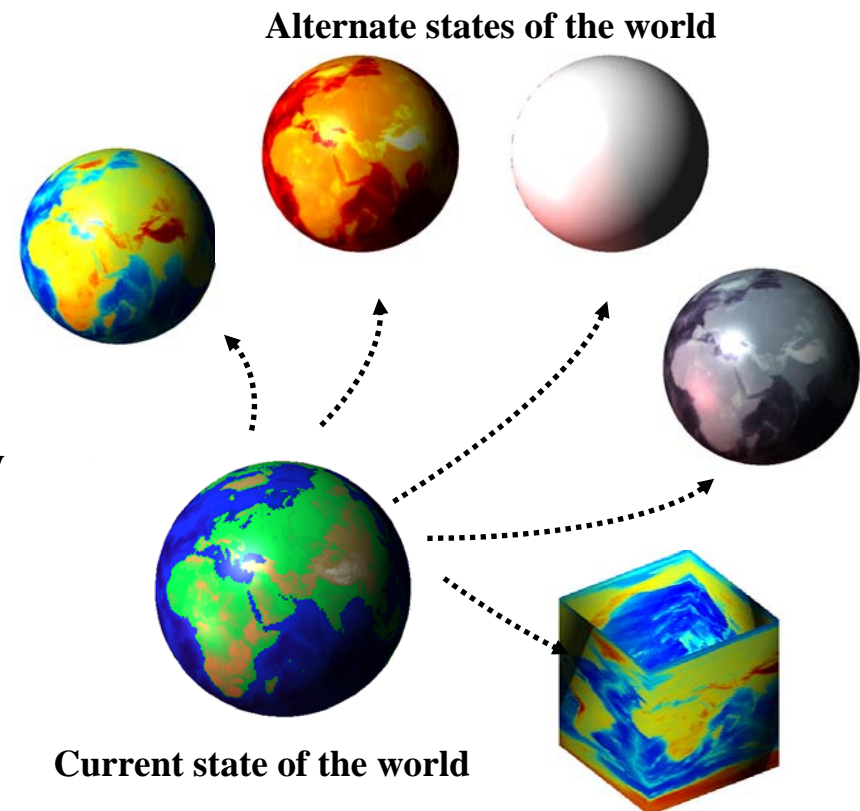


Thinking in Scenarios

“Ersatz experience is a better guide to the future than the real past and present”,
Hermann Kahn in *On Thermonuclear War*

Scenarios can be seen as thought experiments about possible future states of the world. Scenarios are not forecasts, in that they need not predict the future development, but rather should illuminate possible but perhaps extreme situations. Scenarios are also different from sensitivity analysis where the impact of a (small) change of a single variable is evaluated.

Scenario analysis is a core element of all successful risk management frameworks





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Scenarios as a Tool for Risk Management

- It is essential that senior management and the board of an insurer base their strategy on a realistic assessment of the risks and rewards it faces
- Decisions need to be based also on scenario analysis to gain insight into how things might go wrong
- There should be a formal process of scenario analysis in place that deals with potential events the firm can face and situations that are uncertain and cannot be quantified
- Senior management and the board then need to decide which scenarios are **acceptable** and which are **inacceptable**
- There should be documentation which explains the decisions of senior management and the board



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Group Requirements

- Solvency II envisages that groups (or the components of groups) within Europe can use group support declarations to steer their capital
- Local insurers of a group can be capitalized only up to the minimal capital requirement (MCR, which defines a level of capital where ultimate supervisory action would be taken)
- Excess capital can be held by the parent company
- The proposal is controversial within Europe and outside
 - Local supervisor fear that the loss of control over the subsidiaries operating in their jurisdictions
 - Some non-EU supervisors argue that group diversification should not be accepted since it likely disappears in case of financial stress
- The modeling of a group's risks is highly complex and requires sophisticated models due to the complexity of capital mobility between jurisdictions



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Group Diversification

- If risk based solvency frameworks are in place in different jurisdictions, it becomes important that group diversification will be accepted across all jurisdictions
- If each subsidiary of a group has to hold physically the full risk-based solvency capital requirement without taking into account risk mitigation / transfers via intra-group CRTI, the total capital requirement of the group can become prohibitive
- Regulatory group requirements should therefore aim to facilitate as far as possible the use of group diversification for all group's subsidiaries
- It is likely that supervisors of a group's subsidiaries only allow capital reductions if legally binding CRTI are in place
- This implies that groups will have to
 - be able to take CRTI into account in capital calculations
 - be transparent w.r.t. CRTI within the group
 - show that the CRTI are legally enforceable



Group Diversification

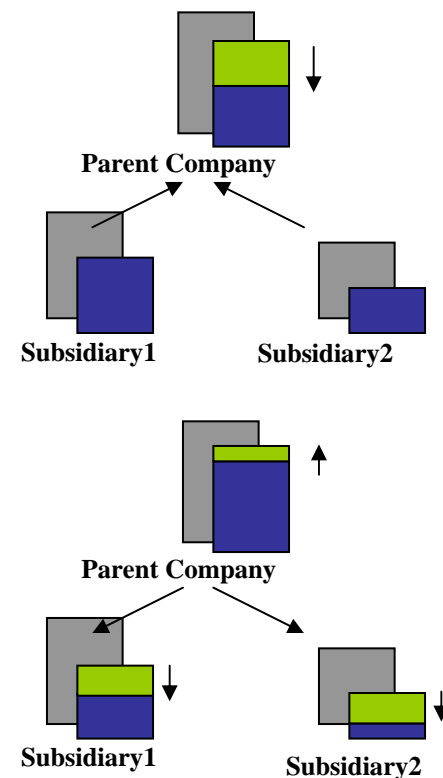
Group Diversification: A parent company benefits endogenously from group level diversification by taking into account the dependency structure between the risks of its subsidiaries and the risks of the parent company. Group diversification exists due to the spreading of risk over different legal entities (geographical and legal diversification)





Group diversification is up-streamed to the parent company via the ownership relation between the parent and its subsidiaries

Down-streaming of Diversification: A parent company can down-stream group diversification via CRTI (e.g. intra-group retrocession, guarantees, etc.) to its subsidiaries.

A guarantee from the parent to a subsidiary allows a subsidiary to reduce its SCR but increases the parent's SCR

Group diversification is down-streamed to legal entities via CRTI



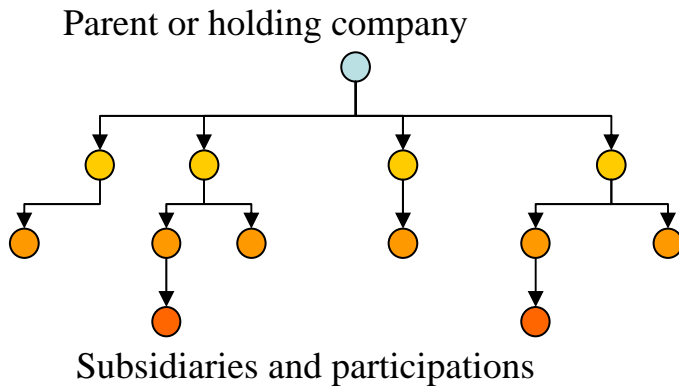
-  Assets exceeding technical provisions and debt
-  SCR
-  Effect of Diversification
-  } SCR without taking into account diversification



What is a Group?

An insurance group is defined by:

Ownership structure

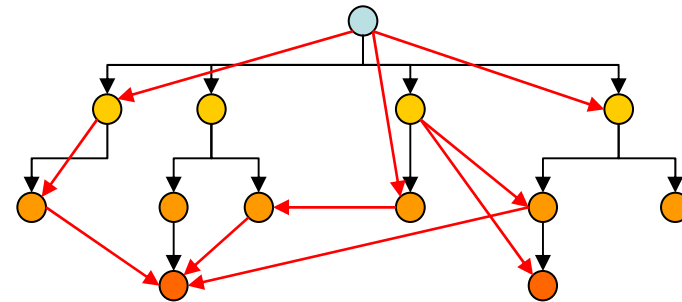


A group consists of a parent company and owned subsidiaries and participations

The undertakings can be located in different jurisdictions subject to varying requirements

The ownership has limited liability

Web of Capital and Risk Transfer Instruments (CRTI)



Capital transfer instruments

- ▶ Intra-group loans
- ▶ Guarantees
- ▶ Participations
- ▶ Dividends
- ▶ ...

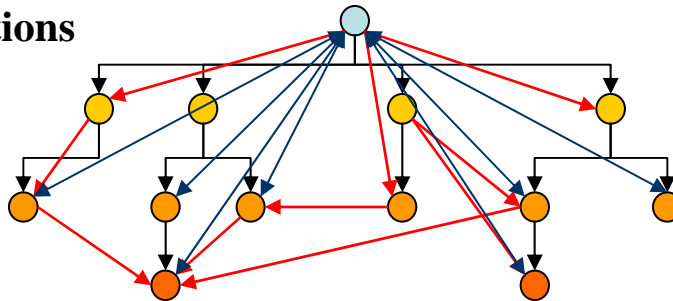
Risk transfer instruments

- ▶ Intra-group retrocession
 - ▶ Quota Share
 - ▶ Stop Loss
 - ▶ ...
- ▶ Intra-group securitization
- ▶ ...



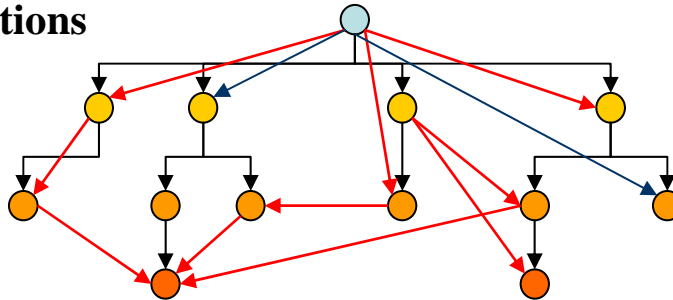
Group Behavior and Management Actions

Normal Situations



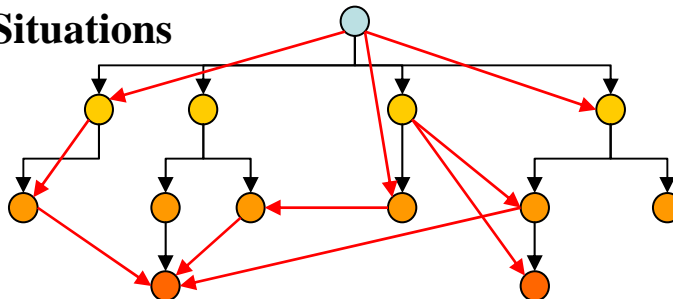
In normal, going concern situations, groups behave as if they are consolidated entities. Capital flows freely to legal entities in distress, even without legally binding CRTI

Stressed Situations



In stressed situations, where the group as a whole is in peril, the group tends to behave more legalistically. Capital flows according to legally binding CRTI and to parts of the group which are of key importance to the group due to reputation reasons

Catastrophic Situations



In catastrophic situations, the group will only try to survive, and transfers capital only if required to by legally enforceable CRTI



Consolidation vs. CRTI Approach

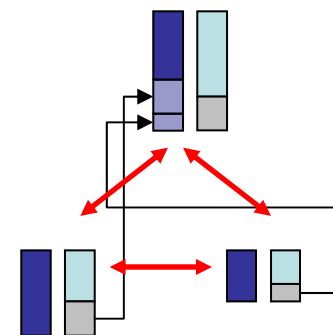
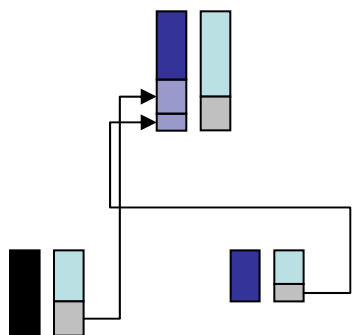
There are two basic approaches to modeling insurance groups:

- Consolidated approach
- Capital and Risk Transfer Instruments (“CRTI”) approach

Group

Consolidated Approach

CRTI Approach



Example of a group with a parent company owning two subsidiaries

In the consolidated approach, assets and liabilities of all legal entities are aggregated in a consolidated balance sheet

Assumptions: Capital is completely mobile, the group structure is irrelevant

In the CRTI approach, the ownership relation and all capital and risk transfer instruments between the legal entities of the group are modeled

Assumptions: Capital is only transferred if a legally binding CRTI is in place



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Group Modeling

- The risk of a group can only be modeled and assessed if the economic balance sheet and the economic solvency of all material legal entities is known
 - In particular for financial stress situation, the capital flow between legal entities needs to be modeled as well as restrictions of capital mobility
- For each legal entity, all legally binding and enforceable CRTI have to be taken into account in the calculation of available capital and the SCR
- All CRTI have to be value market-consistently
- A parent company benefits endogenously from group level diversification by taking into account the dependency structure between the risks in its subsidiaries and the risks of the parent company
- A subsidiary can benefit from group level diversification by taking into account CRTIs between the subsidiary and other legal entities of the group
- The group capital requirement is not a single number but a vector of requirements (one for each legal entity of the group)



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