



INSURANCE SOLUTIONS

Internal Models

Clemens Frey and Ash Ruparelia

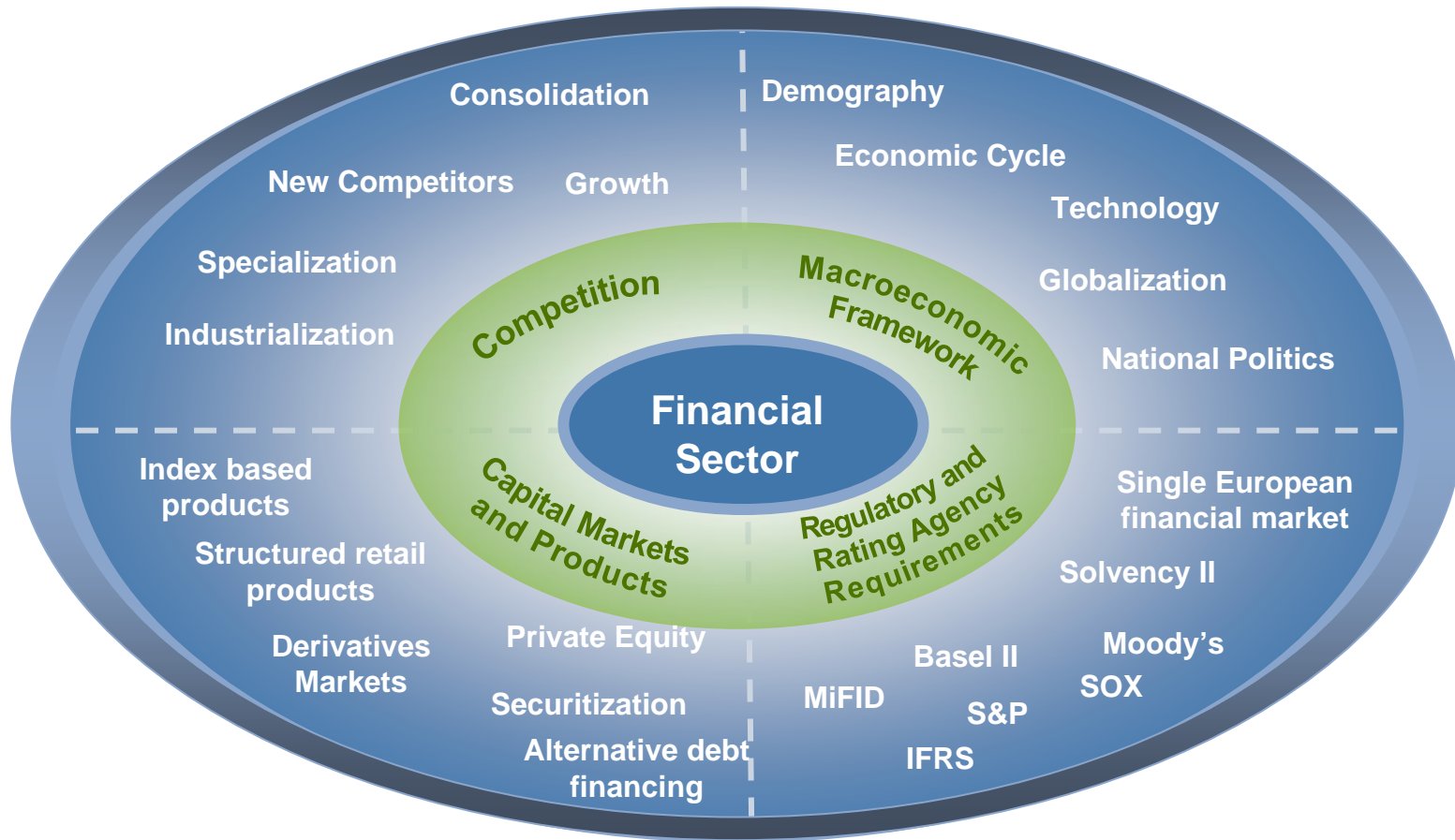
ADVISORY

Agenda

- 1. Motivation: Importance of internal economic capital models**
- 2. Basic principles of risk modelling**
- 3. Measurement of risk categories**
- 4. Internal model requirements**
- 5. Economic Capital Model Assessment (ECMA)**
- 6. Summary**

The Financial Sector has been undergoing dramatic change over the last decade...

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... stakeholders in the insurance sector are demanding better risk management, more transparency and higher returns

The environment for Insurance companies world-wide is changing...

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Trends

- A world wide tendency for regulators to better align capital requirements with the risks insurers face by:
 - Introducing new capital requirements and risk modeling standards
 - Putting strong emphasis on the need for a consistent and comprehensive approach to modeling risk
 - Requiring a higher level of transparency
- New focus of rating agencies and regulators on enterprise risk measurement and embedding internal models into business processes
- Increased reliance on sophisticated internal models in order to base management decisions on risk adjusted return measures

Impact on insurance companies

- Insurers will see fundamental changes in the way that their capital adequacy is assessed:
 - They will need to demonstrate greater understanding of risk and the capital needs of their business
 - Companies that fail to implement capital assessment on time, potentially face having higher capital requirements imposed by regulator
- Improvement in risk model standards by insurers and increasing use of risk models within the business

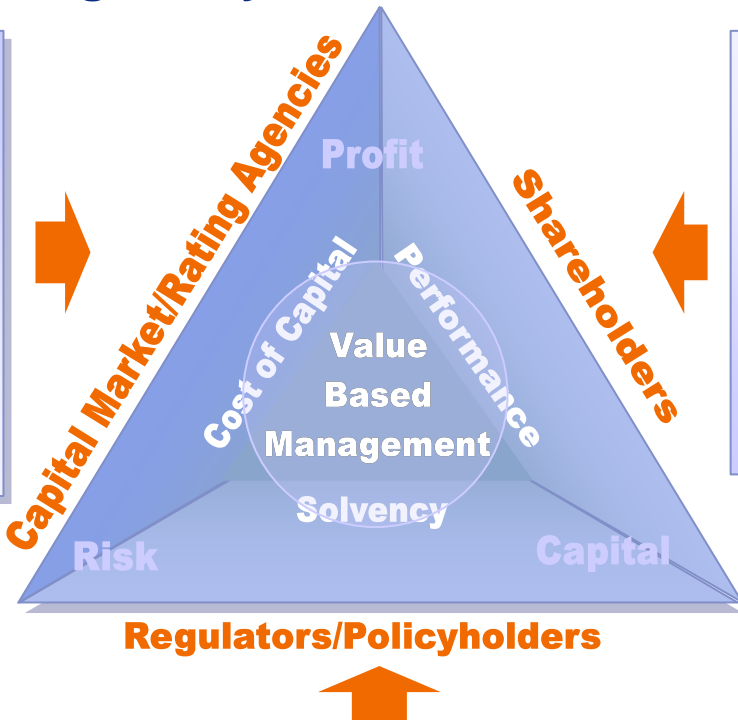
... trends will impact upon the heart of business processes, including calculation of risk-based capital numbers and stochastic modeling

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Time to Take a Look under the Hood of Capital Models

Internal economic capital models are continuously gaining in importance due to regulatory and business drivers

Ratings: rating agencies are placing increasing weight on firms' internal modeling as a key part of their Enterprise Risk Management framework. This focus is likely to increase over time and be reinforced by the changes brought about by regulatory developments such as Solvency II in Europe. The insurance industry is expecting that internal economic capital models will become part of the key criteria used to assess a well managed insurer and thus impact the views of financial analysts.



Return Optimization: internal models are not just about regulatory capital. They provide information to support key business decisions around capital allocation, assessment of risk adjusted return on capital by line, risk or deal, technical pricing, active portfolio management, concentration analysis, risk transfer analysis and optimal reinsurance structures.

Regulators: for EU insurers internal economic capital models are encouraged as an alternative to the standard economic capital model for the calculation of the Solvency Capital Requirement (SCR) under Solvency II. There will be quantitative incentives for firms to invest in their own internal models which will more accurately reflect their individual risk exposures and mitigation strategies. Integration of such models into business processes and decision making should lead to better risk management and deliver Pillar 2 benefits. The International Association of Insurance Supervisors is developing global guidance for solvency regulation. Initial drafts have come to the same conclusions as Solvency II, and the three pillar architecture has been taken up.

External pressures are driving an increasing focus on models as part of doing business, in fact,...

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“Standard & Poor’s will develop robust processes for evaluating institutions’ internal economic capital models (as part of the ERM assessment)”

“The Role of ERM in Ratings”. Standard and Poor’s, March 30, 2007

“About 50 percent of respondents have a capital model in place and of those who don’t, 68 percent of them hope to have one in place in the future”

2006 KPMG Capital Assessment Practice Survey

... modeling is becoming an integral part of decision making

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Industry leaders have expressed concerns about keeping models up-to-date with constantly changing requirements..

Andy Rallis, Sr. Vice President of MetLife (2007)

“... the challenge is that models have to be updated constantly to meet new regulation requirements and changes in the business...”

“Can’t Get No Satisfaction.” Insurance and Technology, January 1, 2007

Insurance and Technology, January 1, 2007

“... many participants felt that their models were not up-to-date. [They] believed that traditional modeling approaches and tools were not adequate in keeping pace with changes in the business.”

“Can’t Get No Satisfaction.” Insurance and Technology, January 1, 2007

... and that traditional modeling approaches are not keeping pace

Solvency II: Development of a supervisory system based on principles and economic valuation

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Rules

- No room for individual risk measurement
- Loopholes in regulation, possibly wrong incentives
- „equal treatment“, little adequacy to actual risks and specific portfolios
- Simple determination of regulatory triggers
- Low technical and person requirements for regulators

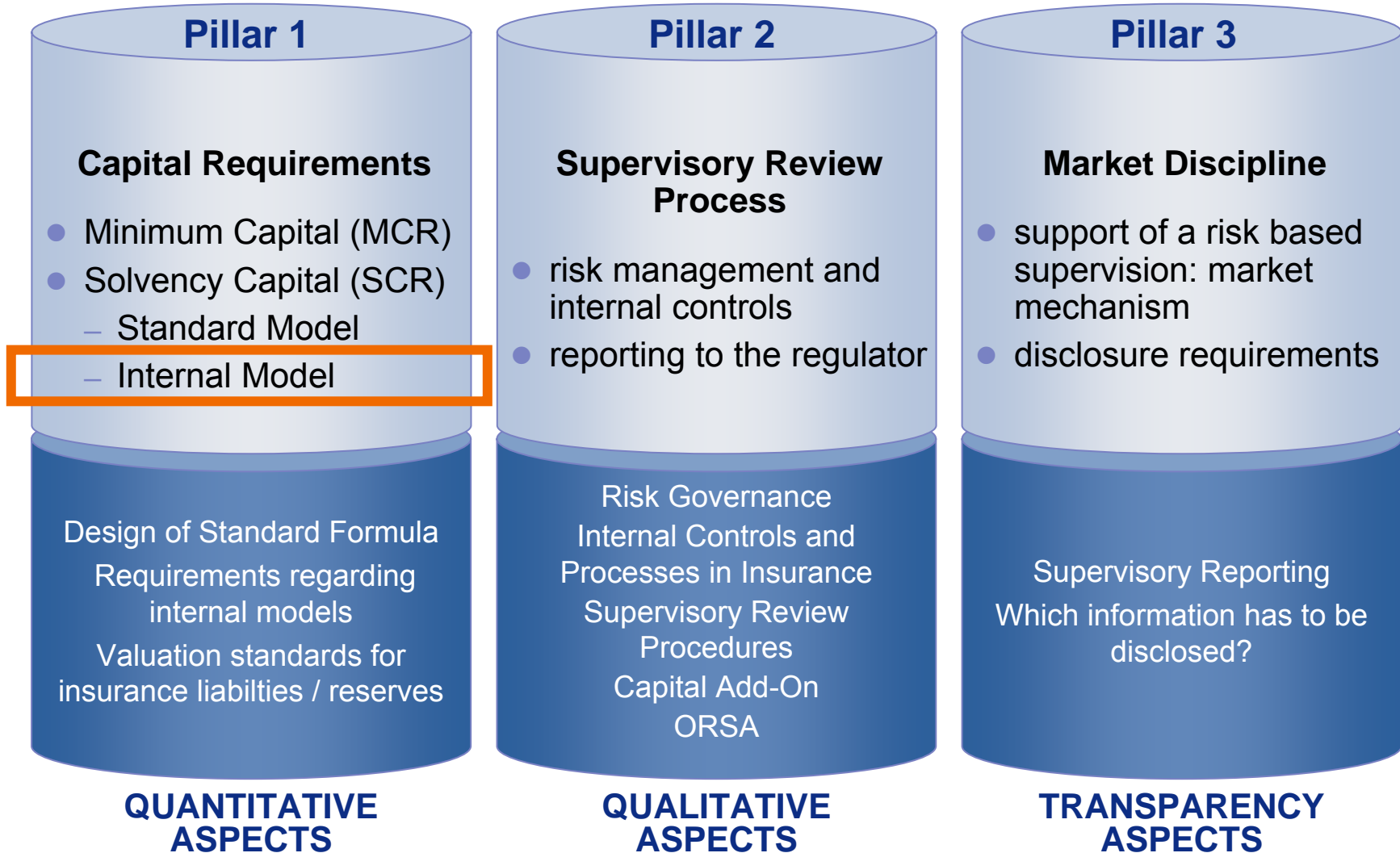
Principles

- Transparent and risk adequate measurement of (solvency-)capital
- Consideration of economic valuation principles
- Realistic risk measurement through consideration of individual cases
- Incentive for risk oriented management
- Level playing field for insurance and banking products
- Enabling comparability between the financial sectors

The straightforward structure of Solvency II

Internal models play a key role

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Pillar 1

The major components of the Solvency II framework

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Valuation of assets and liabilities (Article 74)

- based upon the current IFRS definition of fair value
- liabilities: valuation standards do not take account of own credit standing
- assets: ...take account of current credit and liquidity characteristics

Technical Provisions (Articles 75-85)

- need to be established in order for the undertaking to fulfil its (re)insurance obligations towards policyholders and beneficiaries
- calculation will be based on their current exit value
- calculation must be market consistent
- calculated as the sum of a best estimate and a risk margin (for non-hedgeable risks)

SCR (Articles 103-125)

- corresponds to the economic capital a (re)insurance undertaking needs to hold in order to limit the probability of ruin to 0.5%, i.e. ruin would occur once every 200 years

MCR (Articles 126-129)

- represents a level of capital below which policyholders' interests would be seriously endangered if the undertaking were allowed to continue to operate

Source: COMMISSION OF THE EUROPEAN COMMUNITIES - Amended Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

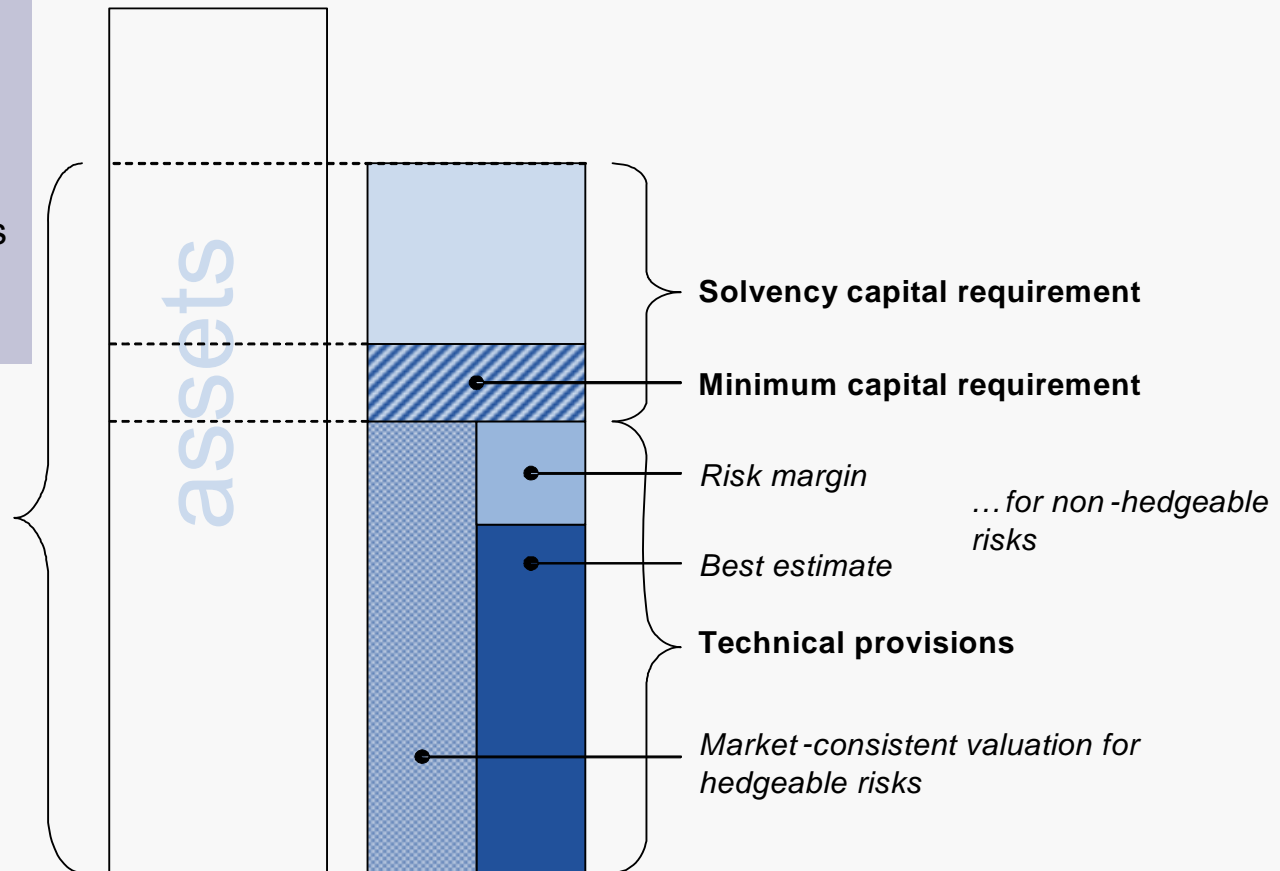
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«In Solvency II, solvency is viewed in the widest sense, including not only the available capital but also the coverage of liabilities by admissible assets and off-balance sheet items. In short, solvency concerns the **whole financial position** and is not merely restricted to the available capital.»*

Assets covering technical provisions, the MCR and the SCR



Source: CEIOPS-CP-09/06, p.9, *MARKT/2515/04

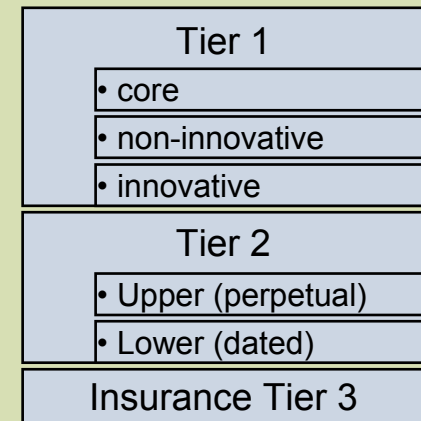
Solvency calculation with a standard model is straightforward

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Use of standard model (snapshot QIS3)

	Total gross of reinsurance	Total net of reinsurance	Direct business gross	Direct business net	Proportional reins. gross	Proportion reins. ne
Technical provisions according to current basis						
Provision for unearned premiums	01	0	0	0		
Claims outstanding	02	0	0	0		
Provision for bonuses and rebates	03	0	0	0		
Equalisation provision	05	0	0	0		
Other technical provisions	06	0	0	0		
thereof: provisions for unexpired risk	07	0	0	0		
Total value current basis	09	0	0	0	0	0
Deferred acquisition costs	09	0	0	0		

Eligible capital



Solvency Capital Requirement



Eligible Capital

Good for

- regulatory purposes, limiting overall exposure

Source: CEIOPS-CP-09/06, Nov. 2006

Standard models form the basis for the development of more advanced models

Standard model reliance ...

- **consistent risk measure**
- **consistent time horizon**
- **all relevant risk categories**
- **consistent risk aggregation**
- **valuation based on economic principles**
- **consideration of diversification (in principle)**
- **consideration of capital release, e.g. due to reinsurance**

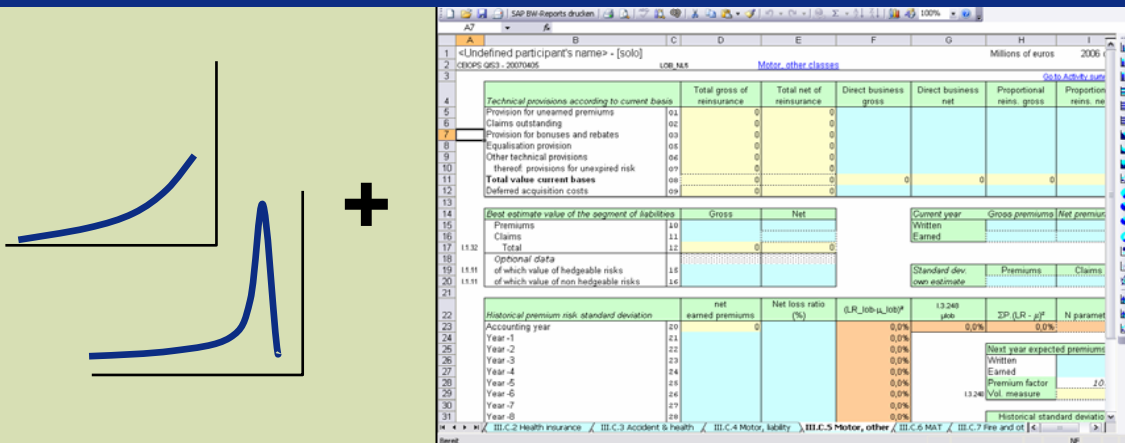
... and limitations

- **consideration of the entire risk profile (instead of only one "point")**
- **adaptation to structure of the enterprise**
- **allocation of capital down to business segments**
- **covering of various time horizons**
- **company specific dependency patterns**
- **accurate consideration of capital release, e.g. due to reinsurance**

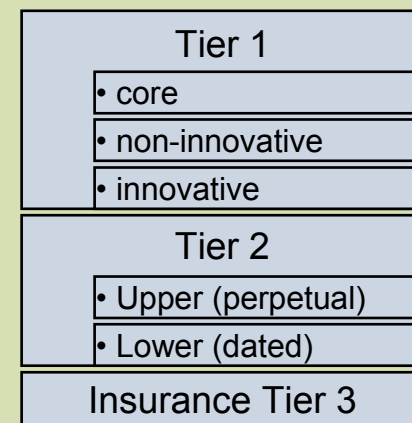
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... by using stochastic parts together with the standard model: this forms a so-called partial model

Use of partial model (one or more non-standard parts)



Eligible capital



Solvency Capital Requirement



Eligible Capital

Good for

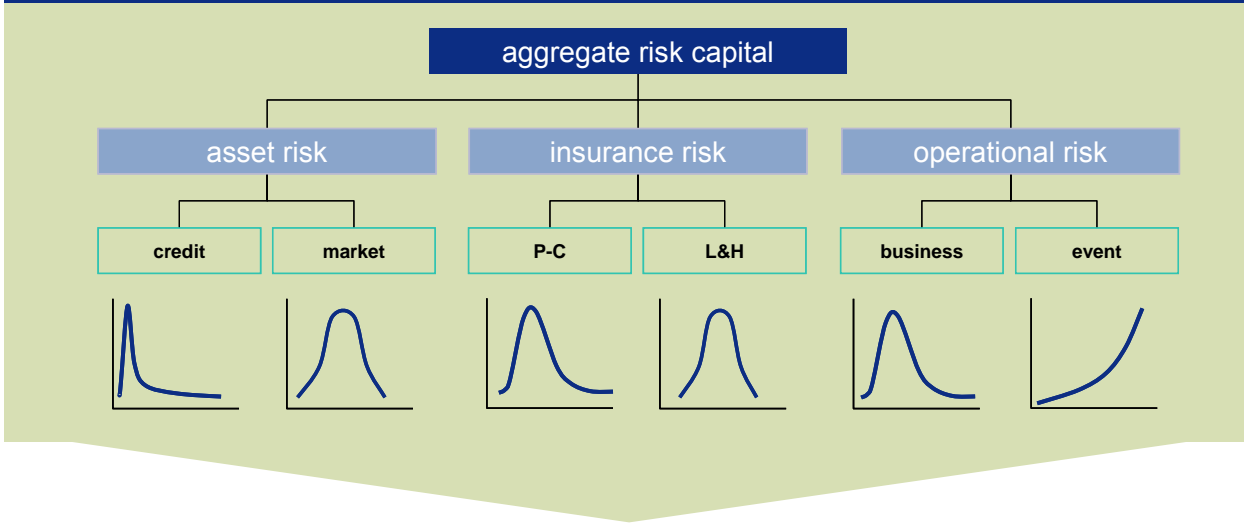
- regulatory purposes, limiting overall exposure
 - structuring reinsurance
- capital allocation and business management in selected segments

Source: CEIOPS-CP-09/06, Nov. 2006

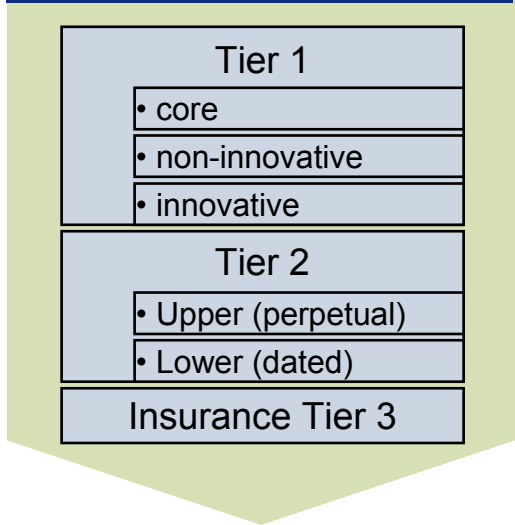
Full internal model allows for the broadest field of application

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Use of stochastic internal model



Eligible capital



Solvency Capital Requirement < Eligible Capital

Good for

- regulatory purposes, limiting overall exposure
- structuring reinsurance
- portfolio optimization and value based management ...

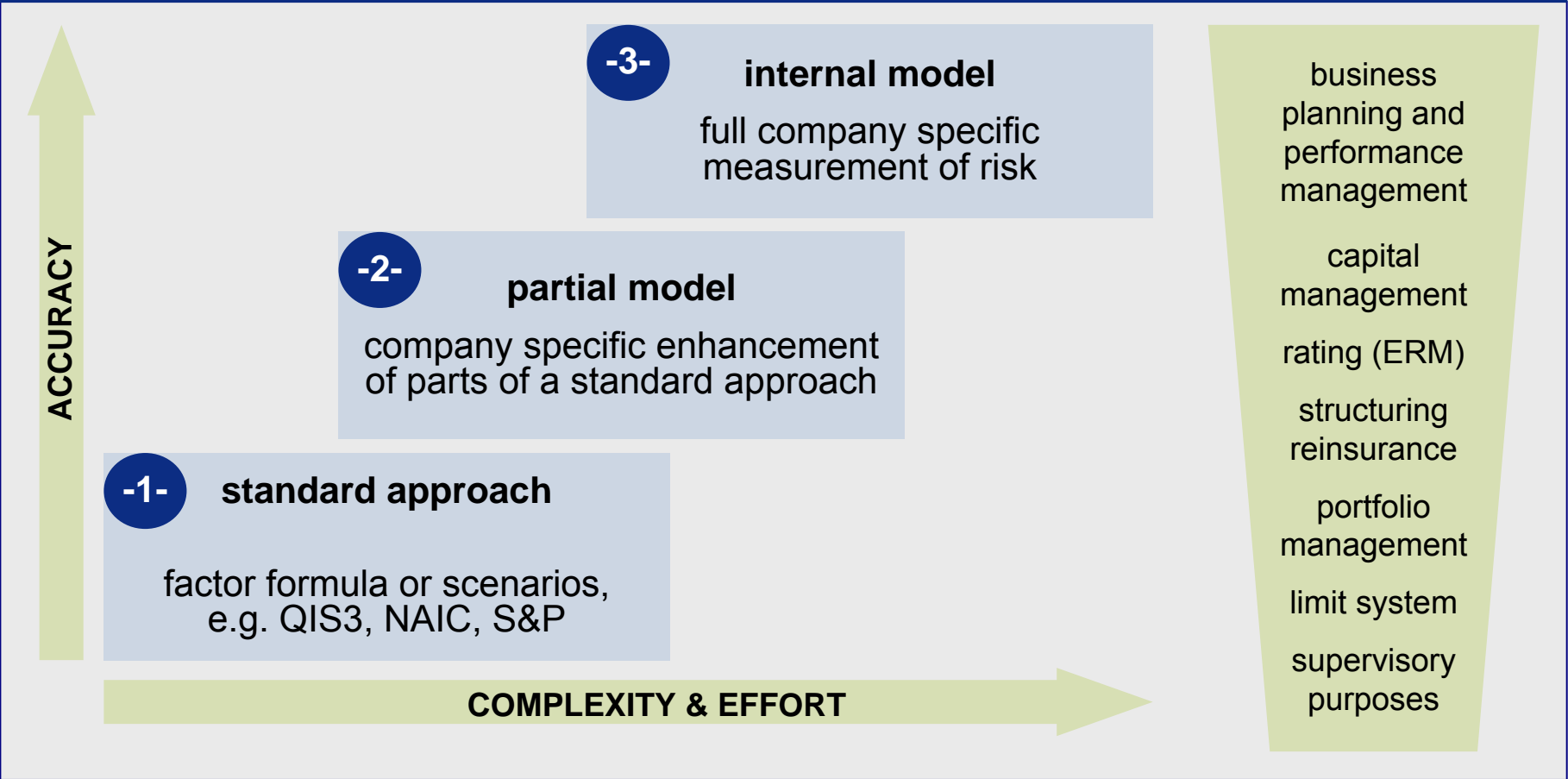
Source: CEIOPS-CP-09/06, Nov. 2006

In Solvency II there will be three different model alternatives

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Model concepts under Solvency II

Fields of application



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Basic categories of risk

Insurance Risk

„risks through underwriting of insurance contracts“

- premium risk
- reserve risk
- catastrophe risk (both life and P&C)
- mortality / longevity trend risks
- lapse risk

Credit Risk

„risk of change in credit quality of counterparty“

- direct credit risk
- credit spread risk
- concentration risk
- counterparty risk

**Interaction of risks and pooling
may give rise to
diversification**

Operational Risk

„risk of internal processes“

- inadequate or failed internal processes,
- fraud people,
- failure of systems
- from extremal events

Market Risk

„risk through level / volatility of market prices“

- interest rate risk
- equity and property risk
- concentration risk
- asset-liability mismatch risk
- currency risk

Liquidity Risk

„risk that investments and other assets cannot be realized in order to settle financial obligations when they fall due “

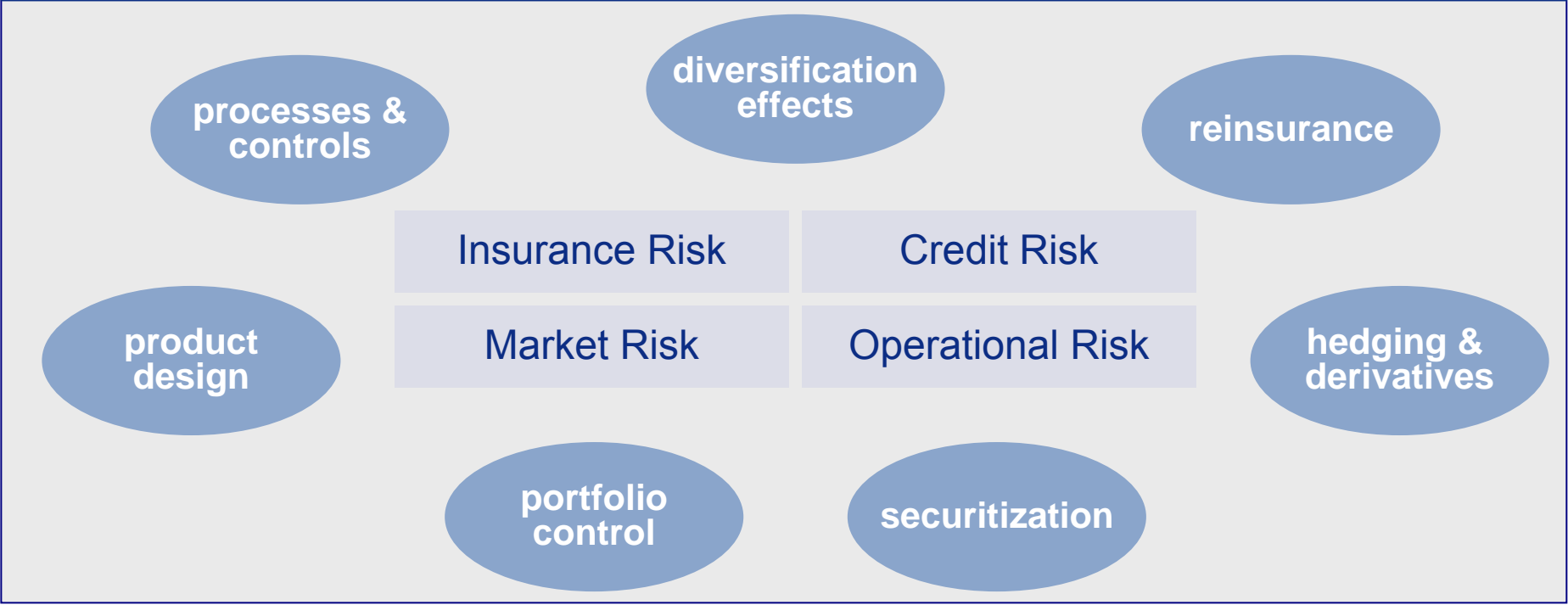
- funding liquidity risk (fund cash flow requirements in order to meet policyholder obligations)
- trading liquidity risk (roll over debt or to meet cash, margin or collateral requirements)

Source: IAA, A Global Framework for Insurer Solvency Assessment

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Risks are ultimately buffered by available capital – after effects of risk pooling, risk mitigation, risk transfer etc.

Methods and measures of reducing risk in insurance



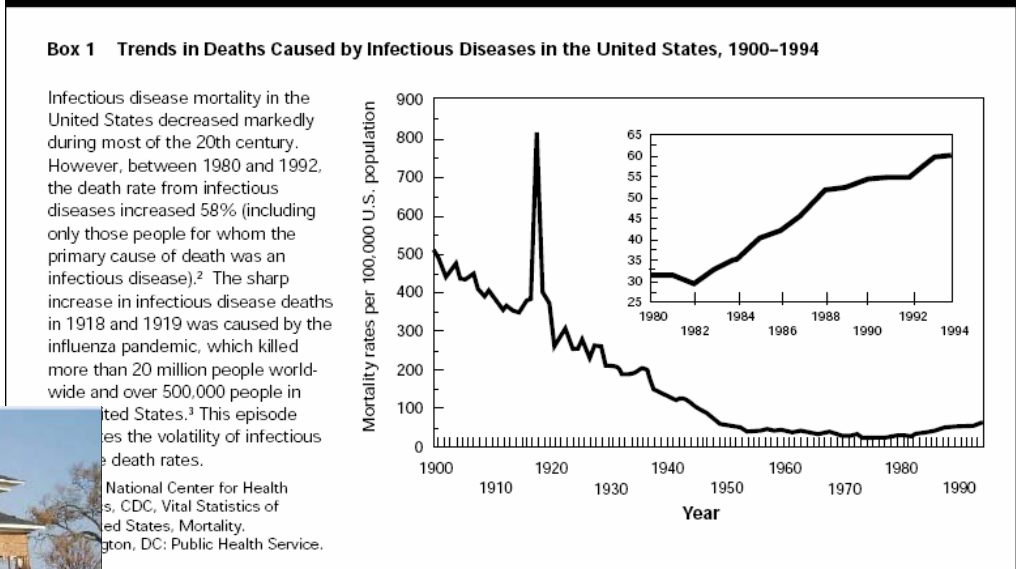
Regulatory view: capital is the ultimate buffer for retained aggregate risks after all risk reducing measures.

Economic view: capital should reflect actual economic risk.

What is insurance risk? – Significant drivers are catastrophes and trends ...

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Catastrophe risks limit diversification effects within insurance portfolios



Trends may run contrary to assumptions made when pricing insurance products or calculating technical reserves

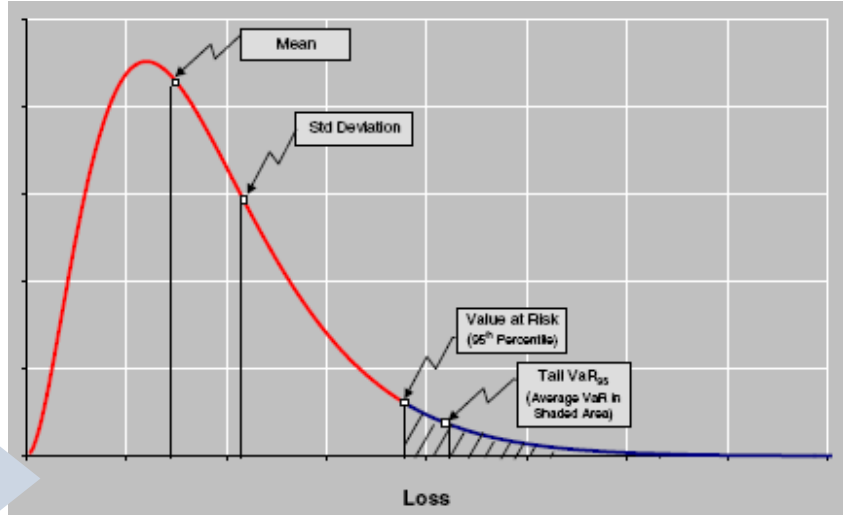
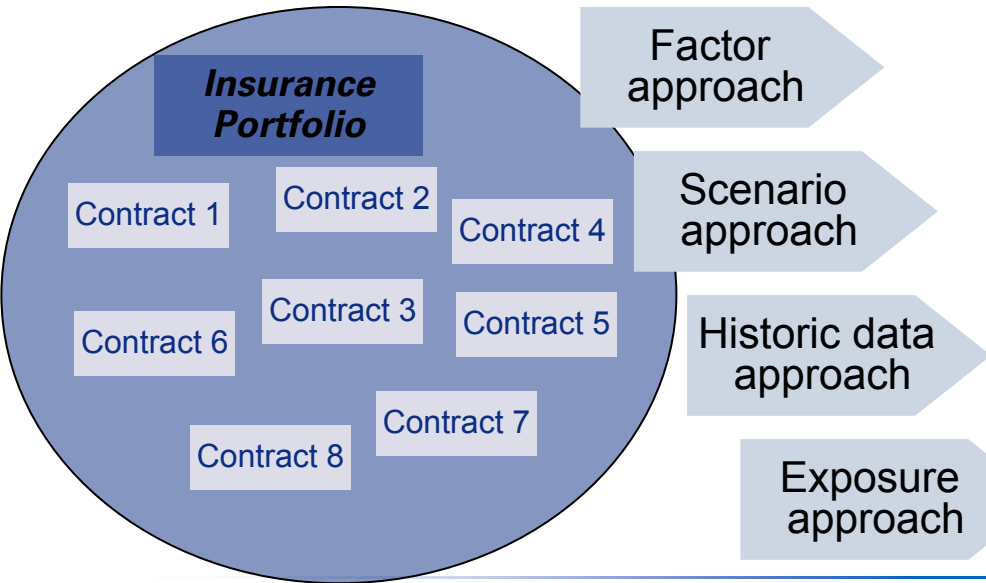
Sources: *Climate Change – Potential Impacts, Munich Re, June 2006;*
Preventing Emerging Infectious Diseases, CDC, 1998

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What is insurance risk? – A whole lot of measurement approaches

Insurance risk components

risk of random fluctuations	<ul style="list-style-type: none"> • random fluctuations from stochastic law
risk of change	<ul style="list-style-type: none"> • stochastic law is changing
risk of error	<ul style="list-style-type: none"> • incomplete information about “true” law of stochastic



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Pillar 1: Valuation principles in Solvency II

Solvency Capital Requirement (SCR)

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- **Article 100: General provisions**

- **The SCR shall be calculated, either in accordance with the standard formula or using an internal model.**

- **Article 101: Calculation of the Solvency Capital Requirement**

- **The SCR shall be calculated on the presumption that the undertaking will carry on its business as a going concern**
- **The SCR correspond to the Value-at-Risk of the basic own funds to a confidence level of 99.5% over a one-year period.**
- **The SCR shall cover at least the following risks: Non-life underwriting risk; life underwriting risk; health underwriting risk; market risk; credit risk; operational risk (including legal risk and excluding risks from strategic decisions and reputation risk)**
- **The effect of risk mitigation techniques shall be taken into account**

Source: COMMISSION OF THE EUROPEAN COMMUNITIES - Amended Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

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Internal models in Solvency II

- **Article 102: Frequency of calculation**
 - **The SCR shall be calculated at least once a year**
- **Article 110: General provisions for the approval of full and partial internal models**
 - **The Internal models must be allowed for the calculation of the SCR (after approval of the supervisor)**
 - **Partial internal models shall be allowed for**
 - One or more risk modules of the standard formula for the BSCR
 - The capital requirement for operational risk
 - The adjustment for profit participation
 - Applied to the whole business or only to one or more major business units
 - **Supervisors shall decide on application within six months from the receipt of the complete application**
 - **For a period of two years after having received approval to use an internal model, the SCR have to be calculated also according to the standard formula**

Source: COMMISSION OF THE EUROPEAN COMMUNITIES - Amended Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

- **Article 111: Specific provisions for the approval of partial internal models**
 - **Approval for partial internal models shall only be given if that model complies with the following additional conditions:**
 - The reason for the limited scope of application of the model is properly justified
 - The resulting SCR reflects more appropriately the risk profile
 - Its design is consistent with the structure of the SCR standard formula
 - **Supervisory authorities may require to submit a realistic transitional plan to extend the scope of the model**

Source: COMMISSION OF THE EUROPEAN COMMUNITIES - Amended Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

- **Article 113: Policy for changing the full and partial internal models**
 - Major changes to the internal model shall always be subject to prior supervisory approval
- **Article 114: Responsibilities of the administrative and management bodies**
 - The administrative or management bodies shall approve the application to the supervisory authority for approval of the internal model
 - The administrative or management body shall have responsibility for putting in place systems which ensure that the internal model operates properly on a continuous basis

Source: COMMISSION OF THE EUROPEAN COMMUNITIES - Amended Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

- **Article 115: Reversion to the standard formula**
 - **After having received approval, insurance undertakings shall not revert to calculating the SCR in accordance with the standard formula, except in duly justified circumstances and subject to the approval of the supervisory authorities**
- **Article 117: Significant deviations from the assumptions underlying the SCR**
 - **Where it is inappropriate to calculate the SCR in accordance with the standard formula, because the risk profile deviates significantly from the assumptions underlying the SCR, the supervisory authority may require the undertaking to use an internal model to calculate the SCR**

Source: COMMISSION OF THE EUROPEAN COMMUNITIES - Amended Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

Pillar 1: Valuation principles in Solvency II Minimum Capital Requirement (MCR)

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- **Article 127: Calculation of the Minimum Capital Requirement**
 - calculation should be clear, simple and auditable
 - the MCR shall correspond to an amount of eligible basic own funds below which policyholders and beneficiaries are exposed to an unacceptable level of risk if insurance and reinsurance undertakings were allowed to continue their operations
 - calibration VaR of basic own funds with confidence level in the range of 80% to 90% over a one-year period
 - absolute floor: 1 000 000 EUR (non-life, reinsurance), 2 000 000 EUR (life)
 - Calculation at least quarterly
 - Reporting of the calculation results to supervisory authorities

Source: COMMISSION OF THE EUROPEAN COMMUNITIES - Amended Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

MCR – the three current approaches

Modular approach

- Aggregation of capital charges for different risks
- similar but simpler than SCR considerate underwriting risk and market risk

Compact approach (two different methods):

- CEA: $MCR = 1/3 * SCR$ by using firm's calculation method (standard formula or internal model)
- European Commission: percentage of SCR using solely standard formula (even for firms using an internal model for their SCR calculation)

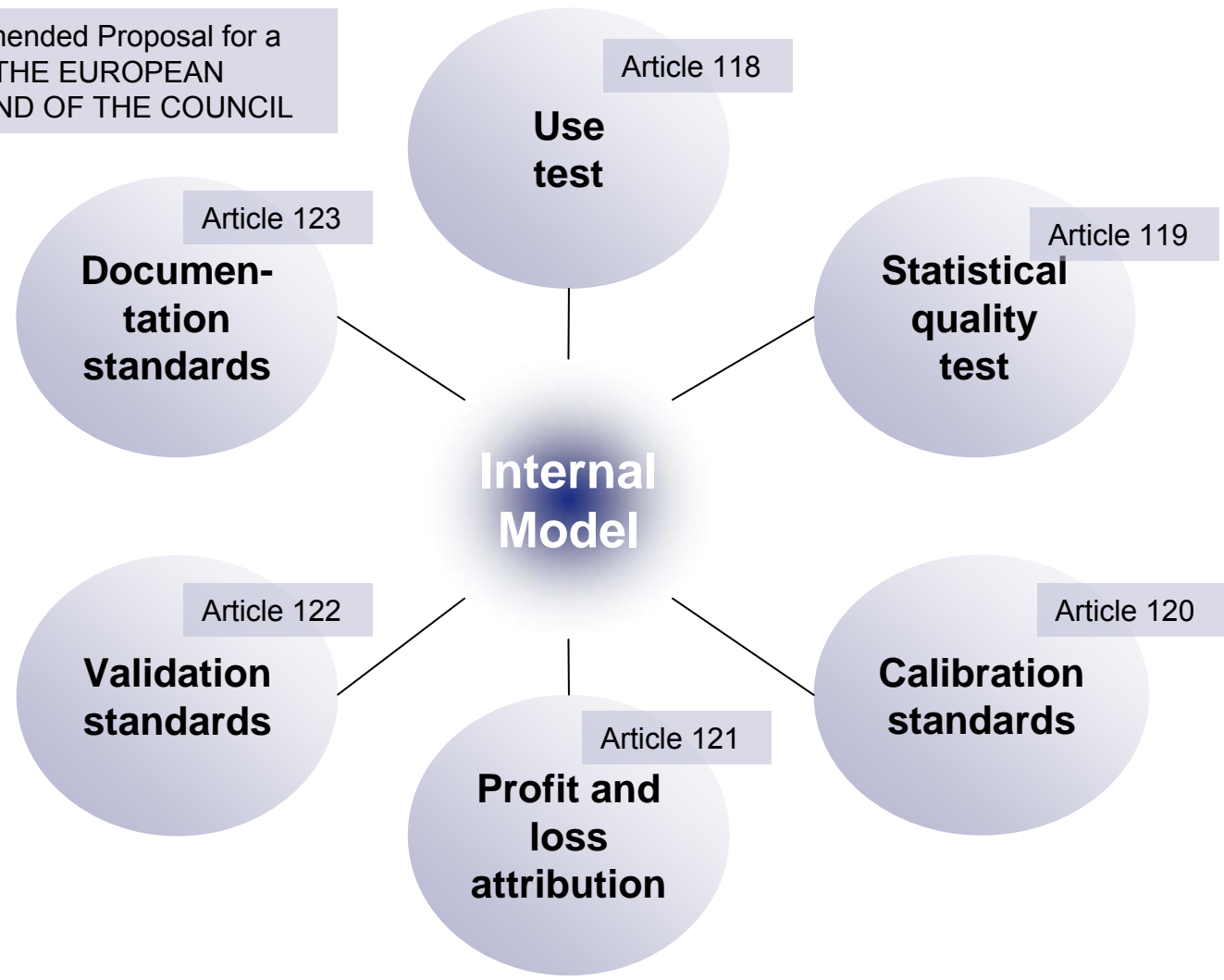
Margin over liabilities (MoL) approach:

- Fixed percentage of technical provisions

Regulators require a range of prerequisites to be fulfilled before accepting an internal model

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Articles of the Amended Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL



Internal model requirements (1/5)

Use test

- **Widely used**
- **Important role in the risk-management system, decision-making processes, internal control and audit system, their economic and solvency capital assessment and allocation processes**
- **Frequency of calculation of the Solvency Capital Requirement = frequency with which they use their internal model for the other purposes covered by the first paragraph**
- **Ensuring the on-going appropriateness of the design and operations of the internal model**
- **Appropriately reflect of the risk profile of the insurance and reinsurance undertakings concerned**

Calibration standards

- **Level of protection equivalent to that set out in Article 100 (calculation of the Solvency Capital Requirement)**
- **Derive the Solvency Capital Requirement directly from the probability distribution forecast (VaR, TVaR)**

Internal model requirements (2/5)

P&L attribution

- **review, at least annually, the causes and sources of profits and losses for each major business unit**

Validation standards

- **Regular cycle of model validation, which includes**
 - monitoring the performance
 - reviewing the on-going appropriateness of its specification
 - testing the results against experience
 - Effective statistical process to demonstrate that the resulting capital requirements are appropriate

Internal model requirements (3/5)

Statistical quality standards

- **Model based on**
 - Adequate actuarial and statistical techniques, consistent with the methods used to calculate technical provisions
 - Current and credible information and realistic assumptions
 - Accurate, complete and appropriate data
- **No particular method for the calculation of the probability distribution forecast**
- **Covers all material risks**
- **Adequate measurement of diversification effects within as well as across risk categories**
- **Takes full account of the effect of risk mitigation techniques, as long as credit risk and other risks arising from the use of risk mitigation techniques are properly reflected in the internal model**
- **Accurately assess the particular risks associated with financial guarantees and any contractual options**
- **Takes account of future management actions**
- **Takes account of all payments to policy holders and beneficiaries, which they expect to make, whether or not these payments are contractually guaranteed**

Internal model requirements (4/5)

Documentation standards (1/2)

- **Documentation of the design and operational details of the internal model, e.g.**
 - Detailed outline of the theory, assumptions, and mathematical and empirical basis underlying the internal model
 - Circumstances under which the internal model does not work effectively
 - All major changes
- **Decision on the application within six months**
- **The supervisory authorities may require the undertakings concerned to use an internal model, where it is inappropriate to calculate the Solvency Capital Requirement in accordance with the standard formula**
- **Specific provisions for the approval of partial internal models:**
 - Reason for the limited scope of application is properly justified
 - The resulting Solvency Capital Requirement reflects more appropriately the risk profile of the undertaking
 - Consistent with the principles of the Standard formula
 - Supervisory authorities may require the insurance and reinsurance undertakings concerned to submit a realistic transitional plan to extend the scope of the model (if the model only covers certain sub-modules of a specific risk module)

Internal model requirements (5/5)

Documentation standards (2/2)

- **Commission shall adopt implementing measures:**
 - The procedure to be followed for the approval of an internal model
 - The adaptations to be made to the standards (Use test ...) in order to take account of the limited scope of the application of the partial internal model
- **Policy for changing the full and partial internal models includes the specification of minor and major changes (Major changes shall always be subject to prior supervisory approval)**
- **The Administrative and management bodies are responsible for**
 - approving the application to the supervisory authorities for approval of the internal model, as well as the application for approval of any subsequent major changes made to that model.
 - putting in place systems which ensure that the internal model operates properly on a continuous basis.
- **Reversion to the standard formula only in exceptional cases**
- **Case of Non-compliance of the internal model:**
 - Reversion to the standard formula OR
 - Plan to restore compliance within a reasonable period of time OR
 - Effect of non-compliance is immaterial

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There are various ways of calculating required capital under Solvency II

Challenges for risk modeling, calculation and aggregation are especially high

Advanced approaches will get special attention of regulators

Effects of diversification and risk mitigation can be especially well modeled with internal models

Embedding risk management into day-to-day business is critical



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Qualifications	Diploma in Mathematics, Dr. rer. nat., Actuary (DAV)
Experience	<ul style="list-style-type: none"> • 4½ years experience at Munich Re departments: <ul style="list-style-type: none"> • Group Controlling department • Integrated Risk Management • Risk Management, Development and Services • committee work (GDV, Groupe Consultatif, DAV, Swiss FOPI) concerning <ul style="list-style-type: none"> • Solvency II - CEIOPS QIS2/3 models • Risk capital modeling - Swiss Solvency Test • accumulation risk control in reinsurance underwriting • catastrophe modeling in insurance portfolios based on various tools (RMS, EQECat, AIR) • group corporate planning in a value based management framework • group risk aggregation and allocation of capital • project management regarding design and optimization of reinsurance programs both for internal and external clients (DRA / DFA / ALM) • calculation of solvency and rating capital based on various models (CEA, FSA, NAIC, S&P, ERM, BCAR)
Sector experience	<ul style="list-style-type: none"> • Insurance and Reinsurance Non-Life (Property & Casualty, traditional & non-traditional types of reinsurance, portfolio-solutions)
Publications	<ul style="list-style-type: none"> • N.v.Bomhard, C.Frey, <i>Future Financial Frameworks – Essentials for Risk-Based Capital Management</i>, The Geneva Papers, 2006 • C.Frey, K.Ehrlich, <i>Solvency II – Zu komplexe Modelle vermeiden</i>, Versicherungswirtschaft, 2006 • C.Frey, <i>Vers une formule européenne standard</i>, RISK, 2005

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Detailed requirements / Use Test (1/5)

Item	Interest of Supervisors
Risk Management	
The internal model includes an assessment of all the <u>material risks</u> highlighted on the risk register.	The <u>risk register</u> has been used as a key input into the internal model
The firm has an adequate <u>governance framework</u> around the risk management department which feeds risks into the internal model	The risk management function is <u>appropriate</u> for the scale, nature and complexity of the business and operates in an effective and active manner.
The outputs of the internal model are used in the firm's risk management function to <u>influence their risk assessment and monitoring</u> processes.	The <u>risk register is driven</u> in part by assessing the results of the internal model (risk quantification exercise).
The <u>effect of any risk mitigation</u> measures taken by the risk management department are <u>assessed in advance</u> by the internal model to determine changes in the level of economic capital which should input into the decision-making process.	<u>Decisions</u> taken from advice by the risk management department have been assessed prior to the decisions being taken <u>using the results of the internal model</u> as an input.
The <u>risk management function</u> is tasked with <u>managing</u> most aspects of the <u>internal model</u> including: <ul style="list-style-type: none"> • design and implementation; • testing and validating; • documentation; and • analysing and reporting on the performance. 	The <u>risk management function</u> are <u>owners</u> of the internal model.
The <u>risk management function</u> is responsible for <u>educating other areas</u> of the business about the internal model, and facilitating their collaboration in its development and continued use.	The risk management function coordinate <u>firm-wide training</u> for all relevant areas on the internal model (as evidence by suitable presentations).

Detailed requirements / Use Test (2/5)

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Item	Interest of Supervisors
Capital Management	
<p>The capital management function <u>continually assesses the solvency</u> of the insurance company using the economic capital resulting from the internal model (at the confidence level appropriate for its business) to <u>compare to the level of its own funds</u>. This assessment should be considered over an appropriate business planning period.</p>	<p>The <u>capital plans</u> that the firm uses to satisfy this requirement. The plans should include <u>details of material assumptions</u> used.</p>
<p>The capital management function <u>allocates economic capital at an appropriate level of granularity</u> (e.g. by business unit, line of business, homogeneous risk group) to enable management to use this within their management information (e.g. return on risk-adjusted/allocated capital).</p>	<p>Details of the <u>capital allocation methodology</u> that the firm has used and any metrics / decisions based on this allocation testing and comparisons to the internal model results.</p>
<p>The internal model will need to <u>incorporate stress and scenario testing</u> to comply with Article 44(2), and these should be used in addition to any stochastic modelling to provide comfort that the stochastic modelling is producing reasonable answers.</p>	<p>The <u>design and results of the stress and scenario testing</u> and <u>comparisons</u> to the internal model results.</p>

Detailed requirements / Use Test (3/5)

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Item	Interest of Supervisors
Other key functions	
<p>The internal model needs to be <u>central to relevant functions</u> within the firm and <u>key business decisions</u> taken by the firm that affect its risk and capital profile should be assessed by the firm in advance by the internal model to determine the changes on the level of economic capital derived from the internal model. These functions should include the following:</p> <ul style="list-style-type: none"> • Reinsurance department • Underwriting department • Investment management • Management information • Strategy department • Corporate finance department <p>Each part of the organisation should get output from the internal model that is relevant for their responsibilities and is used in decision making. They will need to understand how to feed back decisions into the internal model, so the effect on risk and capital can be assessed.</p>	<p>Supervisors should ensure that when material events take place within the firm that the <u>decision making process involves input from the internal model</u> (e.g. assessing the resulting risk and capital profile from a potential purchase of a business, purchasing their reinsurance programme, writing a new business line) as evidence by supporting documentation..</p> <p>If a firm is seeking regulatory approval for such an event, supervisors should ask to see the supporting documentation from the internal model.</p>
Internal Controls	
<p>The internal model needs to be part of the internal control system, and be subject to adequate control procedures when changes are made. Controls should also exist in validating the inputs and verifying the outputs.</p>	<p>Adequate controls exist around the internal model.</p>

Detailed requirements / Use Test (4/5)

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Item	Interest of Supervisors
Internal Audit	
<p>The firm's internal audit function should <u>review control procedures around the internal model</u> to ensure that the internal model is up to date, uses reliable data, is developed and operated by competent persons, has appropriate controls etc.</p>	<p><u>Evidence of the internal audit review</u> and involvement.</p>
<p>The firm's internal audit function should ensure that an appropriate segregation of duties and challenge process routinely operates for all areas of the internal model.</p>	<p>The internal audit review includes an analysis of appropriate segregation of duties.</p>
Actuarial Function	
<p>The firm's actuarial function should be <u>involved in the design, calibration and build of the internal model</u>. The actuarial function should also <u>use the outputs</u> of the internal model, for example in providing an improved understanding of its reserve volatility.</p>	<p>The actuarial function are <u>involved at all levels</u> of the internal model.</p>
<p>The actuarial function should be <u>involved in the training</u> processes at the firm to educate user of the internal model.</p>	<p>Details of the <u>training material</u> provided.</p>
Outsourcing	
<p>Where elements of the internal model are outsourced, the <u>outsourced firm should ensure that the quality</u> of inputs etc. is as required by the firm and it is <u>appropriate</u> to the nature of their business.</p>	<p>The external inputs are not just taken as given but as <u>tailored as appropriate for the firm</u> so it can use them in its business.</p>

Detailed requirements / Use Test (5/5)

1. Motivation
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Item	Interest of Supervisors
Frequency of Calculation	
<p>A firm will assess its economic capital <u>regularly, reflecting changes in risks</u>, asset values, liability values and changes in the business environment.</p>	<p>That the internal model is <u>kept updated</u> to date when used as a decision-making tool based on internal or external changes in the firm's business environment .</p>
<p>The assessment should be run in full <u>at least twice a year</u>, although the firm should do less detailed runs at least twice a year in addition. The cycle should <u>fit with risk reporting</u>.</p>	<p>A <u>regular update and reporting cycle</u> exists within the firm.</p>
General governance requirements	
<p>Designing, building and maintaining an internal model <u>requires experience of risk management, capital management, finance and actuarial knowledge</u> (internally or externally)</p>	<p>The internal model is designed, built and maintained by <u>staff with appropriate expertise</u>. If any of this has been outsourced then the supervisor should ensure that the firm has undertaken a process to ensure that the internal model is appropriate for its business</p>
<p><u>Responsibility</u> for the internal model rests <u>ultimately with the Board/administrative body</u> of the firm. The Board/administrative body <u>should have a good working knowledge of the internal model</u> and understand the business decisions that the internal model should be central too along with the functions of the business that the internal model is required to be used in. The Board/administrative body should also be responsible for ensuring the on-going appropriateness of the design and operations of the internal model, and that the internal model continues to appropriately reflect the risk profile of the insurance and reinsurance undertakings concerned</p>	<p>The <u>Board/administrative body</u> has <u>devoted sufficient time</u> to understanding the internal model so it has a good working knowledge of it and <u>can make informed decisions</u> based on its outputs (<u>evidence by learning material provided to the Board/administrative body</u>). The Board/administrative body should put regular procedures in place to ensure the internal model is regularly updated.</p>

Detailed requirements / Statistical quality standards (1/5)

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Item	Interest of Supervisors
Techniques and assumptions	
<p>Statement, <u>description and justification</u> of the actuarial and statistical <u>techniques used</u>. Comparison with techniques used to calculate technical provisions.</p>	<p>The statistical quality standard ensures that the <u>data and methods</u> underpinning the capital model are <u>appropriate and up to date</u>. Whilst there is a reference to probability distribution forecasts, this does <u>not</u> mean that <u>only stochastic modelling techniques</u> are to be used – a <u>scenario testing approach</u> can give <u>useful</u> information that allows the model to fulfil Article 113 (4), and sometimes this can be more useful than a stochastic approach, for example <u>scenario testing can be easier</u> for a firm's management <u>to understand</u>, and this can help the firm to pass the use test.</p> <p>In most capital models, a combination of stochastic and deterministic approaches will be used, depending on the size, nature and complexity of risks.</p>
<p>Statement, <u>description and justification</u> of the <u>assumptions</u> made.</p> <p><u>Test</u> of the model to calculate the assets and liabilities.</p>	<p>The statistical quality test includes the <u>ability of the valuation model to accurately calculate the assets and liabilities</u>. We expect firms to test this in current conditions (to calculate the technical provisions) and also the ability of the model to <u>accurately predict the financial position of the firm under a number of different possible futures</u> (forward looking scenario tests). There is a link to article 120 (Profit and Loss Attribution).</p>

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Detailed requirements / Statistical quality standards (2/5)

Item	Interest of Supervisors
<i>Data accurate, complete and appropriate</i>	
<p><u>Explanation</u> where data is incomplete or where there may be <u>inaccuracies</u>.</p>	<p>Data may be incomplete, for example, due to processing delays, or because claims have not yet been reported. <u>Allowance will need to be made</u>, or if allowance already has been made, the <u>rationale must be understood</u>.</p> <p>For some risks, in particular, operational risk, <u>data on loss events is limited</u> and to some extent unhelpful. Information about possible future events may be limited by people's experience. This is an area where a <u>clear rationale and challenge process</u> will need to be seen.</p>
<p>What <u>data relates</u> to and the <u>issues with using</u> it.</p>	<p><u>Some understanding of the data</u> will generally be <u>necessary</u> to see how it relates to and compares with the internal model.</p>

Detailed requirements / Statistical quality standards (3/5)

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Item	Interest of Supervisors
<i>No Method Prescribed</i>	
	<p>“The IAIS considers that <u>a range of approaches could constitute an effective internal model</u> for risk and capital management purposes, and supervisory regimes should <u>encourage the use of a range of different approaches</u> appropriate to the nature, scale and complexity of different insurers and different risk exposures. There are several different techniques to quantify risk which could be used by an insurer to construct its internal model. In broad terms, these could range from basic deterministic scenarios to complex stochastic models. Deterministic scenarios would typically involve the use of stress and scenario testing reflecting an event, or a change in conditions, with a set probability to model the effect of certain events (such as a drop in equity prices) on the insurer's capital position, in which the underlying assumptions would be fixed. In contrast, stochastic modeling often involves simulating very large numbers of scenarios in order to reflect the likely distributions of the capital required by, and the different risk exposures of, the insurer.</p>
	<p>The key point is that the <u>model needs to be useful in the management of the firm</u>, by providing enough information about the risks facing the firm to <u>enable decision making</u> to take account of them, and <u>subsequently remodel allowing for decisions</u>. In being a useful model to the firm in other contexts, such as reinsurance optimization, budgeting and capital allocation, a more complex model will tend to be more difficult for management to fully understand and so use.</p>
	<p>A capital model underlying an economic capital assessment <u>will probably allow for more risks than in the standard formula</u>. The firm will have more information and understanding of its own risks than the supervisor.</p>

Detailed requirements / Statistical quality standards (4/5)

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Item	Interest of Supervisors
<i>Diversification effects</i>	
<p>Documentation including <u>justification for any diversification effects</u> assumed. The diversification effects should be reviewed at least annually to make sure they are still reasonable.</p>	<p>Firms often use a <u>correlation matrix based on internal judgment</u> to allow for diversification effects. This is reasonable, provided the matrix has been <u>challenged and the rationale for the final decision</u> is clear and documented.</p> <p>Some firms use <u>copulas to aggregate risk</u>. These are similar to correlation matrices in their aggregating effects, except that they can allow for greater correlation in the most adverse scenarios. For example, a “normal” catastrophe loss may not affect equity markets, but a supercatastrophe could cause a stock market crash. However, copulas are more difficult to understand and add to the complexity of a model.</p> <p>Some models may explicitly correlate assumptions, such as investment returns and future claims inflation, which is reasonable. <u>However, in a complex stochastic model the reasonableness of the correlations may be hard to assess.</u></p>
<i>Risk mitigation and management actions</i>	
<p>Statement, description and <u>justification for all risk mitigation assumed</u> in the internal model, with links to the risk register. Consideration of the possibility of risk mitigation failure.</p>	<p>It is reasonable to <u>allow for risk mitigation</u>, for example, reinsurance in the model. However, it <u>should not be taken for granted that the risk mitigation will work</u>. For example, a firm will often want its reinsurance to respond following a large market loss, which is exactly when the reinsurer is most likely to default. Likewise, although a firm may have rules for underwriters which control underwriting risk, the possibility could exist for an underwriter to systematically break those rules.</p>

Detailed requirements / Statistical quality standards (5/5)

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Item	Interest of Supervisors
<i>Risk mitigation and management actions (cont.)</i>	
<p>Statement, description and <u>justification for all management action</u> assumed in the internal model.</p>	<p>The capital model will generate or be generated by a series of scenarios, some of which <u>management would clearly react to in order to mitigate</u>. It is <u>reasonable</u> to allow for management actions, as long as the <u>management actions are documented as part of the model</u> and it is clear that there is <u>little discretion</u> about whether or not to take them – the action can take place, and the board would agree to the action.</p>
<p>Allowance for time delay until management can take action. In addition, the <u>allowance for management action should be justified</u> in terms of the management information received, in terms of its quality and timeliness.</p>	<p>In practice the <u>ability of management to react to a problem is reduced</u> by the delay until they become aware of it. For example, a non-life insurer may not be aware that it has incurred long-tail claims for years. For scenarios where management may or may not react, or where a course of action is unclear, it would be hard to allow for any future management action</p>
<p>Any <u>history</u> of similar management actions in the past.</p>	<p>Evidence that might support allowing for these actions would be if a <u>similar scenario</u> had happened in the past and <u>management had reacted quickly</u> and in the way projected.</p>

Detailed requirements / Calibration standards (1/4)

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Item	Interest of Supervisors
<i>Time period and risk measure</i>	
<p>A firm <u>may use a different time period or risk measure</u> to fit in with business planning or a timeframe that suits its business.</p>	<p>This is not unreasonable, and an internal model will be able to provide capital levels at different levels of calibration and show the equivalence to regulatory capital.</p> <p>For example, a firm may well wish to <u>maintain a very high credit rating</u>, and so base its model on a <u>higher percentile than 99.5%</u> over one year.</p> <p>The IAIS has <u>not put forward a specific time period or risk measure</u>, and therefore non-EEA regulators may well select other time periods and/or risk measures than those of Solvency 2. A firm with non-EEA operations, especially one based outside the EEA (but with operations in the EEA) would then have to consider <u>different time periods and/or risk measures</u> to meet the requirements of different regulators. <u>Having a single model which can do this would be much preferred</u>: as well as minimising the time and expense associated with building and maintaining internal models, it would cause much less confusion and allow a single model to be at the heart of the business.</p> <p>The main focus of the internal model SCR is to derive a number. The process of reviewing should therefore focus on the ability of the internal model to come up with a more appropriate and risk sensitive figure which is comparable to the result based on parameters which are assumed to be 99.5% events in the standard formula.</p>

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Detailed requirements / Calibration standards (2/4)

Item	Interest of Supervisors
<i>Time period and risk measure</i>	
<p>The internal model should be able to provide a <u>capital requirement number at the 99.5th percentile over a one year time horizon.</u></p>	<p>Using a model that assesses economic capital should naturally be able to produce capital at different levels of calibration. The information in the model should be adequate to provide regulatory capital to the level required by Solvency 2. In addition, the IAIS view is:</p> <p>“As part of a 'calibration test' the insurer should assess the extent to which the output produced by its internal model is <u>consistent with its defined modelling criteria</u>. As part of this process, an insurer may conduct stress and scenario testing to determine the effect of shock events on its capital position derived from the internal model determined at different confidence levels. This should enable the insurer to <u>decide which confidence level</u> it considers to be the most appropriate for its business plan and strategic long-term goals. For example, if an insurer decides to adopt a higher confidence level than the level required for regulatory capital purposes in order to maintain a certain investment grade rating, then calibration testing should be conducted by the insurer to allow the insurer to determine the level of capital needed at this higher level. The insurer should then decide whether holding this amount of capital is consistent with the insurer's overall business strategy.”</p> <p><i>Use Article 101</i></p> <p>Firms will find it easiest to produce the calibration in line with Solvency 2 in terms of discussing with supervisors.</p>

Detailed requirements / Calibration standards (3/4)

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Item	Interest of Supervisors
<i>Consistency between Internal Model and Standard Formula</i>	
<p>Where practicable, firms shall derive the <u>Solvency Capital Requirement directly from the probability distribution forecast generated by the internal model</u> of those undertakings, using the Value-at-Risk measure set out in Article 101(3).</p> <p>This is less of an issue where the internal model is more prudent than the corresponding part of the standard formula</p>	<p>This direct requirement of the Directive (subject to the test of practicability) is helpful in making it <u>easier to compare an internal model against the standard formula and against other firms.</u></p> <p>Some firms may be of the view, for example, that the equity risk charge in the standard formula is imprudent. It is unreasonable to without internal model approval when a firm is being more prudent than necessary</p>
<i>Use of approximations</i>	
<p>It would be preferred that the <u>internal model</u> should be able to provide a <u>capital requirement number at the 99.5th percentile</u> over a one year time horizon.</p>	<p>It would be disappointing if an internal model was unable to provide the necessary calibration without approximations, although the proportionality principle is relevant. Firms should start to design models with this requirement in mind.</p> <p><i>Use Article 101</i></p> <p><i>Firms will find it easiest to produce the calibration in line with Solvency 2 in terms of discussing with supervisors.</i></p>

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Detailed requirements / Calibration standards (4/4)

Item	Interest of Supervisors
<i>Benchmark Portfolios</i>	
<p><u>Run</u> internal models <u>on benchmark portfolios</u> where appropriate.</p>	<ul style="list-style-type: none"> ■ Supervisors will wish for <u>consistency across firms</u> and one way to achieve this is to test a standard portfolio in the internal model. It is unclear how often this would be used by supervisors. Other questions: <ul style="list-style-type: none"> - Will the standard portfolio be public – this may give scope for manipulation - Will it change from year to year? - Will it be the same across Europe? - What will the inputs be? How much detail? ■ This is not straightforward – models are designed very differently from firm to firm. ■ A different approach would be to benchmark across firms’ internal models. Thus similar firms, subject to a scaling factor, should have in principle similar internal model SCRs. ■ The problem with this is the extent to which two firms are indeed similar. Even with firms writing the same lines of business in the same territories, one may write higher risk business than the other, or have a better risk mitigation strategy, or use reinsurance more heavily, to pick just a few examples. Therefore comparing firms is more difficult than it may seem. ■ Despite this, similar firms can be broadly compared, although with due allowance for differences between them; making these allowance will generally require judgement. In doing so, it will help if there are many firms against which to benchmark.

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Detailed requirements / Profit and Loss Attribution

Item	Interest of Supervisors
Explanation of <u>how experience is monitored</u>	Is this likely to <u>identify material developments</u> sufficiently early to enable mitigating management action? Are internal management accounts adequate?
Comment on <u>major developments, events and divergences</u> from plan	Were they <u>identified timeously</u> ? Do comments make sense? Do any of these items <u>indicate flaws in planning or model</u> ?
Major and material <u>unplanned developments</u> .	Were these <u>reported timeously</u> ?
Actions taken (or not taken) or planned as result of monitoring and developments, with reasons	Are actions reasonable? Were they taken soon enough and with proper consideration? Do reasons make sense and has proper consideration been given to the interests of policyholders? Was SCR recalculated if required?
Explanation of <u>how analysis of experience reflects model</u>	Does this analysis appear to make sense? Does it <u>pick up key components of the model</u> ?
Evaluation of <u>relationship between risk drivers and financial outcome</u>	Does this indicate that the model is a <u>good fit to reality</u> ?
<u>Minor changes</u> to model	Do they conform to <u>model change policy</u> ? Do the <u>changes appear appropriate</u> and a proportionate response to experience?
How will any additional risk pending model change be addressed	Is this an appropriate and adequate response?

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Detailed requirements / Validation Standards (1/8)

Item	Interest of Supervisors
Information provided to the Board on the validation process, details of the discussions and challenge made, and the final decisions taken.	That the information is comprehensive; that the Board has <i>demonstrated understanding</i> of the validation; that the Board has agreed the process.
The regular management information on the validation of the internal model being presented to the Board.	That the internal model has been validated in line with Article 121 and that the Board are clear where the validation fails and have a plan to remedy this.
Evidence of the validation process working, for example, what happens when there is a disagreement or an issue.	That issues have been resolved in line with the process, and that the resolution is appropriate.
Details of any independent checks on the internal model – reports from reviewers, details of issues, plans for resolution.	Conclusions of reports and plans for resolution of issues. An indication of how important the issues are. On-going progress reports against plans.
Full internal model documentation (see documentation section)	That the documentation of the validation process and the validation itself is complete, and the firm's plans for improving it.
Documentation of the decisions on where a less detailed approach has been taken, including the rationale. This will need to be accompanied by details of the firm's structure and business volumes by line of business.	Support for the decision to take a less detailed approach, and a context for the decision.
The MI on the past performance of the internal model against actual outcomes.	The supervisor should aim to understand where the internal model is not a good fit and ask the firm to explain why this is the case, and why they have decided not to improve the internal model.

Detailed requirements / Validation Standards (2/8)

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Item	Interest of Supervisors
The validation for the firm's economic capital requirement, calibrated to the risk appetite level.	That the internal model has been correctly calibrated and it can be adjusted to produce regulatory capital.
The rank-ordering ability of the internal model needs to be validated – are the risks that are classed as largest by the internal model really the largest ones facing the firm? Are the relative sizes reasonable?	The biggest risks facing the company, and the level of capital needed to back them. How the capital is allocated.
The MI on the validation should include information on capital model results at different levels of probability to give assurance as to the reasonableness of the shape of curve	Whether the shape of the curve is reasonable and comparable to similar firms.
Management actions may form a key part of the internal model – the validation should confirm that they are documented and agreed.	That the management actions will tackle the risks in the internal model where credit has been taken.
The internal model can be back-fitted to past experience, even if not previously modelled, to validate the overall operation of the internal model. Such comparisons should make use of historical data over as long a period as possible. The methods and data used in such comparisons must be clearly documented by the firm. Management information on validation should include an explanation of differences in actual and expected results or be able to demonstrate that results are within the expected range for the firm.	If results are out of line with past experience, the supervisor will wish to understand the reasons why, and why the firm has not adjusted the internal model.
An overall validation, bringing together each element of the internal model	Whether the overall result is reasonable

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Detailed requirements / Validation Standards (3/8)

Item	Interest of Supervisors
<p>The design should be validated. This should reflect the firm's organisational design and governance structure, and the validation should make sure that the internal model links in to these at the relevant points.</p>	<p>Whether the design reflects the firm's organisational design, and if not, what allowances the internal model has made.</p>
<p>The internal model should be benchmarked against market practice and results, where available. This may be done as part of an external review of the internal model.</p>	<p>If the internal model is based on out of date practice, whether it is still reliable, or whether the firm has a plan to update the internal model.</p>
<p>The internal model design needs to be reviewed against current best practice, for risk management and capital modelling. The validation should include a view of where the internal model fits against best practice and why it may deviate.</p>	<p>If the internal model is based on out of date practice, whether it is still reliable, or whether the firm has a plan to update the internal model.</p>
<p>The design of the internal model will include a level of granularity. The validation should make sure that this reflects the uses of the internal model in decision making.</p>	<p>There may not be adequate detail for some decisions, and the supervisor will need to ask how the firm intends to deal with this.</p>

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Detailed requirements / Validation Standards (4/8)

Item	Interest of Supervisors
<p>Data used in the internal model will need to be validated in respect of:</p> <ul style="list-style-type: none"> • Sources • Process • Owners • Issues • Article 119, also requires data to be accurate, complete, and appropriate. The firm will need to validate this, too. 	<p>If the firm cannot provide an audit trail for data, and details to explain that data flows are understood and managed well, the supervisor will need to ask how they plan to improve this, and what impact it has on the internal model.</p>
<p>The internal model specification will include details of roles and responsibilities for different elements. The validation should confirm that these are appropriate and are working effectively. This is particularly key for operational risk, where risks occur across an organization and across businesses in a firm.</p>	<p>If roles and responsibilities within the internal model are unclear, then the firm will need to assess the impact on internal model inputs and outputs.</p>
<p>An assessment of the extent of internal model and parameter error, and how this is allowed for in the capital assessment</p>	<p>That internal model and parameter error are allowed for and that the amount is appropriate.</p>
<p>Benchmarks to validate the internal model – these may be readily available for some risks such as market risk. Their use needs to be documented.</p>	<p>That the benchmarks are appropriate and have not been selected to give the required answer. A rationale for why one benchmark has been chosen over another. That the benchmarks are used widely. For example, firms might consider whether their equity investment strategy is sufficiently in line with a share index for a benchmark stress test derived from that index to be appropriate.</p>

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Detailed requirements / Validation Standards (5/8)

Item	Interest of Supervisors
Comparison of the internal model output to actually observed losses, either from the firm's experience, or publicly available.	That the output is comparable to the observed losses, in scale and probability level. That there is a satisfactory explanation if this is not the case.
Review of the decision process in selecting distributions and parameters, and the challenge process. This should include review of the data and analysis used to support the decision.	That the distributions and parameters have been challenged widely by the firm's second and third lines of defence and that there is MI demonstrating this, and that they are well understood.
Review of the effect of choosing different distributions or parameters to understand the sensitivity of the results to these assumptions.	That the firm has a good understanding of which are the key parameters and has spent most time on them.
Understanding of where judgment has over-ridden internal model results, particularly in the tail of distributions, to reflect a firm's own view of the risk in the firm.	That the judgment is appropriate, and how much of an adjustment to capital has been made.
Any changes to the firm's situation will bring the requirement for new data and information to model it. This needs to be validated as above. .	That the firm has updated the internal model for the changes and used appropriate data. If data is unavailable, what allowance has been made in the internal model.
New data may become available about a particular risk, for example, a new administration system may store more data than previously. The incorporation of this new data needs validation.	That new data is used appropriately and has been validated as part of the normal validation. That the change in results is explained.
Article 118 requires firms to update data sets at least once a year, and this may require the underlying distributions or parameters to be changed.	That the firm has a process for annual updates, that the data flow is clear and that the effect on results is explained

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Detailed requirements / Validation Standards (6/8)

Item	Interest of Supervisors
The new data may change the parameters underlying the internal model, and they will need to be tested and challenged as in developing a new internal model.	That changes have been validated and the effect on results is explained.
This means that a firm should set up a cycle of review, testing and challenge for the internal model in total to make sure parameters and assumptions continue to be reasonable and to ascertain which assumptions need to be changed.	That there is a process for maintenance of internal model parameters and assumptions, and that the current ones are appropriate.
New data, for example, on actually observed losses may be available, as new claims happen or market events occur. This data can be used to further calibrate the internal model.	That the firm is using up to date loss data, and can explain the effect of changes.
The firm should show which are the key assumptions, and how sensitive the internal model is to these assumptions and provide its rationale for the assumptions.	That the firm can demonstrate that it understands which are the key assumptions. The supervisor can compare to other similar firms as a check. How sensitive the internal model is to changes in these assumptions and whether the assumptions chosen are reasonable in the context of this sensitivity.
The firm should show how volatile the outputs of the internal model are across economic cycles and underwriting cycles as part of this validation.	That the firm has allowed for cycles appropriately and that the results of the internal model reflect the existence of these cycles.

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Detailed requirements / Validation Standards (7/8)

Item	Interest of Supervisors
The firm should highlight possible areas of model / parameter error, which can be considerable.	That the firm has allowed appropriately for these errors, both in the internal model design and in the results.
Validation should focus on areas of correlation between key factors and also on non-linear relationships between parameters to assess whether the internal model truly reflects the severity of events.	That the internal model allows for correlations and non-linear effects, and the firm has understood their effect on capital.
The firm will need to demonstrate that they understand the stability of the internal model and the circumstances in which it is not stable.	To understand where the internal model is not stable and why, and form a view on whether this is an issue.
<p>Validation of accuracy, completeness and appropriateness of data requires a firm to demonstrate that the processes that data goes through before it reaches the internal model from its different systems are understood, and maintain data integrity. The processes can include:</p> <ul style="list-style-type: none"> • Consolidation, for example, by time period or line of business. • Projection to ultimate, for example, including IBNR claims. • Analysis and comparison with historical data to produce statistics such as overall claim frequency or severity. • Analysis to produce statistical distributions for the internal model. 	That data moves from front-line systems to the internal model without losing integrity, and that processes and analyses that change the data to information are documented. That the data flow has been reviewed by second and third lines of defence in the firm, and that the firm has a plan to deal with any issues on data flow.

Detailed requirements / Validation Standards (8/8)

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Item	Interest of Supervisors
<p>The validation process will need to make sure that there are clear processes and review points as data moves along this chain, particularly at the decision and challenge points. In addition, the data will need to be validated to ensure it remains sound.</p>	<p>That the review points are clear and any issues with data have been resolved or the firm has reflected possible uncertainty in the results caused by this by an addition to capital.</p>
<p>Internal controls should ensure that data is accurate and complete. Areas where data is less accurate or less complete than desirable should be flagged by the firm – this may happen if data is not stored to the required level of detail, or where there are processing delays.</p>	<p>That the firm has a plan to improve internal controls and also to review their working regularly.</p>
<p>Appropriate data is not always available, and approximations should be documented and discussed in the firm to make sure there are no better alternatives.</p>	<p>That any approximations are reasonable and that the internal model output makes allowance for them, as this may increase uncertainty in the internal model.</p>
<p>An external review of the internal model would be helpful, as this may enable benchmarking of data standards and results.</p>	<p>Any recommendations for improvement of the internal model are of interest, and the supervisor will want to see the firm's plan to implement them, plus progress against it.</p>

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Detailed requirements / Documentation Standards (1/4)

Item	Interest of Supervisors
A. Summary of results	The supervisor will be interested in whether the firm has adequate capital, and in the differences between economic and regulatory capital figures
1. Economic capital figures	Whether the result is calibrated to the firm's risk appetite, what other risks are included above the regulatory capital figure, what the allocation is between classes of business and between major risks, how this has changed over time.
2. Regulatory capital figures	How the result compares to the standard formula, what the coverage is for the result, what the major risks are
B. Changes since last submission	
1. Details of changes	Whether changes affect internal model design (and, if so, are they in line with Art 113); whether changes affect the capital numbers; how material changes are; the cause of changes
2. Effect of changes	
C. Design of the internal model	
1. Schematic of design	Whether the internal model reflects the operation of the firm; whether the design compares to similar firms; how subsidiary firms are dealt with; how granular the internal model is.
2. Identification of key risks	Whether this compares to similar firms; whether all risks have been identified.
3. Link to governance of firm	Whether the internal model is embedded in the firm's governance and used; whether senior management understand the internal model and its shortcomings

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Detailed requirements / Documentation Standards (2/4)

Item	Interest of Supervisors
4. Outsourced elements of the internal model	The extent of outsourcing and its materiality; how the outsourcing is managed; comparison to similar firms
5. Areas for future development	What the firm's plans are and whether they are achievable
D. Theory, assumptions and basis.	
1. Scientific basis for the internal model	Whether the internal model is up to date; the firm's plan for improvements and keeping up to date
2. Details of assumptions used, with justification	Whether the assumptions are reasonable, both individually and taken together; whether there has been challenge of assumptions and the outcomes
E. Operational details of the internal model.	
1. Platform used	Whether the platform is widely used; how the platform has been used; how much of the internal model is hidden
2. Resources allocated to developing and running the internal model	Whether the firm has allocated enough resources; are development plans achievable with this resource; is the resource experienced
3. Frequency of runs – whole internal model, key elements	Frequency of updates compared to supervisor view on best practice; whether the cycle of updates is reasonable
4. Frequency of updates to assumptions	Whether assumptions are updated consistently across the firm
5. Challenge process for assumptions	How assumptions are challenged and whether there are examples of how the challenge process has worked

Detailed requirements / Documentation Standards (3/4)

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Item	Interest of Supervisors
F. Compliance with the use test	See section on use test
1. Role in governance – risk management	
2. Role in governance – capital management	
3. Role in governance – other key functions	
4. Model governance	
G. Profit and Loss Attribution	See section on P&L attribution
1. Back testing	
2. How actual experience is monitored	
3. Actions to be taken	
H. Where the internal model does not work	
1. Details of areas where the internal model does not work, with explanation	Whether the firm has understood the shortcomings of the internal model; how these compare to other firms; whether the effect is important
2. Plan to remedy this	Whether the plan is reasonable and achievable
I. Compliance with statistical quality standards	See section on statistical quality standards
1. Description of methods used to calculate probability distribution forecast	
2. Description of data and information used	
3. Details of assumptions made	

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Detailed requirements / Documentation Standards (4/4)

Item	Interest of Supervisors
4. Details of risks covered in the internal model	
5. Details of risk rankings	
6. Details of diversification assessment - method and results	
7. Details of risk mitigation – methods and results	
8. Details of how financial guarantees and options are allowed for	
9. Details of payments included	
J. Compliance with calibration standards.	See section on calibration standards
1. Details of calibration used	
2. Reconciliation to Solvency 2 standard	
3. Details of approximations used and effect	
4. Details of any benchmark portfolio test and results	
K. Compliance with validation standards	See section on validation
1. Validation process	
2. Results of validation	
3. Stability analysis	
4. Key assumptions	

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Detailed requirements / External Models

Item	Interest of Supervisors
Modelling platform licensed from a third party and developed / populated by the firm	In addition to general documentation requirements, supervisors should ensure that the internal model architecture is transparent and documented as if it had been developed by the firm itself.
Model licensed from a third party and used as a component part of the overall internal model, e.g. specialised models for credit / market / premium / reserve risk	Documentation and proof of satisfaction of Article 118 – 123 requirements should be as if the internal model is developed in-house
Model licensed by a firm for a subcategory of risk (e.g. reinsurance optimisation), and uploaded into the main capital model	Need to ensure that model integration has been achieved and that any stress / scenario tests are performed as if the entire model were internalised
Modelling activity outsourced to a third party, with resultant output uploaded into the main capital model	In principle, a firm could outsource the entire capital model, but it would be very hard to pass other tests, especially Use Test. Need to ensure that model integration has been achieved and that any stress / scenario tests are performed as if the entire model were internalised
Use test	Has the use of any external data or modelling activity diluted the application or embeddedness of the internal model compared with a fully internalised activity?
Statistical quality standards	Justification of assumptions, data and techniques and management sign-off of their validity. Has the firm actively participated in the process?
Calibration standards	Can benchmark portfolios be run where external models / components are used? Same applies also to sensitivity analysis and scenario tests.
Validation standards	Need to demonstrate a proper understanding of the third party tools, models or activity as if the function were internalised – this is challenging for firms who have externalised to gain access to expertise. Have correlations between external and internal model components been adequately addressed?

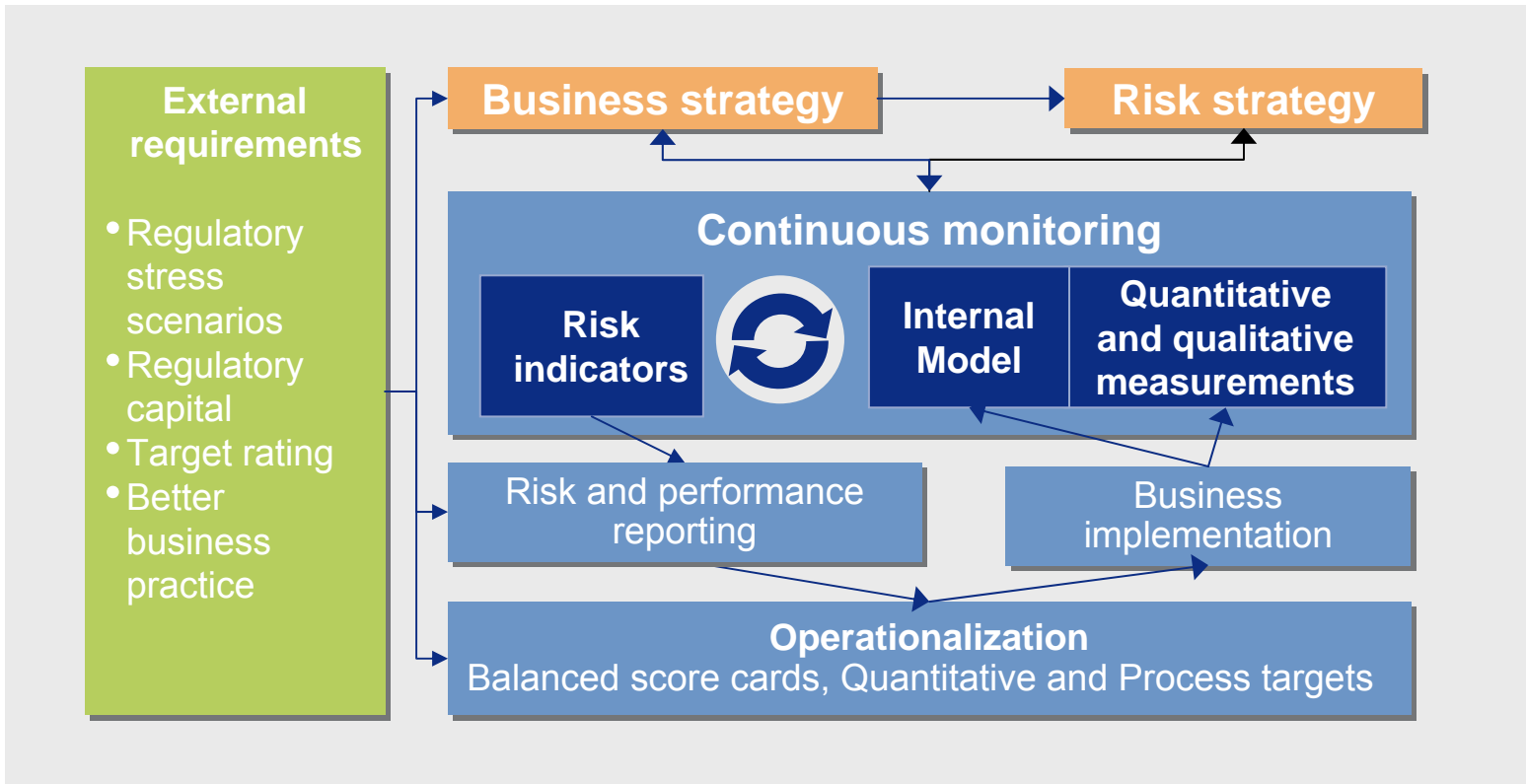
Agenda

- 1. Motivation: Importance of internal economic capital models**
- 2. Basic principles of risk modelling**
- 3. Measurement of risk categories**
- 4. Requirements on internal models**
- 5. Economic Capital Model Assessment (ECMA)**
- 6. Summary**

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Better practice focuses on the integration of internal models into Enterprise Risk Management

Enterprise Risk Management for insurance companies includes several key components ...



... including capital modeling and risk governance

KPMG has developed an approach to modeling that takes into account the standard requirements on internal models

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As an example, the proposed Solvency II internal model assessment requirements may include the following key areas ...



Statistical Quality

- Sound actuarial approaches
- Allows for mitigation and dependencies
- Accurate and appropriate data
- Rigorous back-testing
- Analysis of stability of model
- Documentation of design and operational details
- Rigor around third party models or data



Use Test

- Use in risk management
- Built in to control loops
- Fit within operational and organizational structure



Calibration

- Regulatory capital
- Legal entity and group levels
- Appropriate weighting of data sources
- Rigor around parameterization
- Enhanced use of insurance technical risk data and financial markets data

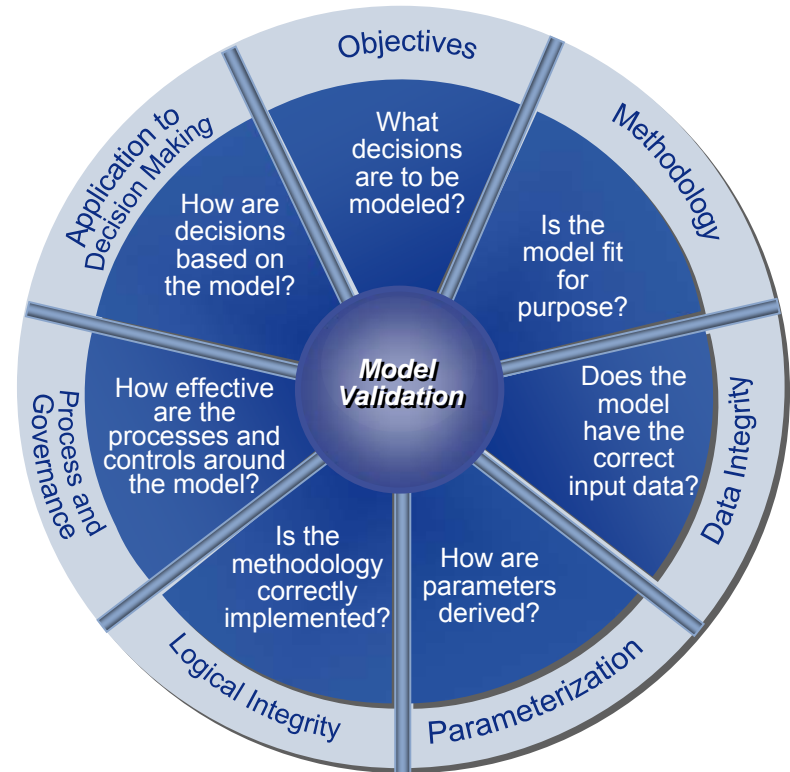
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KPMG's approach to model validation

Model Validation is intended to help insurers:

- Assess the appropriateness of their modeling methodology for their objectives
- Identify any errors, risks or limitations in the implementation of their models
- Gain an understanding of the level of comfort they can have in their existing models
- Identify value-adding opportunities to achieve business benefits by enhancing their models

The diagnostic can be applied at a number of analysis levels based on availability of information and access to personnel



KPMG's Approach to Economic Capital Model Assessment

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1 Objectives

- The analysis of *objectives* is a fact-gathering step, identifying senior management's goals for the model and its use.
- This step should sketch the basic facts about the business environment the model is to be used in, the types of decisions it will support, and the advantages it is expected to create.
- Creating a model suitable for both current and future use is a considerable challenge and it is important to understand these objectives fully.
- Ultimate findings would compare the "as is" state with these objectives.

2 Methodology

- Due to the complexity of economic capital models, structure and methodology are typically described and assessed in several iterations of increasing detail.
- This is usually a substantial part of the assessment exercise.
- Its main purpose is the assessment of the methodology and its appropriateness for achieving the objectives identified above.
- This stage considers whether the model is "fit for purpose" in terms of what it is trying to do and how management wants to use it.

KPMG's Approach to Economic Capital Model Assessment

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3 Data Integrity

- The output of a model depends as much on the data it uses as on the modeling methodology which is employed.
- The assessment of data addresses the data gathering process for the purpose of the model.
- It also assesses whether the interpretation of data in the model's methodology is consistent with the data collected by the insurer.
- Another objective is to analyze if data used in modeling is consistent with data used for business planning and other financial reporting.

4 Parameterization

- Model parameters are derived from collected data.
- Since collected data is typically very scarce for economic capital calculation, parameterization often needs actuarial judgment as a decisive component.
- The objective of this step is to help assess the process used for choosing parameters.

KPMG's Approach to Economic Capital Model Assessment

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5 Logical Integrity

- The logical integrity of a model is distinct from its methodology and refers to the physical implementation of the model's logic in a computer program or simulation.
- The objective of this step is to help assess to what extent the approach taken in the physical implementation matches the intended methodology.

6 Process and Governance

- Modeling and usage of models are extensive processes which require the support of clear governance.
- Responsibilities are usually distributed over several departments and levels of hierarchy.
- Economic capital models generally attempt to model the company as a whole, requiring interaction with many areas and departments.
- Care must be taken so that the incentives to support the modeling effort outweigh possible conflicts of interest.
- The objective of this step is to help assess the processes and governance covering the models, including model build, development, and the use of models in the organization.

KPMG's Approach to Economic Capital Model Assessment

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7 Application to Decision Making

- In the final step, the application to decision making is analyzed.
- This final step identifies potential gaps between the objectives of modeling, the perceived implementation and its actual use.
- It links to the regulatory desire to see the “use test” being fulfilled within the business. In other words, it is where the firm is able to demonstrate that the model is more than a black box that is used once a year to calculate a regulatory capital number.

Models are key to enabling management to improve corporate decision making, and economic capital models are fundamental to an insurer's pricing, financing and capital decisions.

...what are the potential options for these opportunities?

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What are the gaps?

Assess appropriateness of modeling methodology and implementation for achieving objectives

Recommendations		
2.2 Methodology		
Issue	Observation	Recommendation
2a Measurement of diversification	The Gauss copula does not account for tail dependency.	A simple copula family which exhibits some tail dependency is the Gumbel copula family.
Urgency 2	The usage of copulas for aggregating distributions is more advanced than the common present industry practice of using correlation matrices for aggregating risk capital. (However, tail dependency is only rarely captured in company models of peers).	Obtain data on how insurance and reinsurance prices change in relation to last year claims. Use these data to implement a price increase for the second half of the year based on simulated claims for the first half of the year.
Time and effort 2	However, regulators and rating agencies have indicated that they would favourably view an approach to model tail dependency. This is possible within the copula framework.	
2d Pricing cycle	The pricing cycles are not accounted for.	
Urgency 2		
Time and effort 2		

Consider how controls are embedded in processes and governance

Recommendations		
2.6 Process & Governance		
Issue	Observation	Recommendation
6a Collaboration and review	The model is developed by the actuarial department.	It is recommended that a formal testing and reviewing process is introduced.
Urgency 2	Input from other departments are solicited on an informal basis.	This process should involve specialists from every risk category which is modelled.
Time and effort 2	It is not reviewed outside of the department.	A modular design would assist with such reviews (see section 2.5 computer platform).
6b Release process	The current version of the program is on the internet and hence downloadable for employees in asset management, controlling, and the actuarial department, neither input data nor calculations are provided to users.	In order to minimize the probability of different versions of the model being used in parallel, it is recommended to implement a formal release policy for such risk and input data.
Urgency 2		In order to guard sensitive information it may be necessary to restrict access to the model.
Time and effort 2		
6c Risk management	There is no enterprise risk management controls. Risk management processes are developed by controlling and approved by the Board.	It is recommended to establish an enterprise risk management controls. The controls would evaluate the output from the model and other risk measures, and come up with recommendations for processes.
Urgency 2		This committee should have representation from the Board as well as controlling, the actuarial department, and all profit centers.
Time and effort 2		

Consider how the company uses the overall model outputs relative to its decision making

Recommendations		
2.7 Application to Decision Making		
Issue	Observation	Recommendation
7a Usage of the model	The two profit centers "Fire Insurance" and "Third Insurance" use the model for pricing.	It is not recommended that the model is used for asset management as parts of the model do not contain sufficient detail for this purpose.
Urgency 2	Asset management uses the model to find asset allocations which maximize its risk adjusted return.	Process and controls should be created to prevent the kind of bonus optimization through manipulative use of the model.
Time and effort 2		It is also noted that the asset allocation should take long term cashflow patterns into account to minimize liquidity risk.
7b Remuneration of management	50% of the total bonus for profit centers is distributed to profit centers in proportion to how much their risk adjusted return exceeds the internal risk adjusted return.	The choice of base line for bonus allocation is not recommended as some lines of business are inherently less profitable than others.
Urgency 2		It is recommended to base bonus allocation on the situation from originally agreed targets.
Time and effort 2	The remaining 50% of the total bonus are distributed by the Board based on qualitative criteria.	It is recommended to formalize the qualitative criteria inline with the management of other risks and opportunities. This will lead to a transparent assessment of bonus allocation.

3

Identify model gaps

4

Identify process and governance gaps

5

Perform use testing

... and what are the action plans?

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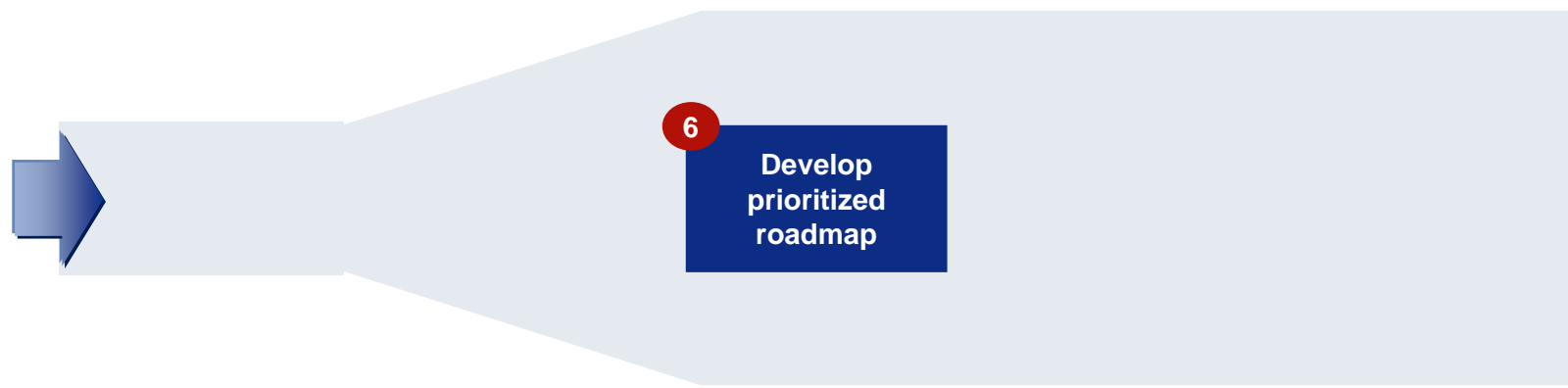
What's to be done in the next 12 months?

Develop a set of urgent improvements to be implemented in the next 12 months. Present to client, priorities and select next steps



What's to be done in the next 36 months?

Identify mid term opportunities to expand use or functionality of models to create value and improved risk-based decision making ability

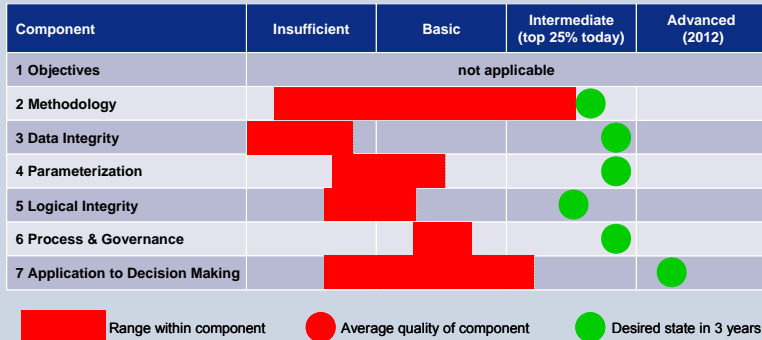


6
Develop prioritized roadmap

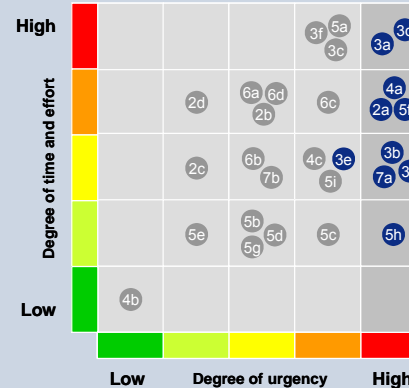
Assessment of opportunities and rigorous project management

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Current vs. Desired State



Prioritization of Enhancements

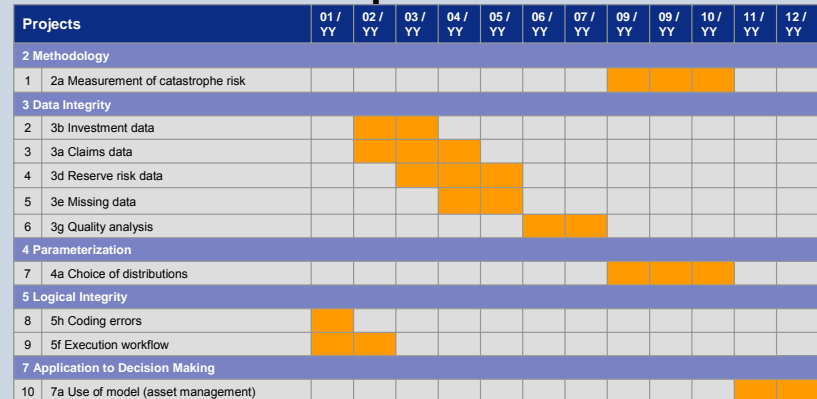


- Remarks**
- Implementation of 5a addresses also 5b-5i. However, as a matter of priority, 5h and 5f must be corrected in the short term
 - Highest urgency issues (highlighted) are considered show stoppers and should be addressed first
 - The top 10 projects are highlighted in blue.
 - In general the prioritization of projects is chosen firstly by high degree of urgency and secondly by low degree of time and effort. Since it is planned to address 5a in the medium plan (see section 3.4), 5c is omitted from the top 10 projects and replaced by 3e.

Observations and Recommendations

Issue	Observation	Recommendation
5d Ergonomics	The structure of the layout of the Excel sheets layouts does not reflect the structure of the formulas in these sheets.	It is recommended to collect all inputs into a few dedicated input sheets
Urgency 3		
Time and effort 2	Input parameters are distributed over 7 workbooks and 28 Excel sheets. They have to be entered manually	It is recommended to colocode the cells according to function, e.g., - all input cells have bold blue font, - all cells used by VBA functions have grey background
5e Transparency	The structure of the layout of the Excel sheets layouts does not reflect the structure of the formulas in these sheets. (see ergonomics)	It is recommended to rectify this in order to make the program easier to maintain.
Urgency 2		
Time and effort 2	There are cell regions where isolated cells do not have a formula analogous to the rest to the region (example)	
5f Execution flow	Some cells contain VBA functions which are not automatically updated (example). This leads to incorrect results.	Cells with VBA functions are not always updated by Excel. It is recommended not to rely on Excel's updating mechanism but instead to write a VBA procedure which controls the calculation flow explicitly.
Urgency 5		
Time and effort 4		

Roadmap and Timetable



Model Validation is designed to deliver...



Comfort in Calculations

- Identify and correct errors in the logic of your models



Understanding of Gaps in Approach

- Assess appropriateness of modeling methodology for achieving objectives



Remove the Black-Box

- Document and explain the operation of internally developed models so that assumptions are transparent to management and key users



Identify Value Opportunities

- Identify opportunities to expand use or functionality of models to create value and improved risk-based decision making ability



Embedding and Enhanced Controls

- Enhanced enterprise-wide close process coordination
- Greater reliance on preventive rather than detective controls
- Corrections of errors moved closer to the "source"
- Clearer definition of roles, responsibilities and segregation of duties
- Documentation of policies and control procedures



Benchmark against Better Practice

- Benchmark your approach against leading industry practice
- Understand where your model's sit and whether that are benefits to upgrading models

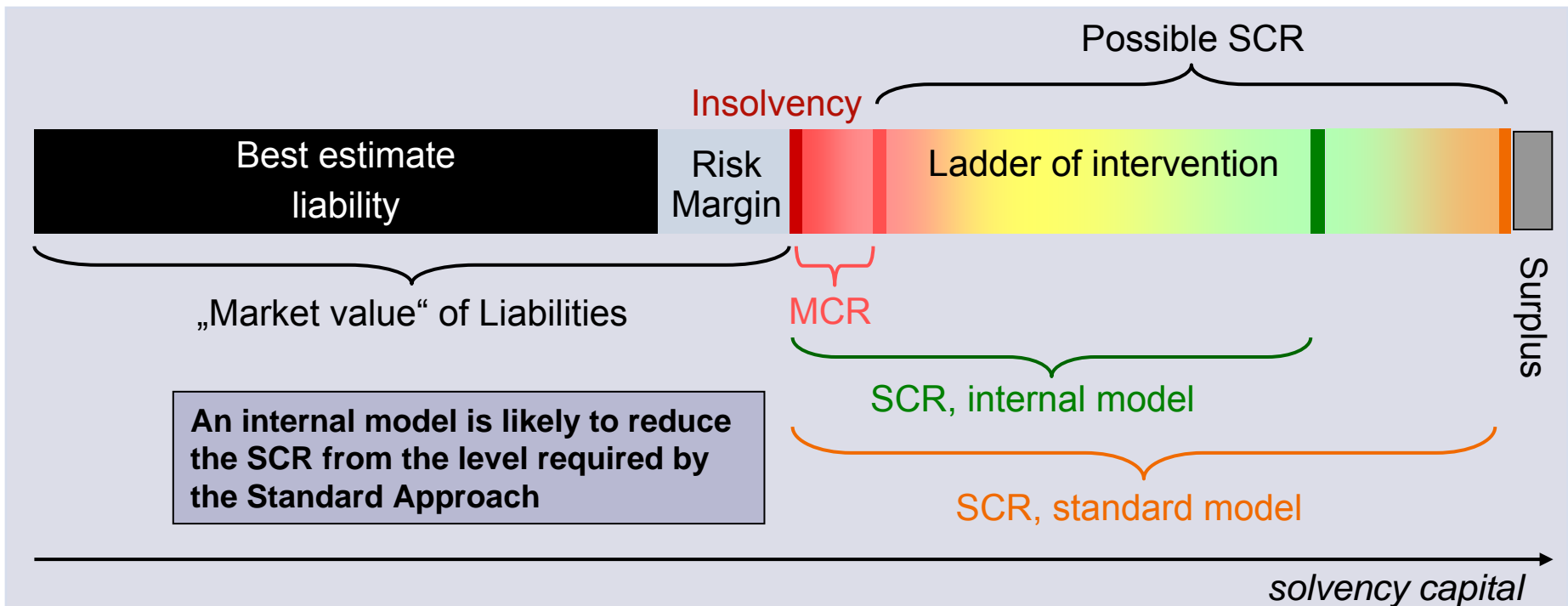
... which may help result in more time for finance to add value to the business

Pillar 1

The major components of the Solvency II framework

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- The technical reserves are the basis of Solvency Capital Requirement (SCR) and Minimum Capital Requirement (MCR)
- Ladder of intervention as available capital falls from SCR towards MCR



Pillar 1

Valuation assumptions of technical provisions

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The risk margin ensures that the overall value of the technical provisions is equivalent to the amount (re)insurance undertakings would expect to have to pay today if it transferred its contractual rights and obligations immediately to another undertaking; or alternatively, the additional cost, above the best estimate, of providing capital to support the (re)insurance obligations over the lifetime of the portfolio

Risk margin

Best Estimate

Separate technical provisions into Hedgeable and Non-Hedgeable components

Hedgeable liabilities

With respect to hedgeable risks – i.e. a risk that can be effectively neutralised by buying or selling financial instruments – the value of technical provisions is **calculated directly, as a whole, and derived using the values of those financial instruments**

Non-Hedgeable liabilities

- **best estimate + risk margin**
- risk margins to be assessed using **cost-of-capital approach**: the cost-of-capital rate used is the same for all undertakings (e.g. fixed percentage) and corresponds to the spread above the risk-free interest rate that a BBB-rated (re)insurance undertaking would be charged to raise eligible own funds

The best estimate corresponds to the **expected present value of future cash flows**, taking into account all the cash in and out flows (**adjusted for inflation**), required to settle the (re)insurance obligations over their lifetime, **including all expenses, future discretionary bonuses, embedded financial guarantees and contractual options**. The calculation of the best estimate is to be based on **sound actuarial techniques** and **good quality** data and **regularly checked against actual experience**

Source: COMMISSION OF THE EUROPEAN COMMUNITIES - Amended Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

Solvency II

Approaches for the SCR

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- **Rough formula**
- **Calibrated on an EU-level**
- **High requirements due to safety margins**
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- **Based on economic capital**
- **Significant lower SCR's possible**
- **Customized to e.g. group's requirements**
- **Should and can be used also for other purposes (e.g. economic decision making)**
- **Three tests are required (Use test, Statistic test, Calibration test)**

QIS4 is presumably close to the final standard model

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Modules of QIS4

- credit risk: located in two separate modules
- additional module "concentration risk"
- non-life premium and reserve risk now in one module
- introduction of a module „Life-CAT" (TailVar 99%)
- positioning of operational risks on the level of the BSCR
- consideration of capital release by "profit sharing" on lower levels of the model
- „Special“: German health insurance
- scenario-based: market risks and insurance-technical risks Life, except „Life Cat“

Source: CEIOPS-CP-09/06, Nov. 2006

Microsoft Excel - QIS3spreadsheetFinal.xls

Frage hier eingeben

Arial Narrow

SAP BW-Reports drucken

100%

	A	B	C	D	E	F	G	H	I	
1	<Undefined participant's name> - [solo]								Millions of euros	2006
2	CEIOPS QIS3 - 20070405								LOB_ML5	Motor, other classes
3										Go to Activity summary
4	Technical provisions according to current basis		Total gross of reinsurance	Total net of reinsurance	Direct business gross	Direct business net	Proportional reins. gross	Proportion reins. net		
5	Provision for unearned premiums		01	0	0					
6	Claims outstanding		02	0	0					
7	Provision for bonuses and rebates		03	0	0					
8	Equalisation provision		05	0	0					
9	Other technical provisions		06	0	0					
10	thereof: provisions for unexpired risk		07	0	0					
11	Total value current bases		08	0	0	0	0	0	0	
12	Deferred acquisition costs		09	0	0					
13										
14	Best estimate value of liabilities		Gross	Net			Current year	Gross premiums	Net premium	
15	Premiums		1.0				Written			
16	Claims		1.1				Earned			
17	1.1.32		1.2	0	0					
18	1.1.32									
19	1.1.32									
20	1.1.32									
21	1.1.32									
22	Historical premium risk standard deviation		net earned premiums	Net loss ratio (%)	(LR_job-μ_job)*	1.3.248 μ_job	ΣP.(LR - μ) ²	N parameter		
23	Accounting year		2.0	0	0,0%	0,0%	0,0%	0,0%		
24	Year -1		2.1		0,0%					
25	Year -2		2.2		0,0%					
26	Year -3		2.3		0,0%					
27	Year -4		2.4		0,0%					
28	Year -5		2.5		0,0%					
29	Year -6		2.6		0,0%					
30	Year -7		2.7		0,0%					
31	Year -8		2.8		0,0%					
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Bereit

General approach

- calibration for each module: 99,5%-VaR
- two-stage approach: "prudent" correlations
- mixture of factor-based and scenario elements

Different capital concepts beyond pure solvency have to be considered to manage businesses efficiently

Available capital (AC):
 “How much capital do I have?”

- Equity-like capital the bank can really use for taking on risks (risk taking capacity)
- Capital which the bank has to earn a fair return on

Economic capital (EC):
 “How much capital do I need?”

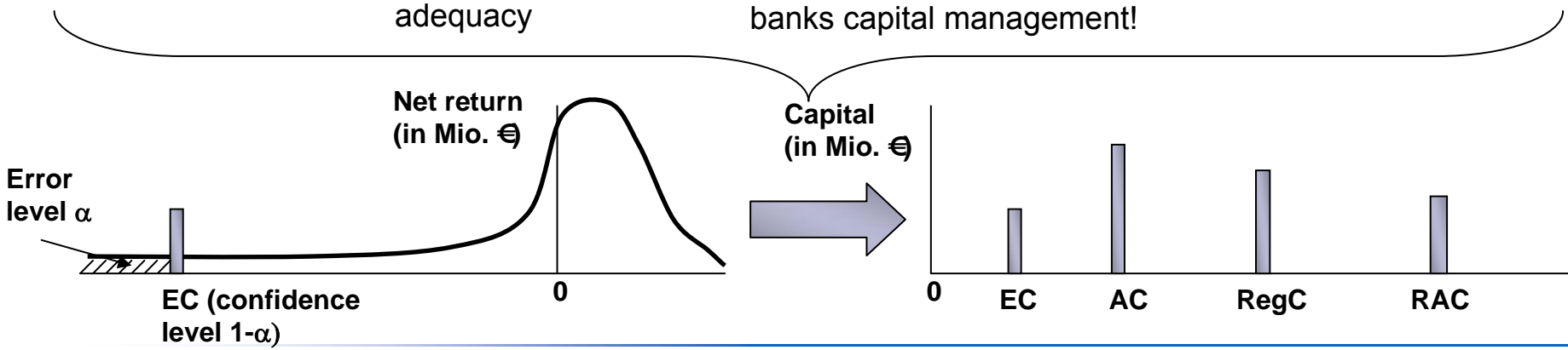
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Regulatory capital (RegC):
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 “How much capital do I need for my target rating?”

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Standard models form the basis for the development of more advanced models

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Client Ambitions

- **Meet regulatory expectations for capital calculations**
- **Meet rating agency modeling expectations**
- **Use of models to inform business decisions**
- **Integrate models into the business process**

Potential Solutions

- **Address concerns of regulators including**
 - modeling of dependencies which are proportional to the size of the loss
 - integration of model output into the management of the business (“Use Test”)
- **Rating agencies may take comfort in an independent external assessment of the model**
- **Identify limitations to the interpretation of model results and identify opportunities for basing decisions on the model.**

... KPMG’s Solvency approach can help insurance companies address their current challenges with modeling

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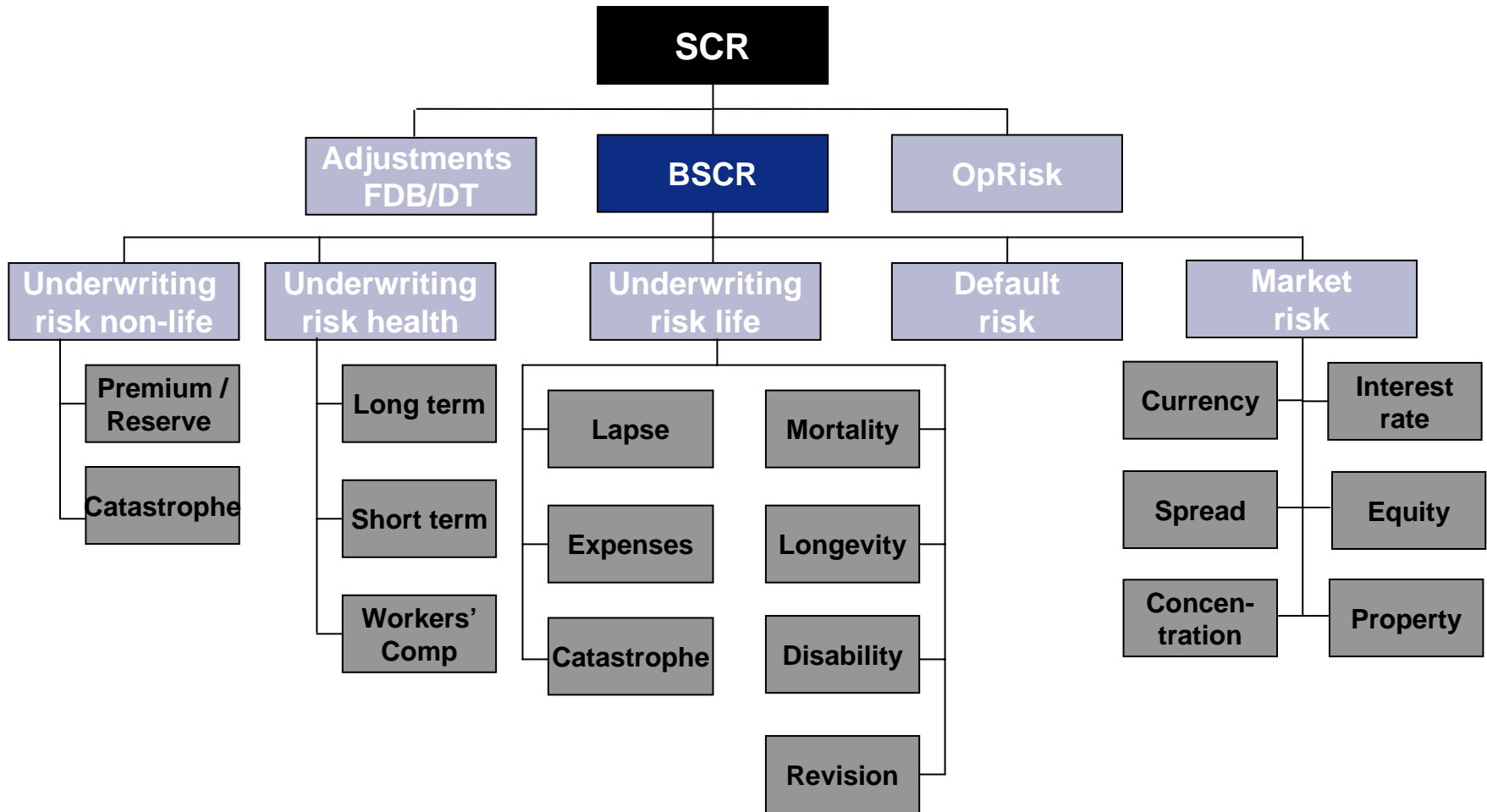
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SCR Standard Formula Structure (QIS 4)



Source: CEIOPS – Technical Specifications of QIS4

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What is credit risk? Definition and components

CREDIT RISK

Credit risk comes from the (unexpected) change of the market value of the portfolio position, caused from adverse movements of credit variables (credit quality of counterparty)

Default is only the extreme event

CREDIT RISK: COMPONENTS

EXPECTED LOSS:

The loss to be expected over the period of a receivable (expected value of the loss distribution)

Expected losses are considered part of doing business and are covered by reserves

UNEXPECTED LOSS

The loss variability (standard deviation) around the expected value of the loss distribution

“Risk” arises from the unexpected nature of the losses: they are to be covered by capital

DIVERSIFICATION

Unexpected loss can be reduced by portfolio diversification

Correlations can exist between one transaction and another or between one portfolio and another

What is credit risk? The expected loss concept

EXPECTED LOSS

Expected loss is calculated by multiplying the probability of default (PD) by the loss given default (LGD) and the exposure at default (EAD). Expected loss can be calculated statistically as the expected value of the loss distribution.

EL

=

PD

x

LGD

x

EAD

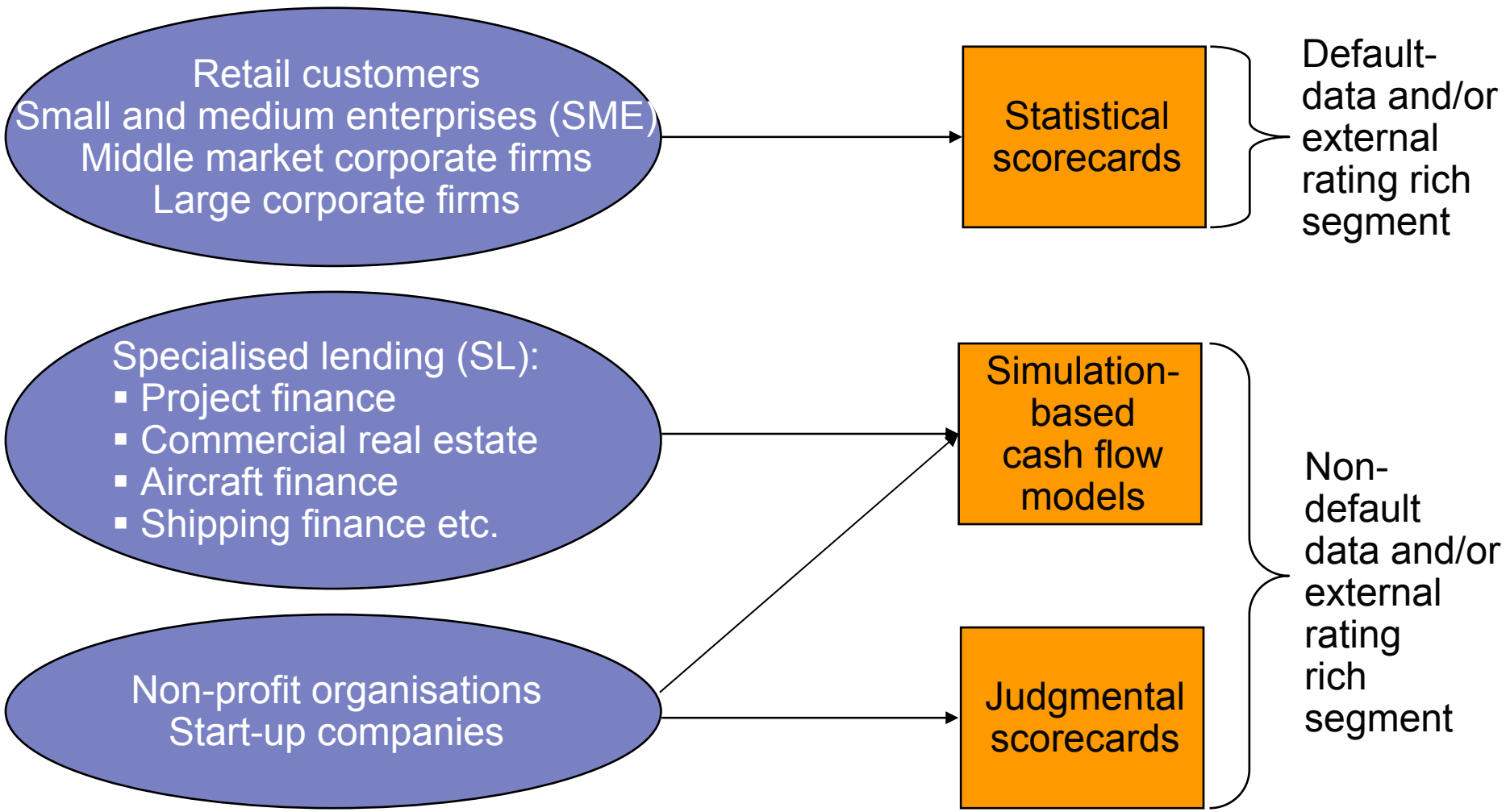
Probability of default (PD): It is a measure of probability that an obligor is not (or only partly) able to repay a claim against him.

Loss given default (LGD): The default rate which quantifies the loss incurred relative to the amount receivable if a debtor defaults. The difference between the amount receivable and the loss given default is also referred to as the recovery rate (RR). $LGD=1-RR$

Exposure at default (EAD): The amount of the receivable at the time when a debtor defaults.

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Measuring PD, LGD and EaD: market best practise

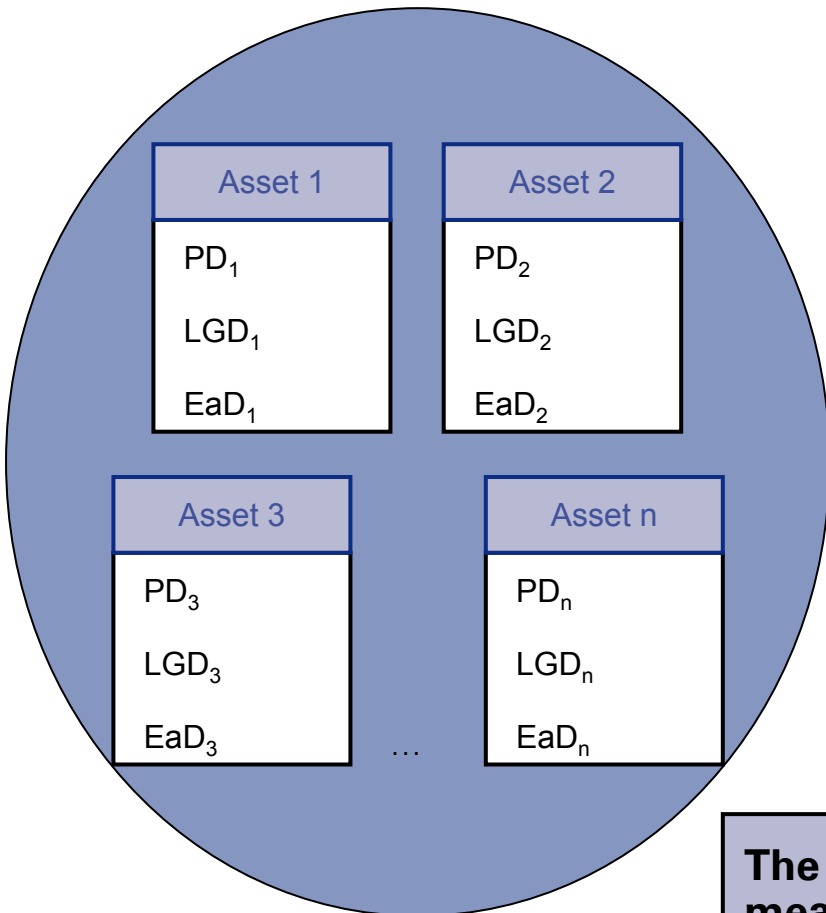


Computing unexpected loss requires a credit portfolio model transforming single credit risks into a portfolio view of credit risk

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Credit Portfolio

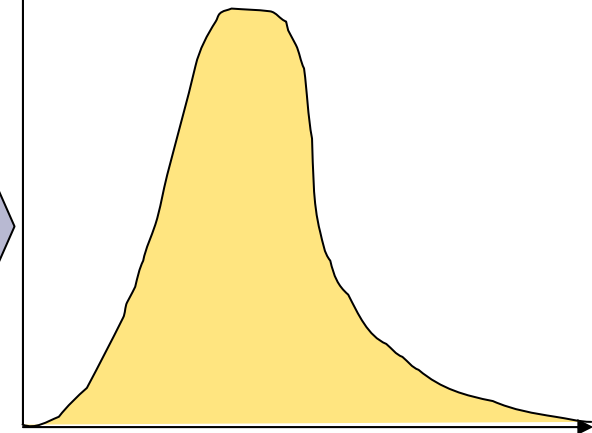
Loss distribution of the credit portfolio



Credit portfolio model incorporating:

- default correlation
- name concentration
- region concentration
- etc.

Loss Amount



Loss Probability

The credit portfolio model is the instrument to measure credit risk diversification on the portfolio!

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What is operational risk?



... the risk of loss resulting from inadequate or failed internal processes, people and systems or from external events.*



* Source: Basel II International Convergence of Capital Measurement and Capital Standards. This definition includes legal risk (e.g. exposure of fine, penalties, punitive damages, private settlements), but excludes strategic and reputational risk

Managing operational risk Market best practice framework

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- **Effective Operational Risk Management requires a comprehensive framework including:**
 - a clear vision
 - an integrated risk management process supported by
 - a consistent risk management methodology and
 - a world-class infrastructure
- **From our experience consideration should be given to:**
 - What activities or components are to be created, enhanced and managed
 - Who should manage these interrelated activities, entity-wide and within the business units
 - How those responsible may go about the process.



What is market risk? Definition and concept

Market risk

Definition

Market risk is the adverse change of market prices or related market risk parameters

Risk classes

- Interest rates
- FX-rates
- Equity and equity index prices
- Credit spreads
- Base metals and commodities
- Correlations
- Volatilities

Price risk

Price risks are potential value changes of held positions which result from unexpected changes of market parameters

Reinvestment risk

Reinvestment risks emerge if coupons cannot be reinvested at the same interest rate which was agreed at inception

Linear risks

- Equity, Bonds, general fixed income
- Swaps, Forwards, Futures
- FX forwards
- Credit default swaps

Non-linear risks

- Options
- Termination rights
- Interest guarantees
- FX- and equity options

What is market risk? VaR to measure market risk

Value-at-Risk (VaR) has clearly become market best practise measuring market risk

Goal

VaR aims at achieving a comprehensive coverage of all loss potentials

Meaning

VaR characterises a loss amount which will not be exceeded with a given likelihood over a given period of time

Strength

- Meaningful aggregation across all risk types possible
- Easy interpretation
- Loss potential directly expressed in monetary units

What is market risk? Three prominent VaR methods



Variance covariance approach

The variance covariance approach uses co-variances of risk factors to approximately compute VaR

Historical simulation

VaR is being computed employing historical scenarios for all relevant market parameters valuing the current market risk portfolio for all of them

Monte-Carlo simulation

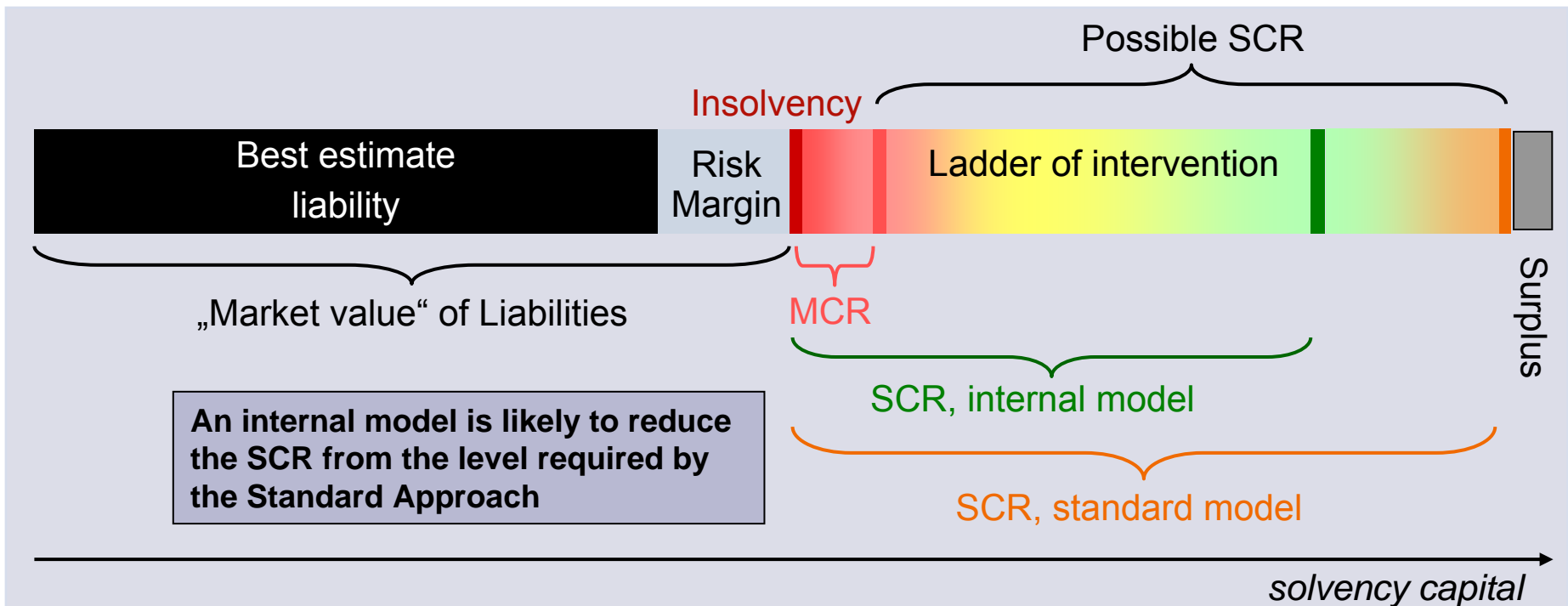
Base principle is identical with historical simulation, but scenarios for market parameters are calculated based on random number generation

Pillar 1

The major components of the Solvency II framework

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- The technical reserves are the basis of Solvency Capital Requirement (SCR) and Minimum Capital Requirement (MCR)
- Ladder of intervention as available capital falls from SCR towards MCR



Pillar 1

Valuation assumptions of technical provisions

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