Internal models in insurance industry- Relevance for India

*****

By

Dr. R. Kannan

Member (Actuary)

Insurance Regulatory and Development Authority, India

Introduction

- Pursuit of more risk oriented prudential supervision and capital requirements
- More risky environment
- New and more complex products
- Rapid development of modeling techniques, data collecting and computing power

Importance of IMs

- A more encompassing treatment of risk

→ All risks are taken into account

→ All interdependencies are taken into account

- Between assets and liabilities
- Loss absorbing capacities of liabilities taken into account
- Between underwritten risks
- Between financial risks of assets

→Diversification benefits are measured and taken into account

- (including Group diversification)

Importance of IMs

- A consistent treatment of risk

→ An integrated approach of risk

- Use of advanced stochastic methodologies
  - ✓ Value-at-Risk
  - ✓ Monte-Carlo simulations, bootstrapping & copulae
- Use of homogeneous parameters
  - ✓ Same interval of confidence
  - ✓ Consistent Value-at-Risk
- Use of consistent data

→A rational approach of risk

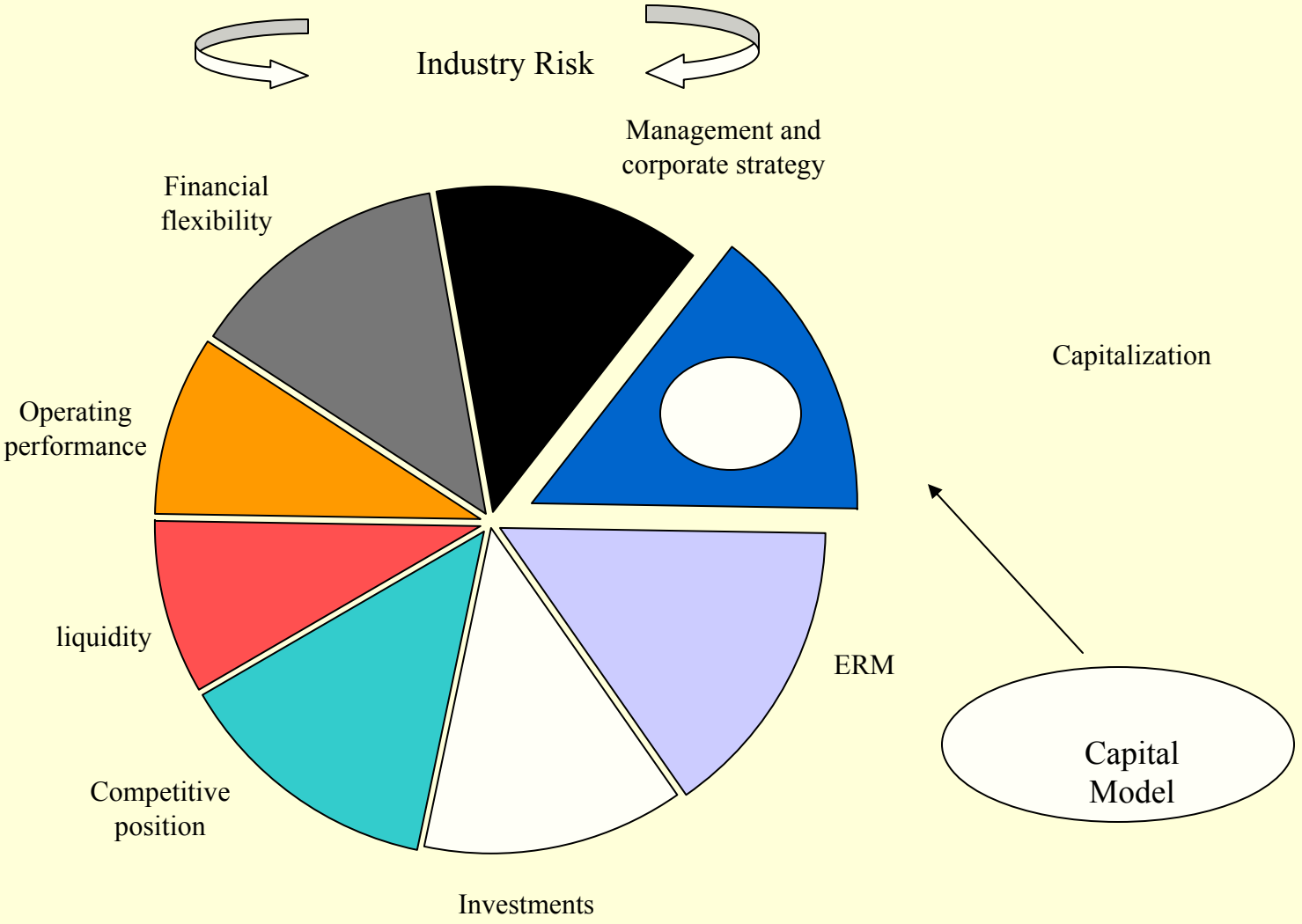
- All available information is included
- All options are taken into account
- An approach fitted to the firm's Specificities

Importance of IMs

- A more efficient mean for controlling risk
  - → Fit well with the requirements for:
    - ➢ Transparency (more accurate information is produced)
    - ➢ Homogeneous level of security
  - → Consistent with regulatory requirements
    - ➢ Risk-based Capital (RBC)
    - ➢ Solvency II
      - ✓ Standard formula
      - ✓ Validated internal models
  - → Consistent with rating agencies approach
    - ➢ Interest in getting internal model results
    - ➢ Interest in developing similar models for rating
  - →A key element of Risk Management

A key element of insurers' Risk Management

Capital Model in Context



Use of IMs

- Investment strategy—ALM
- Profitability analysis
- RBC
- Supervisors rating process
- Risk mitigation approach—RR optimization

What is an Internal Model (IM)?

- Models and methods that recognize directly a company's specific circumstances
- usually stochastic in nature
- each company can construct its own model

The “basic” SA

- Which are the “major” risks?
- What about risks which are not easily quantifiable?
  - The roles of Pillars 2 and 3 shall also be regarded
- Which parameters are defined by regulators and which by the company?
  - How to define the relevant markets and to collect reliable data?
  - How often the parameters should be updated?

simple SA

- Each risk is measured by its standard deviation
- Required capital C for each risk is of the form
- C = kvE, where
  - k = confidence coefficient
  - v = coefficient of variation of the probability distribution of the risk, may take into account the company size
  - E = risk exposure
- Individual C's are combined by usual formulas for variances

Examples of “basic” SA risks, life

- risks related to changes in interest rates and asset volatilities (ALM-risk)
  - The net effect on assets and liabilities is essential
  - Simple techniques based on duration may be sufficient
    - E.g. define asset category dur(B)B – dur(L)L
  - Market (systematic) risk most relevant (IAA WP: A- and B- risks)
- credit risk of bonds
  - IASB accounting not yet available
  - BIS- rules? (expected and unexpected credit losses)
- currency risks
  - Included in ALM-risk?

Example of “basic” SA risks, life

- surrender and lapse risks
- biometric risks (level, trend, volatility, catastrophe)
- operational risk
  - Difficult to quantify; a part of it is reflected in loss ratios etc.
- reinsurance counterparty risk
  - Utilize credit ratings
- concentration risk
  - Limits, deductions
- cost risk
- the correlations between risks shall be taken into account

Example of “basic” SA risks, non-life

- ALM-risks
- credit risks of bonds
- underwriting risk (by lines)
  - Systematic and non-systematic risks
- run-off risk (by lines)
  - A systematic under reserving should not be assumed
- operational risk
- reinsurance counterparty risk
- concentration risk

Who determines parameters: example

- Underwriting risk: $C = k \cdot \mathrm{sqrt}\{\Sigma[a(j)(EX(j)) + b(j)2(EX(j))2 + c(i,j)E(X(i)E(X(j))]\} + \Sigma\alpha(j)(EX(j))$
- Company:
  - EX(j), α(j)
- Regulator:
  - k, a(j), b(j), c(i,j)
- For each market or European wide?
- Data availability

What does an IM contain?

- The most usual risks
  - Insurance risks
  - Asset risks
  - In some cases Asset/Liability mismatch is modeled explicitly
  - Operational risk
- Aggregation of risks
- Group level modeling

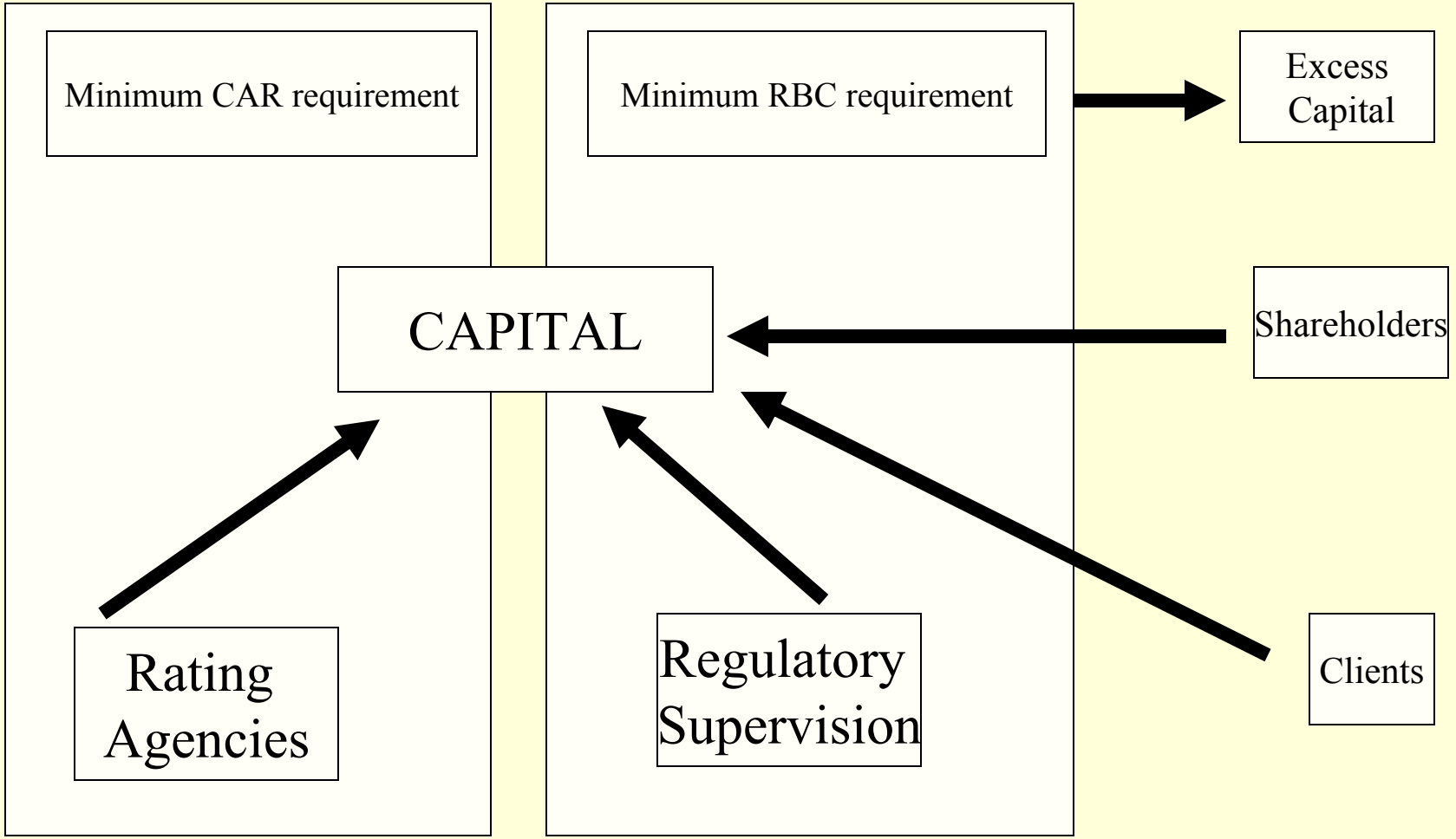
The use of IM's in supervision

- Options
  - Solely in Pillar II
  - Standard model and a limited scope for derogation
  - Standard margin requirement and full derogation
- Confidence level has to be explicitly defined
- Checking and validitation
  - Qualitatitive and quantitative criteria (see Stuart's presentation)
- Relation to "Fair Value – models"
- Who validitates? Supervisor? Auditor? Actuary?

IMs strategic allocation

- Capital at the core of firm's relationship with its environment
  - → With shareholders
    - Competition for capital allocation
    - RoE as key driver
  - → With clients
    - An element of security
    - A determinant of pricing targets (cf. SCOR's Matrix model)
  - → With competitors
    - An area of competition
    - A determinant of market share
  - → With supervisors
    - Public supervisory bodies
    - Rating agencies

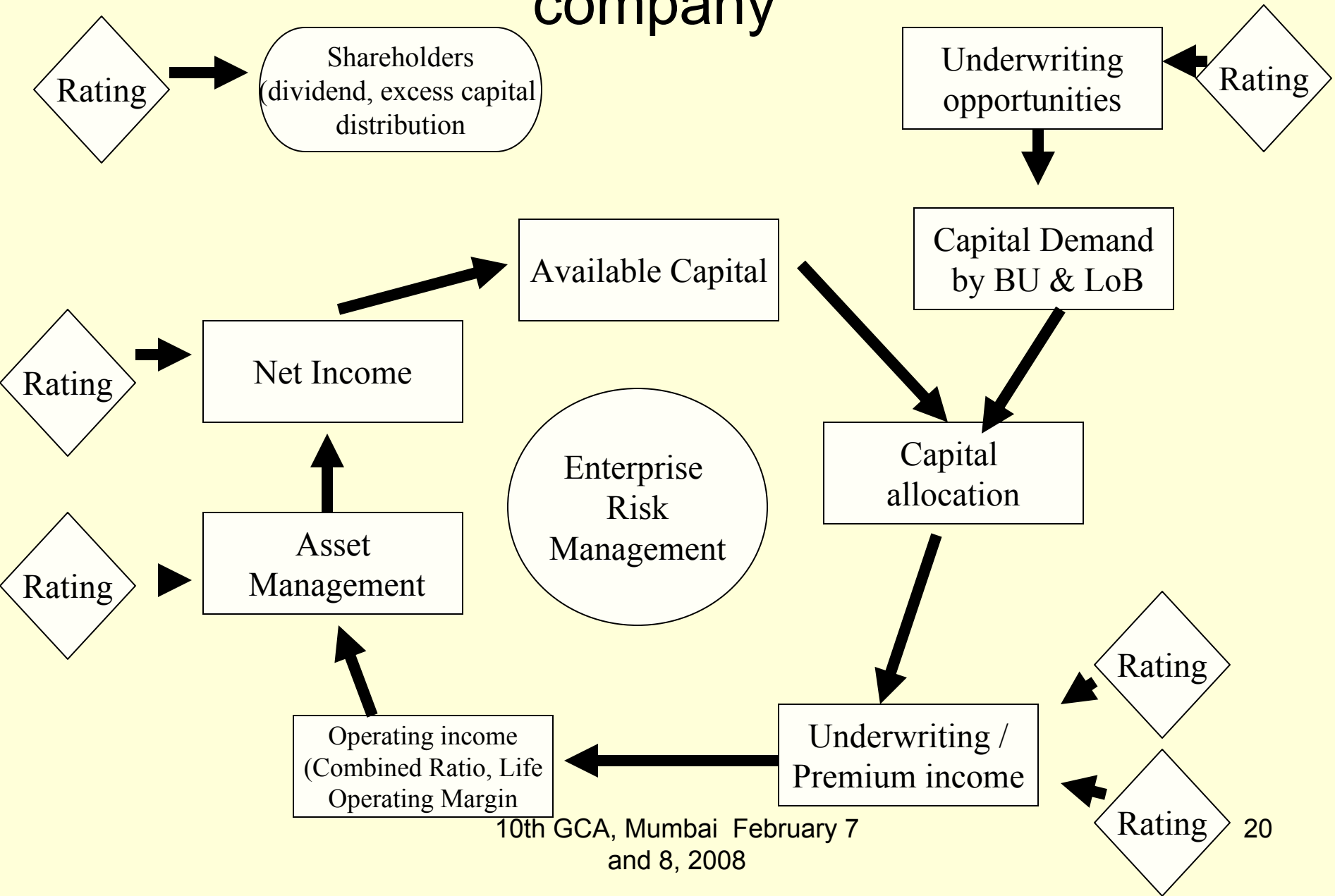
Dealing with a set of constraints on capital



IMs and strategic allocation

- Reinsurance and insurance to be capital driven
  - → Capital allocation to determine underwriting and investment
    - Quantitative underwriting and investment potential
    - Pricing conditions and limits and return requirements
  - → Capital allocation to be based on performances
    - LoBs and geographical profitability and volatility
    - Assets profitability and volatility
  - → Capital base to be protected
    - Shareholders are not reinsurers
    - Capital shield to be defined and implemented
  - → Capital to be remunerated according to company's risk profile
    - IM core for analyzing company risk profile
    - IM core for analyzing company's income potential

The capital cycle of a capital driven company



IMs and strategic allocation

- Reversing the traditional IM problem
  - → Traditional use of IM
    - Defining the existing risk profiles
    - Inducing from these risk profiles the capital requirements
    - Adding these requirements for determining total capital requirement
  - → Strategic use of IM
    - Defining the amount of available capital
    - Inducing from this amount the underwriting potential
    - Sharing out it between LoBs and areas according to their risk profile
  - → A pure optimization problem
    - Searching for the maximum RoE
    - By determining the optimal portfolio of risks
    - Under the constraint of predefined underwriting & asset risk profile

Internal Model serving the internal company's organisation

- IM at the core of ERM
  - → Governance and organisation
    - Implementation of standards of good governance => market
    - Implementation of capital driven principles => IM
  - → Risk identification
    - Identification of risks, emerging and their correlation => IM
    - 4 dimensions: exposure, probability, mitigation, metrics => IM
  - → Risk and capital requirement
    - Risk tolerance level of the company => board + regulation
    - 3 main components: Raroc, pricing model, reserving model => IM
  - → Risk Control
    - Setting consistent limits to exposures for both assets and liabilities
    - Warning systems for emerging markets
    - Encompassing external and internal audit program => IM

Internal Model serving the internal company's organisation

- IM structuring company's management
  - → A question of credibility
    - IM externally acceptable only if key for internal management
    - IM acceptable by supervisors if used by board and management
  - → A question of efficiency
    - Consistency between operational and group capital decision
    - Ex post metrics for group audit and risk control
  - → An instrument for projects' selection
    - Capital cycle => RoE => Criteria for selection of project
    - Excess capital => Returned to shareholder / used for long term project
  - → Source of specific organizational needs
    - Top competences => rise of actuaries inside insurance companies
    - Worldwide integrated IT platforms => external resources ?
    - Industry wide solutions allowing interoperability => external resources

Internal Model to optimize client's relationship

- Increasing client's security

→ IM key for reducing risk of ruin of (re) insurance company

- Typically 0.5% by anticipated supervisory standard (Solvency II)
- Less than 0.5% depending on rating when above single A

→ IM key for credibility of the announced security level

- A better controlled level of security
- A more consistent level of security

→IM key for increasing transparency

- More consistent information produced by use of IM
- More information shared with all stakeholders: shareholders, supervisory bodies and rating agencies
- Incentive to share more information with the market

→IM key for benchmarking by investors

- Standardized actuarial philosophy of IM
- Facilitated by the use of IM built externally

Internal Model serving to optimize reinsurance

- Optimizing cession's and retrocession's strategy & structures

→ Better identification of insurers' reinsurance needs

- Better identification of their pooling capacity of insurers
- Better measure of their risk exposure
- Better ability to trade-off own capital vs. cession

→ Better identification of reinsurers' underwriting potential

- Better identification of their underwriting capacity by reinsurers
- Better ability to optimize the diversification of their portfolio
- Better ability to trade-off own capital vs. retrocession

→ Better equilibrium of reinsurance market

- Market able to clear more quickly thanks to better information
- Cession's and retrocession's solutions to become more accurate
- Terms and conditions to be improved thanks to more transparency

Internal Model serving to optimize reinsurance

- Supplying total balance sheet solutions

→ Solutions based on the concept of risk transfer

- Efficiency of alternative risk transfer instruments
  - ✓ Securitization (cat bonds, longevity bonds, mortality bonds)
  - ✓ Super subordinated debt
- Optimality of combining these instruments with reinsurance
- Reinsurers to supply solutions balancing diversification + dispersion

→ Offering solutions for Solvency II

- Higher Capital requirements for monoliners and SMInsurers
  - ✓ Higher Standard Capital Requirement
  - ✓ Degree of diversification systematically taken into account for non life
- A problem of optimization under constraints (supervisory constraints)
- Reinsurers to offer solutions balancing optimality + constraints meeting

→ Changed relationship with insurers

- Reinsurers to supply more sophisticated solutions

SCR and MCR

- **Pillar 1 needs to recognize the different role of different solvency control levels - the MCR and SCR - and ensure that these are both linked to the risk profile of the insurer**

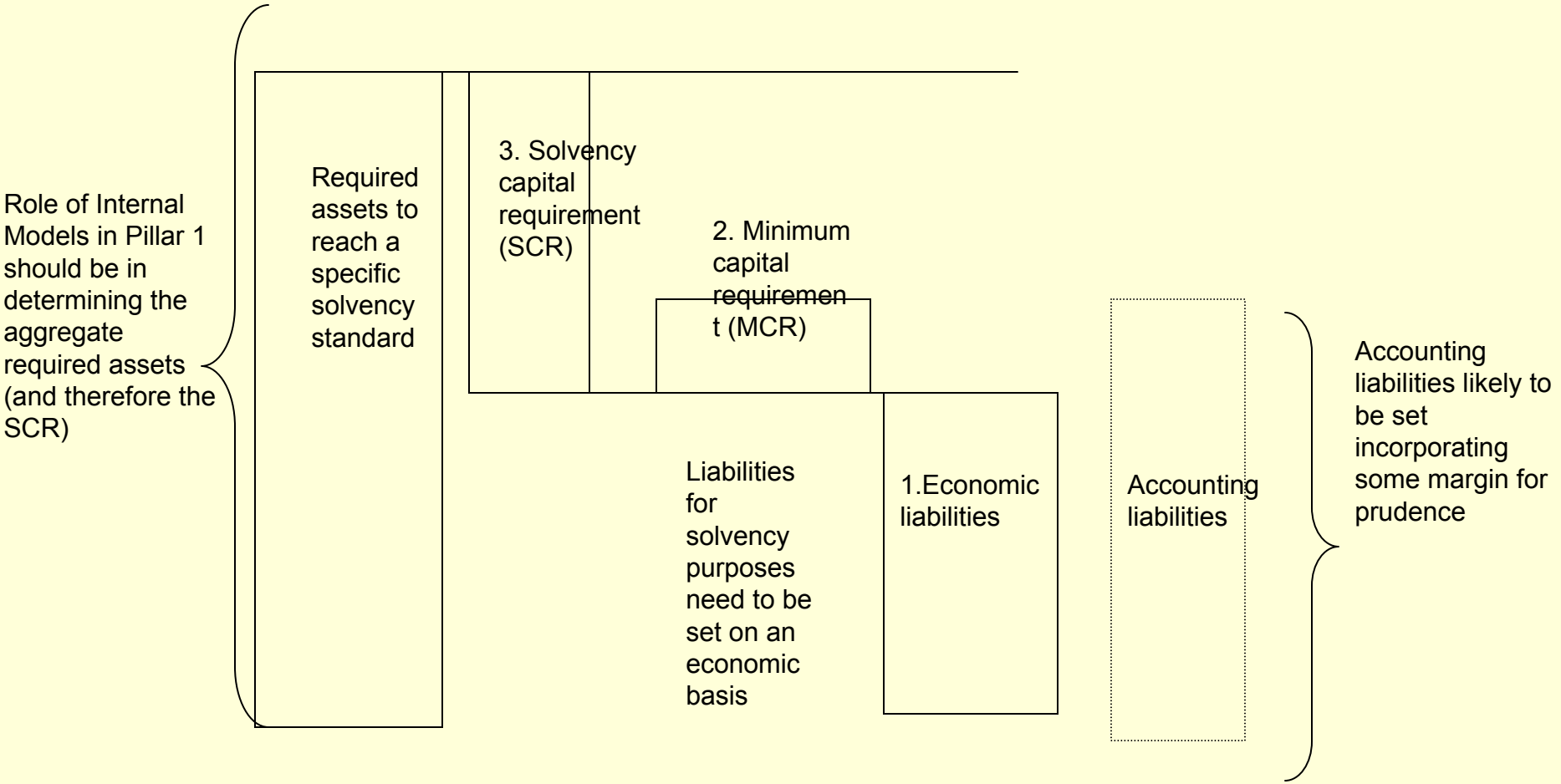
Objective of SCR and MCR

- SCR is a **target** level of solvency – not a minimum
- MCR is a strict **minimum** level of solvency, below which regulatory intervention should occur:

➢ The MCR should define a legal intervention point so that there can be an orderly wind-up of liabilities

➢ The level of the MCR should ensure that there is prudence in the resources available to meet policyholders' claims in the event of a wind-up

SCR AND MCR—ACCOUNTING DIFFERENCE



SCR AND MCR

- SCR, MCR and Reserves
  - The SCR should be able to be calculated using the output from internal models
  - The SCR should be set in order to ensure a target standard likelihood of economic loss to policyholders
  - SCR should be based on the economic value of liabilities and the insurer's risk profile, and should be independent of the accounting liabilities
  - The level at which the MCR is set should not interfere with the operation of the SCR, and should strike a balance between being linked to the economic value of liabilities and the risk profile of the insurer risk in a transparent manner, and allowing for continuous monitoring and the need for a legally certain trigger for intervention.

Admissibility of Internal Models

- **Framework definition ("Output Criteria")**
  - Choice and calibration of risk measure
  - Time horizon
  - Definition of available capital / insolvency
- **Modeling Methodologies ("Design Criteria")**
  - Market risk
  - Credit risk
  - Insurance risk
  - Operational risk
  - Risk aggregation
- **Implementation ("Usage Criteria")**
  - Frequency of calculation and assessment of risk model
  - Documentation, sign-off and review of methodologies and tools
  - Use for decision-making
  - Integrity of data and systems environment
- **"Input Criteria" <u>not</u> addressed in Chief Risk Officer Forum Principles**
  - Appropriate input criteria will depend on the adopted Framework and Methodologies
  - Need to be take into account the heterogeneity of insurance risks and modeling techniques
  - Requires further technical work before appropriate standards can be defined

Three main areas of internal models

- Time horizon
  - One year versus Multi-year
  - Risk modeling time horizon and valuation time horizon
- Definition of available capital / insolvency
  - Definition of insolvency – economic, statutory or other
  - Inclusion of future new business
- Choice and calibration of risk measure
  - VaR versus TailVaR/expected shortfall
  - Calibration approaches

Time horizon – multi-year and one-year time horizons

Description	One year risk horizon	Multi-year risk horizonphilosophy'
Description	Risks modeled over one year, then economic value calculated by projecting all subsequent cash flows over the remaining run-off and discounting-risk measure typically VaR-style loss in economic value	Risks modeled over multiple years, with risk measured over the whole multi-year time horizon (e.g. probability of default over 20 years, expected economic loss to policyholders over entire run-off)
Pros	Simple and transparent Consistent and comparable with most regulatory risk-based 'standard models'	Provides deeper understanding of dynamic path-dependent risk exposures Allows for analysis of inter-temporal aspects, including business cycles, regime changes and management actions
Cons	Fails to accurately reflect time-dependent or path-dependent risk Can be hard to model risks which in practice take several years to emerge (e.g. modeling longevity changes requires one to estimate the adverse change in expectations that might occur over 1 year)	High sensitivity to assumptions and prone to error propagation Larger number of parameters to be estimated and risk factors to be modeled Computationally complex when checking for economic solvency every year during the simulation
Use by insurers Regulatory perspective	9 participants DNB, BPV, FSA, APRS	4 participants (1 with a hybrid view) OSFI (Canda)

Proposed approach for defining for defining calibration of internal models

Multi-year models allowed where these are consistent with the 1-year risk horizon calibration

A strong view that economic, not accounting or cash flow, is the appropriate way to define insolvency and avialble capital

	Economic	Statutory / Accounting	Cash Flow
Definition	Economic value of Assets < Economic value of liabilities	Statutory surplus or accounting not assets value < 0	Assets are not available to support cash outflow
Comments	Measures true ability of insurers to fiancé obligations at current point in time	Arbitrary – leads to capital requirements changing purely due to changes in statutory rules or accounting treatment	Confuses liquidity with solvency, unless modeled over the entire run-off of the business
Usage by insurers	10 participants	3 participants (largely due to current regulatory constraints and all support moving towards an economic view of solvency)	

Regulatory Perspective

DNB, BPV, FSA, APRA, OSFI

Proposed approach

- Where economic value is used, it is defined by all insurers as being “The present value of future cash flows, valued in such a way as to be consistent with current market prices where these are available”, with several implications.
  - All assets should be valued at market value, where market prices are available
  - All liabilities that depend on market returns should be valued based on the arbitrage-free principles of derivative pricing theory
  - All fixed cash flows should be valued using the current term structure of interest rates
- For risks which are **hedge able** no market value margin should be applied

Economic Valuation of Assets and Liabilities

- VaR/Confidence interval
- Widely accepted, especially in banking industry
- Straightforward to calibrate to solvency standard defined by historical data on frequency of default
- can lead to inconsistent results when aggregating across skewed loss distributions (not a coherent risk measure)
- Does not take account of the severity of insolvency
- Sensitivity analysis necessary in order to identify possible stability issues for certain distributions

- TailVaR / ETC
- Consistent in aggregation (a coherent risk measure)
- Accounts for the severity of insolvency, not just the probability of insolvency
- Less widely known outside of industry
- More complex to calibrate to solvency standard defined by historical data

Calibration of risk measures to confidence intervals

- Industry practices
  - 11 participants that use VaR calibrate to confidence intervals that range between 99.6 % and 99.99%Regulatory perspective
  - BPV calibrates to 99% expected shortfall
  - DNB and FSA calibrate standard models to 99.5% confidence intervals
  - APRS – each insurer has to set an entity –specific confidence interval, of at least 99.5%
  - OSFI – for segregated funds, capital required to be held up to CTE (95%)

Principle 2

- Risk Modeling Framework
  - Internal models need to be based on the adverse movement in the Economic Value of (assets-Liabilities), calibrated to an annualised 99.5% probability of solvency
  - Modeling approaches based on longer time horizons or alternative risk measures (e.g. TailVaR) are permissible, provided the calibration approach used can be shown to be consistent with an annualised 0.5% probability of economic insolvency
  - One year's new business should be explicitly modeled, based on assumptions that are consistent with business plans, where this has a material impact on the risk profile of the Group
  - Assets which are not likely to be available in the event of insolvency (for example, profits from future new business, the components of deferred tax assets arising form losses carried forward), should not be included as available capital in the internal model
  - Best estimate liability cash flows should be discounted at swap rates, as they are typically the most liquid, complete and reliable such risk-free rates available –this is more conservative than using a truly economic discount rate that would include an allowance for the credit spread of the insurer itself (or of the counterparty to whom the liabilities would be transferred in the event of insolvency)
- Internal model features to be covered by Pillar 2
  - Insurers need to have a stated risk tolerance, which should be at least as conservative as a 99.5% probability of economic insolvency, and which is used for internal capital allocation and risk management
  - Insurers should also model risk and solvency levels over multiple years taking into account the effects of new business, over at least their business planning horizon, in the form of a risk-based continuity test
  - Further work is needed concerning regulatory action around the target SCR, particularly bearing in mind the need to avoid amplifying cyclical effects.

Market Risks

- All insurers model and measure market risk, typically including risks from all financial instruments / indices:
  - Interest rates (the entire yield) – where cash flow matching is carried out insurers typically model the entire yield curve (10 participants) e.g through key rate interest rates
  - Equities
  - Real estate indices
  - FX rates Etc.
- However approaches for modeling market risks (scenarios, analytical approaches, simulation) vary across companies and lines of business
  - For markets / businesses where optionality is significant, simulation approaches typically used (occasionally scenario or analytical approaches), otherwise analytical approaches more prevalent
- Liquidity risk – Liquidity risk only measured quantitatively within the risk model by 3 participants, others use qualitative approaches within a broader liquidity management framework
- Dependencies between market risks modeled explicitly
  - Where simulation modeling is widely used, this is increasingly through consistent, global Economic Scenario Generators (ESGs)
  - But variance / covariance approaches are still used for some businesses where ESGs not available
- FX risk
  - Most institutions distinguish between FX mismatch risk, where there are differences in the currencies of assets and liabilities / supporting capital, and FX translation risk, which arises in Groups where the currency of both assets and liabilities / supporting capital in a local entity is different to the base reporting currency of the Group
  - FX mismatch risk is modelled for risk-based capital purposes – for Groups, this modeling needs to be at a Group level if there is excess capital held in one currency in one part of a group that is effectively supporting risks in another currency taken elsewhere within the same Group
  - FX translation risk is typically not modeled for risk-based capital purposes, as the solvency of an insurer is independent of the currency in which it reports its financial results (this is a pure shareholder risk, not a solvency risk)

Industry practices

- **Embedded options and guarantees**
  - 9 participants assess these risks explicitly, typically through simulation modelling / scenario modelling (similar to models used by banks), and the other participants developing models towards capturing these risks
  - Participating business modelled explicitly, with profit sharing rules either linked to internal management rules, or to external indices
- **Management behaviour**
  - 8 participants explicitly model management actions, for example by linking bonus rates and asset mix to level of solvency within the simulation
  - 5 participants do not currently have quantitative rules for management actions, but 3 of them are investigating this
- **Policyholder behaviour**
  - 7 participants explicitly link policyholder behaviour (e.g. lapses) to market movements (e.g. interest rates)
  - 5 participants use static best estimate assumptions for policyholder behaviour

Regulatory perspective

- **FSA –** parallel yield curve shifts in standard approach, but embedded options, management and policyholder behaviour expected to be dynamically modelled in simulation-based valuation of liabilities for participating life products
- **BPV** – use of 23 market risk factors, including granular term structure, and dynamic modelling of lapses
- **NAIC –** impact of specific interest scenarios (e.g. “New York 7”) required to be tested in certain states, with additional scenarios required if interest rate risk is significant (>40% of RBC)

Market risk

- **All sources of market risk need to be modelled probabilistically with inter-factor dependencies explicitly modeled**

- **– Choice of modelling approach (simulation-based or analytical) and granularity of modelling needs to be proportionate to the risks / businesses being modelled. For example:**
  - **Interest rates – Cash flow matching taken account of by modelling of the whole yield curve**
  - **FX mismatch risk – Currency mismatches between assets and liabilities / supporting capital explicitly modeled**
  - **Equity risk – Equity risk modelled based on analysis of the relevant market index – where concentration in individual sectors / individual stocks differs from the index, such concentrations should be explicitly modeled**
  - **Real estate risk – Real Estate risk modelled based on analysis of the relevant property market index, or reasonable proxies if such an index is unavailable – where concentration in individual sectors / individual stocks differs from the index, such concentrations should be explicitly modeled**
  - **Derivatives / market risk mitigation – Explicit modelling through simulation / scenarios, with counterparty credit risk also being measured**

Internal Model features to be covered by Pillar 2

- **Market risks not included in Pillar 1 need to be actively measured and controlled**
  - **Liquidity risk is not part of Pillar 1, but should be measured and controlled as part of Pillar 2 supervisory review**
  - **FX risks arising from translation to a base currency are not part of Pillar 1 since it is not a solvency risk, and should be measured and managed as part of Pillar 2 insofar as they represent a risk to shareholders (including dividend payments for example)**
- **Management and control of market / ALM risk needs to be consistent with the assumptions and philosophy behind the internal risk model**
  - **The cost of guarantees and options needs to be evaluated using internal risk models during product development and pricing, and subsequently over the lifetime of the contracts**
  - **Market / ALM risk reports need to be produced using the internal risk model on a regular basis, of at least a frequency that enables risk mitigation action to be taken**
  - **Actual ex-post management actions need to be consistent with the codified management actions that are assumed to take place in the internal risk model**
- **Regular stress-testing and back-testing of internal models and their calibration should be carried out**

Credit Risk

- **All sources of credit risk need to be modelled, or demonstrated to be insignificant**
  - **Investments**
  - **Reinsurance / derivative counterparty failure**
  - **Credit insurance**
  - **Trade creditors, debtors**
- **All different manifestations of credit risk should be modeled**
  - **Default risk**
  - **Migration risk**
  - **Spread risk**
- **Credit insurance should be modelled using methodologies that reflect the specific exposure characteristics and risk mitigation options inherent in the business**
- **If credit exposures can be accurately represented by external credit indices (e.g. Euro 'A' corporate bond index) and credit concentrations are not material relative to the relevant index, then default risk, migration risk and spread risk can be modelled on integrated basis through direct modelling of the index (e.g. through an Economic Scenario Generator)**
- **If representative credit indices are not available, or credit concentrations are material, then default and migration risk need to be modelled explicitly in a manner aligned with the principles of Basel II**
  - **Individual credit exposures rated, with ratings calibrated**
  - **Each exposure assigned an expected probability of default, an exposure and an expected Loss Severity**
  - **Credit risk concentrations captured through the use of portfolio models such as Moody's KMV or CreditMetrics**
  - **Spread risk captured separately based on historical volatility in spreads of similarly-rated instruments (e.g. bonds)**

Insurance Risk

- **Insurance Risk**
  - **For Life / Health insurance, mortality, morbidity and persistency risk should all be measured, ensuring that parameter, process and calamity risks are all covered by the modeling**
  - **For Non-Life insurance, the risk associated with current year underwriting (premium risk) and prior years' underwriting (reserve risk) should both be measured (either in an integrated model, or separately), again ensuring that parameter, process and calamity / catastrophe risks are all covered by the modeling**

Insurance risk

- **For both Life / Health and Non-Life insurance, process, catastrophe / calamity and parameter risk should be measured using either scenario or probabilistic approaches**
  - **Process (or volatility) risk, the risk associated with the anticipated year-to-year volatility in insurance result, should be measured probabilistically, supported by scenario analysis where appropriate**
  - **Separate estimation of calamity / catastrophe risk should be carried out using scenarios / probability distributions based on scientific analysis and expert opinion**
  - **Parameter risk – if significant, level and trend risk should be measured separately based on a combination of scientific analysis, expert opinion and analysis of historical experience**

Insurance risk

- **Reinsurance / risk transfer**
  - **Proportional reinsurance can be modelled consistently with the approach used for modelling the gross losses**
  - **For additional credit to be given for non-proportional reinsurance, scenario or probabilistic approaches must be used**
  - **Capital must be held to cover the risk of counterparty failure, taking into account possible dependencies between the size of gross losses occurring and counterparty failure**

Chief Risk Officer Forum Principle 3.4

- **Operational Risk**
  - **Operational risk needs to be explicitly accounted for under Pillar 1, in a manner aligned with the principles of the Basel II approach**
  - **A standardised charge for operational risk is acceptable, similar to the Basic Indicator Approach and Standardised Approach of Basel II – however, further research needs to be done to establish the level of the charge and the metric that it should apply to (e.g. net income, assets, SCR excluding Operational Risk, premiums, economic value of liabilities, etc.), in order to ensure that it is consistent with a annualised 0.5% probability of insolvency**
  - **Advanced Measurement Approaches (AMA) based on insurers' own internal models should be allowable as substitutes for standardised charges, subject to criteria consistent with those adopted by Basel II for determining the acceptability of AMA for determining operational risk capital requirements for banks**
- **Internal model features to be covered by Pillar 2**
  - **Operational risks need to be identified, classified, quantified, reported and controlled, using both qualitative and**
  - **quantitative approaches, in a manner consistent with the principles of the Basel II Pillar 2 requirements**

Four issues in assessing risk aggregation

1, Aggregation methodology

- **Industry practices – a variety of tools used depending on the level of granularity and the risk**
  - **Dependency between financial risks – typically measured explicitly using either integrated stochastic economic scenario generators, or through using explicit correlation matrices**
  - **Dependency between specific catastrophe events – typically measured through stochastic modelling taking account of geographical reach of such events, with convolution between independent events**
  - **Across different risks – a mixture of approaches – 6 participants use simulation to generate an aggregate distribution at group level, 6 participants use Var/Covar approaches to aggregate standalone risk measures**

Four issues in assessing risk aggregation

2, Regulatory perspective

- **BPV – Var/Covar approach used to aggregate standalone risk positions, supplemented with tail scenarios**
- **DNB – Standard model implicitly uses Var/Covar approach with standard correlation assumptions**
- **FSA – inter-risk correlation implicitly accounted for by choice of scenarios**

- **Setting of risk dependency assumptions – mixture of stressed correlations and copulas in use, with tail dependencies set by a combination of expert opinion and empirical analysis**
  - **Correlations in partial use by all participants**
  - **Copulas in partial use by 6 participants**

Four issues in assessing risk aggregation

3. Allocation / attribution methodology
- **8 participants explicitly allocate out diversification benefits either on marginal or proportional basis**
- **5 participants do not explicitly allocate diversification benefits to individual units, but implicitly incorporate it into target setting and performance measurement**

4. Treatment of Intra-Group issues addressed through the separate report from the Chief Risk Officer Forum – "A Framework for Incorporating Diversification in the Solvency Assessment of Insurers"

Operational Risk

- **Operational Risk**
  - **Operational risk needs to be explicitly accounted for under Pillar 1, in a manner aligned with the principles of the Basel II approach**
  - **A standardised charge for operational risk is acceptable, similar to the Basic Indicator Approach and Standardised Approach of Basel II – however, further research needs to be done to establish the level of the charge and the metric that it should apply to (e.g. net income, assets, SCR excluding Operational Risk, premiums, economic value of liabilities, etc.), in order to ensure that it is consistent with a annualised 0.5% probability of insolvency**

Operation risk

- **Internal model features to be covered by Pillar 2**
  - **Operational risks need to be identified, classified, quantified, reported and controlled, using both qualitative and**
  - **quantitative approaches, in a manner consistent with the principles of the Basel II Pillar 2 requirements**

IMs--issues

- Don’t always cover the group’s entire business
- Some risks may be occasionally neglected
- Lack of sufficient data
- Some subjectivity (e.g. the choice of the probability distribution)
- Trade off between the refinement of the model and IT constraints
- Maintaining and developing the IM

IMs--issues

- Technical limits
  - → Data reliability often insufficient
    - Too short experience for most existing portfolios
    - Stochastic simulations used for generating substitutes data
  - → Experience of extreme events limited
    - Most statistical knowledge focused on the core of the distribution
    - Increase in risk interdependencies in extreme cases difficult to calibrate
  - →Still no sufficient care for dynamic interdependencies
    - For intertemporal pooling effects (because of a one year horizon)
    - For causality beyond traditional correlations ("Granger causality")
    - SCOR's models among the few models taking causality into account
  - →Still high model and parameter risk
    - Because of joint modeling of many factors
    - Because of incorporation of details that cannot be reasonably

IMs--issues

- A static approach to risk
  - → An approach too often accounting driven
    - Too much care given to imitation of accounting & to accounting details
    - SCOR models among the few investigating economics of value creation
  - → A strategic view of risk, which is circumscribed
    - Main focus on minimization of current risks
    - Dynamic dimension of diversification effects not taken into account
    - Changing environment and moving competition not considered at all
  - → No account for the Bayesian part of risk
    - No account for managerial flexibility & firm reaction
    - A complex problem of optimization
    - Key to understand competition and its risks

IMs--issues

- An instrument that can be improved
  - → Technical improvements
    - Incorporate managerial flexibility into strategy modeling
    - Improve the modeling of dependence and extremes in risk factors
    - Learn to deal with uncertainty beyond statistical tractability
    - Analyze simulation results beyond empirical moments & quartiles
    - Target a “flight simulator for management” but not an “auto-pilot”
  - → Organizational improvements
    - Models = a main but not exclusive input for the more complex ERM / governance process of the (re) insurance company
    - Strategic Plan all the more important for incorporating intertemporal effects and dynamic dimensions of diversification in models
    - Users to understand intrinsic limitation of the instrument

Thank you