

Benchmarking Study of Internal Models

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Carried out on behalf of The Chief Risk Officer Forum

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Preface

This benchmarking study was initiated in late 2004 by the CRO Forum, which includes 13 major European insurance companies and financial conglomerates. The study provides a qualitative benchmark towards Solvency II for the insurance regulators to assess internal models. It should foster the discussion about the application of internal risk capital models for legal solvency purposes.

Organizational support was provided by a core team (Allianz, AXA, SwissRe), while we, Damir Filipovic (Chair for Financial and Insurance Mathematics at the University of Munich) and Daniel Rost (Assistant Professor) were responsible for the set-up and the evaluation of a questionnaire that was sent out to the member companies in January 2005. We received the fully completed answers from 12 companies and one partially filled out questionnaire. In addition, the Swiss Federal Office of Private Insurance (BPV), De Nederlandsche Bank (DNB) and the German Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin) contributed their answers where appropriate regarding their views on internal and their regulatory standard models – the Swiss Solvency Test (SST) and the Financial Assessment Framework (Financieel toetsingskader/FTK).

We met with representatives of all 13 participating risk management groups. During these interviews we obtained numerous useful and constructive comments. We would like to thank to all those individuals who have provided support and input on this report.

Damir Filipovic and Daniel Rost, University of Munich, April 2005

1 Introduction

This study shall provide a benchmark and guidelines towards Solvency II for the insurance regulators to assess internal models. The results of the study are a contribution of the CRO Forum to the Solvency II project. It should foster the discussion about the application of internal risk capital models for legal solvency – both Pillar 1 and 2 – purposes.

The CRO Forum delegated to us the duty to carry through and deliver a study with the following terms of reference:

- Take inventory of the risk measurement frameworks used by the CRO Forum member companies
- Evaluate strengths and weaknesses of various frameworks and compare them with the standard solvency models developed by the Swiss and Dutch insurance regulators
- Provide a common denominator of the analysed internal risk models (“minimum standards”)
- Propose a summary of principles supported by the CRO Forum member companies
- Develop a glossary of common terminology

The scope is on internal group capital adequacy. Other aspects, such as performance measurement or compliance with rating agency demands, may require different concepts of value and risk. The focus is on integrated internal models of the group, where group refers to the top level of the companies. This could be a conglomerate of different financial sectors or a stand alone life insurance business. All other levels are referred to as sub-units; this includes business, legal or other entities.

The main part of this report anonymizes and summarizes the comments and answers to the questionnaire from the participating companies (we received one partially and 12 fully completed questionnaires). In addition, the Swiss Federal Office of Private Insurance (BPV), De Nederlandsche Bank (DNB) and the German Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin) contributed their answers where appropriate regarding their views on internal and their regulatory standard models – the Swiss Solvency Test (SST) and the Financial Assessment Framework (Financieel toetsingskader/FTK). These are essentially quoted as original text where applicable. So are excerpts from the report by the Insurer Solvency Assessment Working Party of the International Actuarial Association (IAA) where appropriate.

This report is organized as follows

- Section 3 – “Participating institutions” summarizes the business activities, areas of application of internal models and risk profiles of the participants.
- Section 4 – “Internal models” places the analysed internal models in the landscape of regulatory and industrial standards; describes future developments and the major obstacles in development and use of internal models; and provides a summary of proposals supported by the participants for the admissibility of internal models.
- Section 5 – “Glossary” provides a glossary of common terminology
- Section 6 – “Capital adequacy” reviews the high level concepts for risk tolerance, solvency, available and required risk capital

- Section 7 – “Valuation of assets and liabilities” describes the valuation principles for assets and liabilities
- Section 8 – “Modelling of risk variables and dependencies” describes the modelling principles for the major risk types; and provides a risk model classification
- Section 9 – “Aggregation and diversification” analyses the diversification effects in the aggregation of risks and points out some difficulties (fungibility) and pitfalls
- Section 10 – “Risk measurement” classifies the risk measurement methods; and describes their mathematical implementation
- Section 11 – “Risk steering and capital allocation” reviews the structures and methods for the allocation of risk capital and risk taking capacities
- Section 12 – “Model implementation and infrastructure” provides a survey of model assessment, processes, tools and data management

2 Executive Summary

This study has been prepared for the Chief Risk Officer (CRO) Forum to contribute to the Solvency II project. It provides a qualitative benchmark and guidelines towards Solvency II – both Pillar 1 and 2 – for the insurance regulators to assess internal models.

To foster the discussion about the application of internal risk capital models for legal solvency purposes, this study evaluates the risk measurement frameworks used by the CRO Forum member companies and compares them with the solvency model proposals of the International Actuarial Association (IAA), and the Swiss, Dutch and German insurance regulators.

To start with, there is a variety of methods in use. There exists currently no fully consistent common denominator of the analysed frameworks. This is, on one hand, caused by the lack of standards and also by the different actuarial traditions in the European countries. On the other hand, this is – at least partially – due to the fact that some components of the internal models were originally designed by different external consultants. As a result, this report does not primarily provide minimum standards but rather a characterization and classification of the various methodologies. It evaluates the strengths and weaknesses of the analyzed frameworks and proposes a summary of principles supported by the CRO Forum member companies for the admissibility of internal models.

This classification of methodologies comprises:

- Capital adequacy:
 - Solvency point of view: economic, regulatory, rating agency
 - Level point of view: group vs. sub-unit
 - Capital point of view: policyholder vs. shareholder
- Liability valuation: statutory vs. market consistent
- Risk modelling: scenario based, static factor model, covariance model, stochastic factor model
- Scenario definitions: event/hypothesis, deterministic projection, randomly generated sample path, sensitivity or stress test
- Risk measurement
 - Time horizon: one-year vs. multi-year
 - Risk measure: VaR, TailVaR, target ruin probability
 - Aggregation: risk numbers vs. overall P&L distribution

The main problem regarding consistency with Solvency II is the conflict of structures: legal entities vs. business units. For an internal model to be truly embedded in the management process, the Solvency II regime should allow for reflection of management structures. This requires a clear definition and standardization of the notion of contingent capital to account for diversification effects between subsidiaries and group level.

Participating institutions (Section 3)

The participants of this study can be characterized as worldwide operating (re-)insurance companies, partly financial conglomerates, with a broad range of business activities and heterogeneous business profiles.

When breaking down the use of the integrated internal models to the different areas of application, the core observations are:

- A high degree of (partial) usage of internal models especially in the typical “risk businesses”, like risk steering, asset liability management, allocation of capital and risk taking activities (degree of application higher than 75%.)
- Internal models are becoming an operational management tool, notably for underwriting policies, performance measurement, and management compensation. However, the degree of usage for management compensation is still rather low.

All participants employ a hierarchical structure with sub-units on legal, country, and/or lines of business basis leading to important and acknowledged differences between risk profiles at group and sub-unit levels. We recommend that special attention is given to

- systematic risks which emanate at group level from the aggregation of relatively non-material risks at sub-unit level (e.g. pandemics);
- additional regulatory risks at group level where fungibility aspects have to be taken into account.

Internal models (Section 4)

Internal models are expected to reflect each company’s individual risk exposures more appropriately than just applying standardised rules driven by jurisdiction or regulators.

The impact of certain external model providers cannot be ignored. However, most internal models meet the overall objectives of the IAA proposed solvency assessment principles. The major differences to the IAA proposals concern

- confidence level;
- aggregation method (copulas proposed by the IAA not prevalent);
- risk measure (VaR is predominant);
- capital point of view (a few participants base their model on a shareholder point of view);
- concept of default and solvency (statutory instead of market consistent liability values used by some participants).

Moreover, some local models – used in sub-units – are related to industry (Moody’s, S&P’s) or statutory standards (e.g. US RBC).

An integrated internal model comprises methodology, parameters, tools and processes. The main obstacles in developing and using the internal model and its flexibility towards Solvency II lie on the process side, e.g.

- human resources (inflexible structures, the lack of cooperation, insight, skill and knowledge are source of delay, errors and mismanagement);
- data problems (data quality, reliability and availability in connection with tough timelines, lack of data underlying estimation, efficient storage).

Moreover, changing the technical and process implementation of the model might be a huge, material, and costly task, since many sub-units are involved.

There is a trade-off between flexibility towards developments and adjustments to future requirements and “user friendliness” of internal models. When it comes to the individual assessment of separate risk types, business lines and legal entities, essentially all participants believe in the modularity and flexibility of their internal models. At least 1/4 of the participants revealed their intention for their internal models to replace the future regulatory standard approach entirely.

Preferably the internal model is fully stochastic based, generating an overall P&L distribution (stochastic factor model). On the other hand, it can be expected that a modular approach aggregating single risk numbers will be the core of a future Solvency II standard assessment. It is therefore recommended that:

- The internal model is kept flexible enough to assess separate risk types, business lines and legal entities individually.
- The regulators should, however, allow internal models to replace the future regulatory standardized approach entirely (especially when the company has already implemented a stochastic factor model).
- The risk assessment should be flexible towards the time horizon; there is no ultimate preference of one-year to multi-year models (indeed, about 1/3 of the participants have currently implemented or plan to implement a multi-year risk assessment model). However, for sake of comparability every model should be calibratable to an annual confidence level (taking into account an appropriate risk margin for the liabilities).

The participants are ready to meet Solvency II requirements including public disclosure of methodology and assumptions if the regulations allow for flexibility, showing “business sense” and do not lead to rising capital requirements. Here is a selection of principles supported by the participants for the admissibility of internal models extending the IAA proposals:

- Usage of internal model as a truly embedded management tool
- Internal models based on realistic economic factors and assumptions
- Detailed documentation to include implementation and development, deviation from the regulatory standard model, impact of reinsurance and diversification, etc.
- Minimum list of business and risks to be assessed (no cherry picking of low capital business units)
- Minimum standards for calibration, parameter selection, stress testing, diversification (including fungibility)
- Capital adequacy at group level, allowing for diversification mitigation
- Public disclosure of methodology and assumptions
- Clear definitions concerning the time horizon
- Internal model is more than just stressing the balance sheet – new business must not jeopardize the sufficiency of current assets
- Criteria from the banking sector should be reflected and revised for admissibility for insurance models
- Regular assessments and continuous development of internal models; clear processes for approval of model changes
- One lead regulator co-ordinating with other regulatory bodies.

Capital adequacy (Section 6)

Essentially all participants agree that the economic view of the world provides the most accurate picture of the risk profile and capital adequacy. However, it is also recognised that in a realistic model there are regulatory and rating agency constraints to be met.

The assessment of capital adequacy depends on the solvency (economic, regulatory, rating agency), level (group, sub-unit), and capital (policyholder, shareholder) point of view.

Currently, there are various perspectives in use, which is due to the different accounting systems and the complexity inherent in determining the capital structure. We recommend that

for comparability of the capital adequacy between the companies, further effort is invested to achieve consistency between the internal methodologies and concepts.

Valuation of assets and liabilities (Section 7)

It is understood that those assets and liabilities are considered for capital adequacy assessment which are material from an economic point of view, and are expected to give rise to or to influence future cash flows from an economic point of view.

Throughout the companies, assets are valued on a market consistent basis. That is, assets are marked to market if a market value is available and otherwise marked to model.

As for the valuation of liabilities there is currently no industry standard. There are essentially three basic approaches for the valuation of liabilities in use: best estimate, best estimate plus risk margin, or statutory values.

We recommend that the best estimate of the liabilities comprises any market consistent value with no explicit margin for insurance technical risk (such as mortality level risk). Market consistency would require to taking into account policyholder participation and all embedded options and guarantees subject to market risk.

A risk margin, reflecting prudence in a market consistent way, may be added on top of the best estimate. This margin is to be distinguished from any additional solvency capital required for e.g. a target rating. We do not recommend that the risk margin is defined as a quantile of some loss distribution without linking it to an economic argument.

Modelling of risk variables and dependencies (Section 8)

An internal risk-based capital adequacy system should go beyond absorbing the normal business fluctuations. The sources of randomness are uncertain cash flows and future asset and liability values, which again are caused by more fundamental underlying random risk factors. It is understood that these risk factors are categorized under the four major headings market risk, credit risk, insurance risk (underwriting risk), and operational risk. Following is a selection of comments and recommendations:

Operational risks: about 1/3 of the participants are using and/or developing stochastic operational risk models. It is recommended that a clear and standardized sub-classification of operational risks is developed as a step towards a systematic quantitative assessment.

Intra-group risks: 2/3 of the participants do not consider intra-group risks at group level (netting out assumption). It is recommended that internal models are developed towards capturing the real side effects of intra-group transactions, at least qualitatively, say by a 3-4 year cash-flow test.

Model uncertainty: there is no clear trend and homogeneity among the participants. It is recommended that model uncertainty is – in a first step – qualitatively assessed. Important is to know the sensitivity of the results towards variations of the key parameters.

The analyzed risk models can be categorized in scenario based models, static factor models, covariance models, and stochastic factor models. Many participants start with calibrating a stochastic factor model, and translate it in a tabular form, which is then practically used as a

covariance model. This is claimed to serve for better communication between the risk management unit and the rest of the staff. We believe that this is a matter of culture and education, which can be improved and adapted if necessary.

We recommend that an aggregate P&L distribution is considered in any case, since only then one can trade off the capital adequacy and confidence level.

As for dependencies, a mixture of correlations, copulas and tail adjustment are in use. It is recommended that dependencies are consistently modelled across different levels: central simulation of market risk factors and specific catastrophe events taking account of the geographic reach of such catastrophe events

It is further recommended that the shortcomings of correlation aggregation are mitigated, using “tail-correlations”, back-tested by full stochastic models including copulas and replacing stand alone VaRs by TailVaRs for very heavy tailed loss distributions, to capture the potential losses beyond the quantile.

Scenarios form an important part of risk models. Scenarios can be categorized in event/hypothesis, deterministic projection, randomly generated sample path, and sensitivity/stress test. These concepts are multiply used by all participants.

As for the time horizon of the risk assessment, about 1/4 of the participants use or plan to use a multi-year horizon. It is recommended that, beyond a one-year risk assessment, (stochastic) multi-year studies are performed, such as the FTK continuity test. This includes a comprehensive qualitative group-wide liquidity test on a time horizon which allows for realistic refinancing programs (e.g. 2-4 years).

As for reinsurance, 3/4 of the participants take reinsurance into account for risk mitigation, and at the same time, take account of reinsurance default. It is recommended that reinsurance default is correlated with equity markets and catastrophe losses, and reinsurance concentration risk is minimized by diversification. Insurance cash flows should be modelled net and gross of reinsurance to test for the credit risk exposure.

Aggregation, diversification, and fungibility of capital (Section 9)

It is understood that stand alone risks for sub-units are aggregated to a higher (e.g. group) level, converted in capital equivalent which is then allocated to the sub-units. In both steps – aggregation and allocation – diversification effects, which are the core of the insurance industry business, come into play. This results in less capital being needed at group level for supporting the sub-units than it would be needed on a standalone basis (“the need of the sum is less than the sum of the needs”). As a consequence, the sub-units will have to support each other in case of distress. So, for diversification to really work at a group level it needs to be ensured that if capital is held in several sub-units it will be able to flow freely from one sub-unit to the other in case of need (fungibility). In practice, this might not be the case for e.g. the following reasons:

- The company’s management may be unwilling to provide the necessary capital injection.
- The regulators may prevent capital to be transferred from the legal entities under their jurisdiction (regulatory risk).

Since all participating financial conglomerates take full account of diversification benefits between insurance and banking business at group level, and essentially all participants measure diversification benefits between their local entities, it is necessary that fungibility restrictions are taken into account as realistically as possible (it may be interesting to note that the assumption of perfect fungibility will presumably not be acceptable for the SST). The major difficulty for quantifying regulatory fungibility restrictions is the possible inconsistency of business and legal structures. We recommend that:

- Fungibility of capital is to be assessed under financial distress situations. Taking into account solely the transferability constraints on the available capital under normal situations may underestimate the risk of illiquidity.
- Since fungibility restrictions seem to have never been a practical problem for the participants, a case study of fungibility issues under financial distress should be performed.
- For the sake of comparability of regulatory and economic capital structure, a legal entity compatible diversification allocation model should be developed.
- Minimum capital requirements (MCR) for legal entities and a standardization of the notion of contingent capital to cover the MCR are to be defined.

Risk measurement (Section 10)

The risk measurement methods can be classified by the time horizon of the assessment and the risk measure (VaR, TailVaR, or target ruin probability). It seems to become an industry standard to calibrate target confidence levels to annualized VaR. That does not mean that VaR shall be the ultimate risk measure. It is recommended that the internal risk models produce aggregate P&L probability distributions, so that their risk measurement can easily be benchmarked with the standard annualized VaR. Moreover, for one-year risk measurements, an explicit risk margin should be included to assert the continuation of business after a one-year financial distress. This risk margin should be calibrated such that it accounts for the cost of capital to run off the liabilities in a going concern context. Example: SST risk margin.

The internal annualized VaR calibrated confidence levels at group level range from 99.6% to beyond 99.99%. Apparently, these confidence levels are not the only factor driving the rating. About 2/3 of the participants aim at a “AA” rating, while their confidence levels vary within a range of 99.8% to 99.98%.

Risk steering and capital allocation (Section 11)

As insurance is a complex industry there are often key variations in local products, guarantees etc. Therefore, a group wide internal model will need to take into account the thoroughness of a bottom-up approach if it is to be used for risk appetite decisions rather than just high level capital allocation and performance measurement.

Model implementation and infrastructure (Section 12)

Model implementation and infrastructure is about model assessment, governance and audit processes, IT questions, and data management. Following is an extract of observations:

Governance and audit processes:

- rely on an independent (from business responsibilities) internal risk management unit
- have to include the senior management
- can be supported by external consultants assisting in the risk assessment process

IT questions and problems:

- a great variety of IT platforms and systems in use
- harmonization of the systems no issue for more than half of the companies
- software is developed in-house or at least operated by in-house resources

Data management:

- update, feed, adjustments, source, and lack of data are greatest concerns

Model implementation and infrastructure is a material issue for the companies, very demanding with respect to human resources and still a broad field for improvement.

It is expected that regulators would prefer a partial model with methodological drawbacks but which is truly embedded in the management process showing a clear model implementation and infrastructure to a perhaps technically refined “window model”.

In view of Solvency II, the overall aim is to establish an open and transparent risk culture on which basis the internal model can continually be discussed within the company as well as with the regulators.

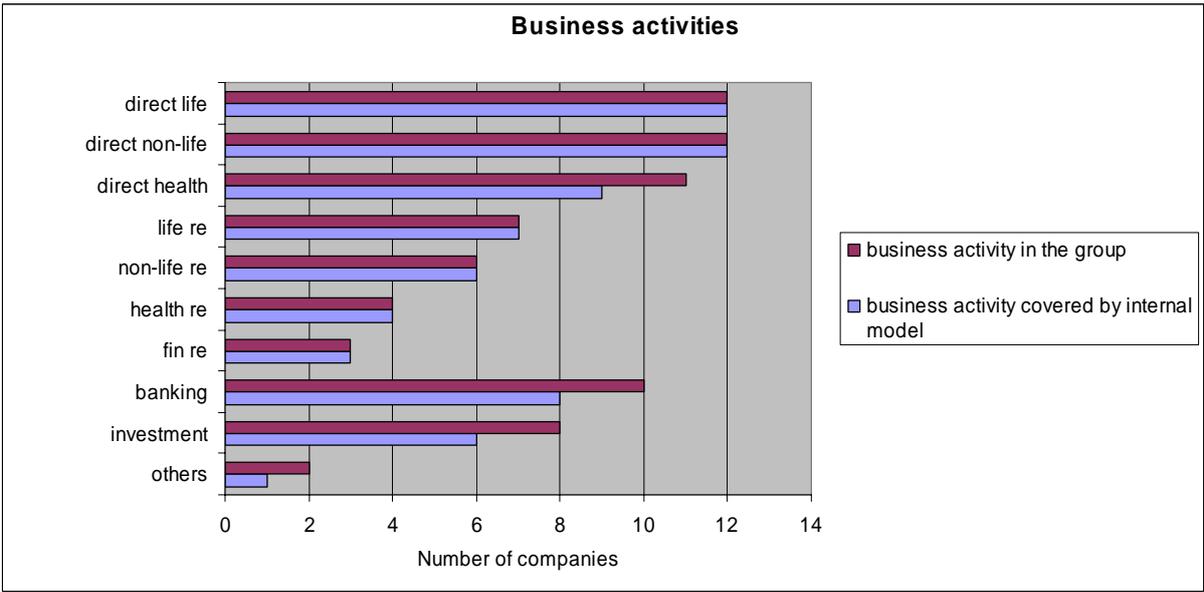
3 Participating institutions

We received data and information from 13 companies – hereinafter referred to as “participants”.

In addition, the Swiss Federal Office of Private Insurance (BPV), De Nederlandsche Bank (DNB) and the German Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin) contributed their views where applicable on internal and their regulatory standard models – the Swiss Solvency Test (SST) and the Financial Assessment Framework (Financieel toetsingskader/FTK).

3.1 Business activities

The participants were asked to report their activities in direct insurance (life, non-life, health), reinsurance (life, non-life, health), banking, and investment. The length of the upper bar in the following diagram represents the number of participants with the activities set up on the left margin.



Note that we have also counted the activities which constitute only a small part of the participants’ business program or which are in the run-off, but still on the balance sheet. This was observed in a few cases especially in the banking and investment sector and in the health reinsurance subcategory. Activities mentioned among “others” were credit & surety and equity release.

The participants were also asked to tell which of the above activities were (or are to be) covered by their integrated internal model. This comprises risk and governance processes on one hand and financial modelling methodology on the other. As it is seen from the lower bar in the above diagram the coverage rate in nearly every sector is (almost) 100%. This may be explained by

- the crisis on the stock exchange market in 2001 has given a strong impact on risk assessment and risk modelling
- big companies have the resources and sufficient staff in order to be able to introduce internal models and thus already heading for a future Solvency II assessment
- the complexity of a firm structure might demand for an integrated internal model

The high coverage rates as shown in the above diagram are the ground for this survey investigating integrated internal models.

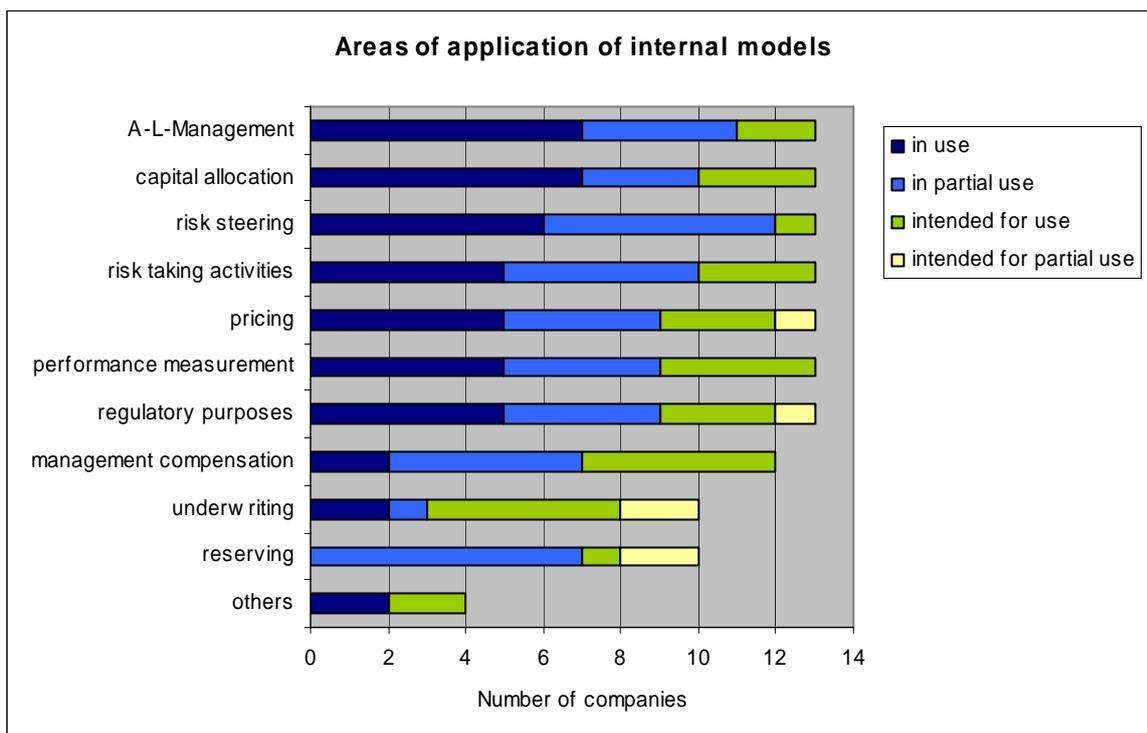
BaFin

BaFin supervises all of the above activities.

BaFin prefers “integrated internal models” in the sense that common risk drivers (like interest rates) are used “top-down” such that the group-level model has access to the exposure data (=position data) in a uniform fashion across business units. We are aware that such “top-down” models are more difficult to build and maintain and that they tend to lack precision at the lower levels of aggregation. Hence, we are prepared to also accept “bottom-up” models that are better suited for modelling the risk at the individual business units. The results of the sub-models are then to be “aggregated” at group level. The key point is that the aggregation usually has to work on probability distributions, not just numbers. We also see that some companies use *different* models for different levels of aggregation. In such a case, the regulatory capital requirement should be based on the top-level model, but the “use test” will look at the whole risk management process and thus also at the lower-level models

3.2 Areas of application of internal models

In the following diagram, the length of the bars gives the number of the participants with the different status of usage for the areas of application of their internal models.



Areas of application mentioned among “others” were Solvency II, rating agency analysis, purchase of reinsurance and determining fair values.

It follows that for the typical “risk businesses” (risk steering, ALM, risk taking activities, capital allocation) the degree of application of internal models is higher than 75%. But it is important to note that only about half of the participants use their internal model for management compensation at this time, in full use within only 2 out of 13. The usage of the integrated internal model for management compensation can be considered as an indicator of the acceptability of the internal model, both internally and externally.

With only a very few participants, the internal model has been in partial (for “risk business” purposes, see above) use before 2000. In most companies the construction, invention, and implementation of an internal model began after the turn of the century (2001-2004), and this is still an ongoing process with most of the participants (see the “intended for (partial) use” checks in the diagram above). Some state of completion is envisaged for 2006/2007.

The integrated internal models serve a whole bandwidth of purposes within the companies. They will not only be used in connection with risk measurement but will also underlie performance measurement, steering, underwriting and reserving. Thus, the integrated internal model is becoming the core for the company’s activities and performance and therefore cannot be ignored by the regulators.

However, the alleged use of an internal model does not prove its true embedding in the management process yet. Indeed, this will be one of the key aspects for the regulators on their stay with the companies when judging the internal models with respect to methodology, areas of application and degree of implementation (see also Chapter 12).

BaFin

The first nine points are possible aspects of the “use test”. The key question of the use test is whether the risk management processes - based on the internal model and steered by the management board - are working properly.

3.3 Risk profiles at group and sub-unit levels

About 10 participants confirm that there are important differences between risk profiles at group and sub-unit levels stemming from the fact that:

- Some risks are not written or considered in the sub-units, but only at group level (e.g. major natural catastrophes, management of assets, operational risk, and regulatory risks as pointed out in the comments by BPV below).
- There is diversification across the sub-units, leading to the effect that there are risks important for a sub-unit which are “diversified away” on group level. Also, individual sub-units may have opposite exposure to some risk factors (e.g. negative vs. positive sensitivity to interest rates) so that the overall group risk position may be opposite to that of an individual sub-unit.
- The risk profiles of different sub-units differ.

Those few participants which declined any major difference in the risk profiles were rather referring to risk profiles of different sub-units, and not in comparison to risks at group level.

These participants were either concentrating on special lines of business or had a very homogenous product structure across sub-units.

We recommend that special attention is given to systematic risks which emanate at group level from the aggregation of relatively non-material risks at sub-unit level (e.g. pandemics). Scenario based methods may be needed. Also fungibility aspects have to be taken into account at group level.

BPV

The SST has a legal entity view (Swiss business + branches). However if diversification benefits on target capital are to be accepted by FOPI, the group would need to model the group risk and the allocation down to legal entity.

The two main additional risks to be modelled then are

a) regulatory risk: The risk that regulators from other legal entities might freeze assets (SCR or MCR) and the remainder of the group then is in a worse financial situation (fungibility of capital).

b) The risk, that the group might let subgroups (in particular the legal entity in the scope of the SST) be sent into run-off.

BaFin

This was discussed in the corresponding CEIOPS working group. One of the additional risks identified were reputation risks.

4 Internal Models

It is generally agreed that there shall be two alternatives to calculate regulatory solvency capital requirements – a standardised method and the internal model method. Under a standardised approach, capital would be determined using the same calculations for all companies in a jurisdiction, in accordance with the to-be-developed European Solvency II standards. This would necessarily be a simple rule-based one-size-fits-all method, such as a static factor model, where for each source of risk a standardised measure of a company's exposure to that risk would be multiplied by a standardised factor determined for the jurisdiction as a whole. Similarly, the rating agencies' models are of rule-based type. Internal models are expected to reflect each company's individual risk exposures more appropriately.

4.1 Positioning to regulatory and industry standards

The Financial Assessment Framework (FTK) of the DNB requires that “an internal model must model the probability distribution of shareholders' equity at realistic value at a horizon of one year after the reporting date”.

A probability distribution is not targeted by all internal models that have been analysed in this study (even though, in principle they all do implicitly). The majority of the internal models lie between a standardised approach and the FTK probability distribution type.

Most internal models are developed from first principles, ensuring that the risk profile of the group and sub-units is appropriately reflected. One cannot ignore, however, the impact of certain external model providers, which results in a kind of modelling culture clustering across the participants.

As for the (economic) valuation principles, the majority of internal models meet the overall objectives and ambitions of the IAA standards, such as marking the balance sheet to market. The major differences to the IAA proposals are

- Confidence level: the participants use higher target confidence levels than 99%.
- Aggregation method: the IAA proposes copulas, while they are not so prevalently implemented in practice (they are, however, used for back testing).
- Risk measure: the IAA proposes TailVaR. In practice, VaR is predominant.
- Capital point of view: while the IAA takes a policyholder point of view, a few participants base their model on a shareholder point of view (different discount factors, etc).
- Concept of default and solvency: the IAA proposes to compare market value of assets and liabilities, some participants use statutory liability values instead.
- Local models in use may be related to either industry standard (like Moody's, S&P's) or to statutory standards (like US RBC), due to the need to monitor the statutory position at business unit level.

The FTK, SST and BaFin share in principle the views of the IAA proposals. It is noteworthy that some participants (not solely Swiss insurers) explicitly mention to be “reasonably close” to the SST framework.

As for the rating agencies, their impact is mainly due to providing the target rating for many participants (AA rating or higher). Also market and credit risk is sometimes modelled according to industry standards, such as the S&P credit capital charge approach.

For the model implementation, there are many commercial tools in use. See Section 12.3.1 “IT platforms and infrastructure” for further account.

BPV

Operational risk is not quantified; the SST is not a factor/RBC model as proposed by IAA. The market risk (ALM) part of the model is closely related to the RiskMetrics approach. The credit risk part is Basel 2, the P&C part mirrors closely the methodology of many internal models.

BaFin

Our views are principally in line with the IAA proposals. Additional ideas that have not yet been widely discussed are presented in the attached “BaFin White Paper on Internal Models – Key Issues”. We expect a variety of internal models.

4.2 Future developments of internal models

An integrated internal model is more than just an own way of calculating available and required risk capital. Indeed, it can and must be considered as a common framework for discussion of risks, of dependencies, of links between different areas of the business etc. It comprises

- Methodology: assumptions, models, mathematics, mapping of the real world to a conceptual framework, etc.
- Parameters: interest rates, volatilities, mortality tables, dependencies, allocation numbers, estimates based on financial or insurance data or on expert opinion, etc.
- Tools: software codes, data warehouses, IT platforms, etc.
- Processes: testing, plausibility checks, reporting, documentation, implementation, model building, construction and enforcement, integration of sub-units and management into the model, etc.

Although these four categories are not clearly separated (the construction of data interfaces, for example, might belong to tools and processes) they may serve as benchmarks.

It follows that an internal model cannot be a static object but is subject to continuous changes and developments due to

- changes in the company’s structure
- evolvement of markets and technology
- scientific (mathematical and statistical) progress
- changes in the political and legal environment

The participants were asked to comment on future developments of their integrated internal models. Most of them gave exhaustive answers from which we present a short survey:

Methodology:

- refine reserving model
- tail value at risk approach in some applications

- extend to multi-year modelling
- include 5 years' of new business
- extend range of risk factors modelled
- introduce analytical approach to operational risk
- include credit risk methodology in insurance
- capture emerging hedging strategies
- integrate ALM analysis into embedded value work
- development in life business (AL-dynamics)
- more detailed analysis of non-life pricing risk
- new approach in loss modelling

Parameters:

- alter time horizon in risk assessment
- adjust risk tolerance to regulatory evolution
- align ALM parameters in insurance
- sourcing higher quality of internal and market data on volatilities and correlations
- review of aggregation matrix

Tools:

- implementation of appropriate new scenario generators
- explore the use of an alternative platform of the model
- development of Excel based models
- roll out new software to provide a common platform for both risk management and internal audit
- evolve the P&C projection system

Processes:

- building a fully integrated bottom-up model
- extending computation to lower levels of granularity
- reappraisal of the IT infrastructure
- build a legal entity version of the model
- integration of sub-units into the integrated internal model
- strengthening documentation and checks
- integration into standard data systems and automatic calculations
- create a central repository for the collection and storage of risk driver and exposure of liability data
- derive faster (quarterly) updates
- include behaviour of management, rating agencies and regulators in internal model
- improve external acceptance by the regulators and rating agencies
- improve system robustness

The main fields of future development are methodology and processes. This is not very surprising since most of the participants are still in the building-up phase of their internal model (2 participants, however, have stated explicitly that no major changes were planned on the methodology side).

We can sum up the planned developments stressing one or two points in each category:

- Methodology: here the main developments can be categorized as improvements in the modelling process and the range of risk factors (especially operational and asset-liability mismatch risks).
- Parameters: no major field of future development; 2 participants intend to switch from a one-year to a multi-year risk assessment (this, of course, will heavily affect both the methodology and process side).
- Tools: no major field of future development.
- Processes: an important field for future development, concerning the IT infrastructure and the risk governance process.

BPV

Guidelines for modelling fungibility of capital and the risk of sending parts of the group in run-off have to be developed. The market risk model will be expanded by additional risk factors. For companies with substantial risk in branches, global (high level) scenarios have to be formulated. The reserving risk quantification in P&C has to be improved and parameter risk has to be taken into account. The life model has to be expanded and stochastic risk has to be taken into account. The modelling of the group pension business has to be improved (replicating portfolio approach and guidelines for the prescribed minimal performance guarantee).

Guidelines on corporate governance and risk management have to be formulated.

BaFin

The rules should be liberal enough so that internal models can evolve with markets and technology.

IAA

Amongst other considerations, it should be recognised that evolution of the modelling capabilities is to be encouraged.

4.3 Major obstacles in development and use of internal models

We give a short survey of the major obstacles in development and use of internal models, separately for the fields methodology, parameters, tools and processes as outlined in Section 4.2 above.

Methodology:

- the misalignment of economic methodology and prescribed (regulatory) methods
- model unable to reflect reality within a reasonable cost and time
- sophisticated valuations under base and stressed scenarios

Parameters:

- calibration of asset return scenarios for smaller geographies

Tools:

- costs of developing or purchasing and implementing suitable information technology
- current run-time issue (→ associated accuracy, limiting the number of simulations)
- computer capacity

Processes:

- complexity of the model (→ increase of model risk)
- human resources (education of the people involved)
- management untrained on the meaning and uses of economic capital
- inflexible structure, reluctant cooperation on the side of the sub-units
- internal and external resources: quality and time
- deficits in cooperation, responsibility, risk management skills
- communication of results
- coordination of input requirements
- willingness and ability of the business units to cope with the volume of developmental work
- keep methodological consistency between the business lines
- consistent estimation around sub-units

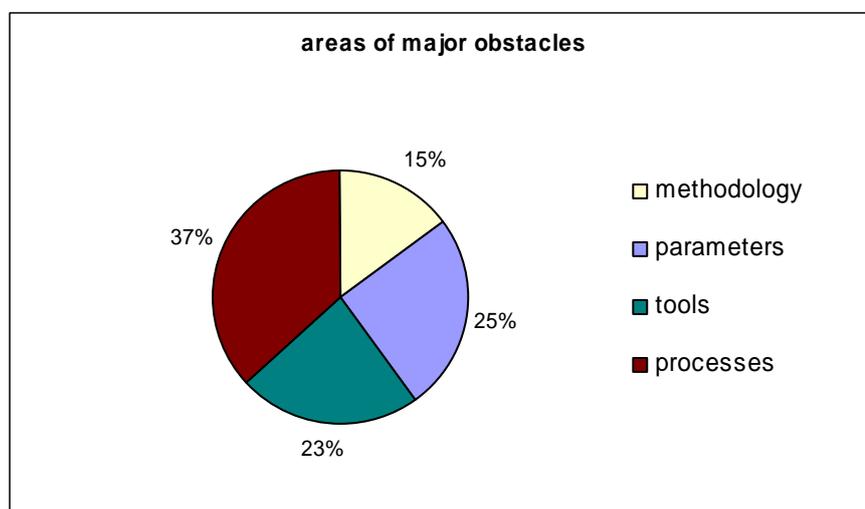
One major obstacle, perhaps the most decisive of all, is not mentioned yet, and it will be given extra room here: almost 90% of the participants stressed that **DATA QUALITY**, **DATA RELIABILITY** and **DATA AVAILABILITY** in connection with tough **TIMELINES** constitute one major obstacle when developing and using the integrated internal model.

Data problems can be attributed to the parameter, tools, as well as to the processes section:

- reliability of data (e.g. lack of data) underlying estimation of correlation of assets, behaviour of policyholder, extreme event probabilities etc. (→ Parameters)
- efficient storage and usage of company's and external (data pools) data and automation of input data flows (→ Tools)
- data quality checks for errors, missing values, inconsistencies etc. (→ Processes)
- data availability according to tough timelines set by the company's management (→ Processes)
- data homogeneity from different databases all around the world (→ Processes)

Data questions may also affect the methodology section since the application of a statistical method is always subject to the availability of suitable data sets.

The following picture shows the average obstacle-wise percentage weights that are given to each category, including the data issues as outlined above:



From it we can deduce that although methodology could be identified as a main field of development for the integrated internal models (together with Processes, see 4.2), the main obstacles for development and use do not seem to lie on the methodology side. The maximum percentage number given to the methodology section was 33%, while on the other hand two participants mentioned no methodological problems at all. To the processes category, 4 participants assigned 50% and more. The average percentage numbers for parameters and tools are higher than expected due to the attribution of data problems to these sections. [To conclude the statistical analysis: There is no significant difference between the means for parameters and tools. However, the methodology mean is significantly lower and the processes mean is significantly higher. The empirical standard deviations are 9.5, 16.9, 13.3 and 14.2 for methodology, parameters, tools and processes, respectively.]

We summarize:

- The main obstacles seem to lie on the process side, as expected. One of the great problems here is connected to human resources (lack of cooperation, insight, skill and knowledge, source of errors and mismanagement).
- Obstacles in methodology seem to be less important, e.g. quantification problems of special risk factors (credit risk, operational risk) were not mentioned at all here (this might be different within smaller companies).
- Data problems (getting data organized, timely handling and validation of input data and data storage, etc.) seem to constitute the main overall obstacles (if “Data” were a separate category it would be weighted with about 40% as was mentioned by some of the participants).

BPV

For small companies the data used and know-how will be a problem and actuarial knowledge needs to be built up. Some companies might struggle with the quantification of market and especially credit risk.

BaFin

The success of the regulatory use of internal models will primarily hinge on whether the incentives are sufficient to make the deal “more information in exchange for lower capital requirements” work.

4.4 Flexibility of internal models towards Solvency II

An internal model, to gain approval by the regulators and market participants, must offer a high degree of adaptiveness to new products, new risks and market changes. We recommend that a clear process is defined for approval of model changes.

Our observations made it apparent that the main difficulty for a model adjustment comes from the process side. Changing the technical and process implementation of the model might be a huge and material task, since many sub-units are involved. Large expenses may already be triggered by an increase of the frequency of calculation from once to twice a year, as has been mentioned by a participant. Also, some of the current tools in use show limited flexibility.

Methodology and parameters seem to be comparatively easy adoptable, if necessary. In fact, several participants already have had internal discussions and assessments of alternative

methodological approaches, such as TailVaR vs. VaR, multi-year vs. one-year risk measurements, etc. However,

- significant additional developments might be required if the basic construct of Solvency II diverges in a material way from the accounting changes (IFRS and EEV) and the local regulatory changes.
- it would be the wrong way – in our opinion – to strictly require a one-year risk assessment throughout by Solvency II guidelines. Some participants have currently implemented (or plan to implement) a multi-year model.
- a fundamental choice has been made by some participants to take the covariance method to determine the economic capital needed. This means that the entire group and its sub-units are not currently modelled on a full stochastic basis.

We observed a trade-off between flexibility towards developments and adjustments to future requirements and “user friendliness” with which the tools can be used. In that regard, we clearly recommend that flexibility is favoured.

It is understood that, in order to provide an incentive for large portions of the industry to move rather soon to advanced modelling techniques, the legislator may wish to allow models also to substitute parts of the (future) standard regulatory formulas.

As for the latter and as at today, no EU standard regulatory approach is yet devised in any great detail. It has been mentioned to us, however, that the industry, overall - i.e. small, medium and large companies with local vs. international scope – seems to be agreed on the following principles for solvency assessment in the context of a Pillar 1 standard approach:

- total-balance sheet approach
- valuation of liabilities based on best estimate plus some explicit measure for risks and uncertainties (how, yet to be determined)
- solvency capital determined based on a confidence level (at least) equal to investment grade over a one-year time horizon
- preference for a set of covariance-based formulas, rather than for scenario and stochastic factor modelling
- capital quantification of all major risk exposures, based on IAA-equivalent classification, with the two partial exceptions: operational and catastrophic risks, which would only be covered in Pillar 1 insofar as they lend themselves to reliable quantification EU wide (otherwise, candidates for Pillar 2 qualitative assessment)
- conservative levels of diversification between liability classes, asset classes, assets and liabilities, geographical and sectoral basis.

In view of these premises it seems likely that a modular approach would have to aggregate single risk numbers, which requires changes in the methodology of those participants whose current approach aggregates cash flows and probability distributions. This could encourage the intention for their internal models to replace any standard regulatory formulas entirely.

We recommend that any model is kept flexible enough to assess separate risk types, business lines and legal entities individually. Essentially all participants mentioned their confidence in their internal models to be modular and flexible – with varying level of detail – in this regard. On the other hand, at least 3 participants revealed their intention for their internal models to replace the future regulatory standard approach entirely.

It is desirable that internal models which are compatible with the legal entity structure could be used to substitute for the solo Pillar 1 capital requirements in local jurisdictions where available.

BPV

The SST is modular and should be adaptable to be Solvency II compatible. The risk measure can be changed since the SST is distribution based. However, the SST does not quantify operational risk which might need to be included to be Solvency II compliant.

BaFin

We envision liberal standards for internal models, such that only minor modifications or additions are necessary to use existing models also for regulatory purposes.

There has been an extended discussion about partial models in the CEIOPS non-life working group that cannot be repeated here. The main point is to strike a balance between too liberal and too restrictive partial use. On the one hand “partial use” should be allowed, possibly only temporarily, to ease transition from the standard method to the internal model or to treat special cases like mergers. On the other hand, cherry picking and minor tinkering on the standard method should be avoided. A general approach is to view the mixture of standard and internal model as a whole and attach essentially the same statistical quality criteria to this mixture model as to a full internal model.

4.5 Proposals for admissibility of internal models

The IAA WP report comprises a discussion on the regulatory validation and approval of internal models (Section 7.4). The report mentions three instances where internal models have been adopted for required capital calculations: Basel I (market risks), the Canadian life, and the Australian non-life regulation.

Out of those instances the IAA extracts some essential minimum requirements for the admissibility of internal models in respect of prudence, comparability and consistency within a supervisor’s jurisdiction (the following five paragraphs are from the IAA WP report):

Prudential Requirements: The insurer must demonstrate that the internal model operates within a risk management environment that is conceptually sound and supported by adequate resources. It also needs to be supported by appropriate audit and compliance procedures. A number of qualitative criteria follow from these minimum requirements:

- The insurer should have an independent internal risk management unit, responsible for the design and implementation of the risk-based capital model.
- The insurer’s Board and senior management should be actively involved in the risk control process, which should be demonstrated as a key aspect of business management.
- The model should be closely integrated with the day-to-day management processes of the insurer.
- An independent review of the model should be carried out on a regular basis. (Amongst other considerations, it should be recognised that evolution of the modelling capabilities is to be encouraged)
- Operational risks should be considered.

Comparability and Consistency Requirements: The model's output needs to fit closely with the supervisor's view of key minimum performance criteria, such as probability of default and other important measures of financial soundness. Quantitative criteria relating to these needs could include:

- A requirement for the model to calculate the capital needed to keep the annual probability of default below a certain level (or levels)
- An ability for calculating the likely spread of economic costs relating to a range of potential outcomes for the business, etc.

In addition the model should include the capability for specification of the key risk factors for general insurance business. These would include factors relating to both assets and liabilities including:

- Measurement of cash flows for both assets and liabilities
- The risk of changes in outstanding claims valuation due to changes in economic, environmental or experience-related factors
- The risk of changes to the adequacy of premium rates due to changes in economic, competitive or environmental factors
- Catastrophe concentration risk
- Expense risk
- The reinsurance security risk and risk of reinsurance cost variability

The model should include a facility to enable comparability of correlation effects between risk classes as well as a system of stress testing and other scenario-based examinations.

The model should be in a format to allow a reasonably straightforward detailed review by appropriately skilled representatives of the supervisor to enable a relatively "painless" approval procedure.

From our survey we now extract some additional aspects which could serve as further minimum European Solvency II standards for admissibility of internal models and may lead to practical yet prudent approval criteria that can effectively be applied by the regulators.

- True embedding of the internal model in the management process, i.e. capital allocation, performance management and pricing, etc. (the model may and must serve many masters, not just one). This will be the best available review process as the management will be concerned about the relative fairness of model. This, however, may require the new regime to allow for reflection of management structures rather than legal structures, especially by focusing on the group-level rather than the legal-entity level. Subsidiaries should accordingly get regulatory relief if appropriate parental support is in place.
- The internal model is subject to yearly renewals. Changes that lead to material capital changes have to be reported to regulators. Rules based criteria cannot capture this dynamic aspect of internal models. Principles based requirements are therefore needed: the regulator should set the broad objectives and framework of an internal model, leaving the detailed guidelines to be set and disclosed by the company.
- Framework should be based on economic, realistic and risk based assessment of assets and liabilities and risk exposures.
- History of the model: how, by whom and when has it been developed and implemented.
- Public disclosure of all relevant internal model methodology and assumptions.

- A standard model, reflecting the Solvency II principles, shall exist for insurance companies not maintaining an own internal model. This standard model shall be conservative to provide a benchmark and incentive to use internal model.
- Supporting documentation to include: asset model, frequency and severity models, impact of reinsurance, impact of diversification, etc. Clear exposure as to where the internal model deviates from the regulatory standard model.
- Minimum list of business and risks to be identified and assessed (e.g. to avoid cherry picking of low capital business units).
- Minimum standards for
 - calibration (comparing market value against model value for a basket of different aspects)
 - parameter selection, with a particular focus on correlations
 - stress testing
 - diversification benefits (including fungibility)
- Unnecessary complexity versus effectiveness (e.g. whether the selected modelling points/number of scenarios are sufficient to have a reasonable representation of the risk profile of the business).
- Cost-benefit assessment (whether the running times, staff, processes involved and data requirements are reasonable in terms of costs). There has to be business sense in the regulatory requirements.
- Flexibility to allow for changes in variables, modelling and output, and flexibility in analysis (i.e. modular structure, user-friendly platform, add-in spreadsheet tools, etc.).
- Many of the admissibility criteria applied to internal capital models in the banking sector are appropriate for the insurance sector. However, the key differences between banking and insurance models need to be understood and reflected in revised admissibility criteria for insurance models. An example: Banking models are typically based on just one part of the business model – for example the market trading book or the credit risk portfolio – and projections are made for relatively short periods of time (days or weeks); substantial blocks of actual and modelled outcomes can be built over relatively short time periods to validate or “back test” models. In the insurance sector models cover long time periods and are whole enterprise models – there is unlikely to be ever sufficient data to allow fully credible “back testing” and alternative approaches must be taken to validation. This requires
 - an extensive testing and validation of input assumptions – through back testing where feasible
 - external reviews and benchmarking
 - a detailed analysis and testing of modelled scenarios focusing on both mean scenarios and individual extreme scenarios
- The internal model should be more than just stressing the balance sheet. New business must not jeopardize the sufficiency of current assets.
- Clear definition of what different time horizons mean. For multi-year risk assessment it has to be found out where the residual risk of the run-off becomes small enough.
- Separate treatment of life and non-life business.

It can be expected that there will be migration over time of the models towards internationally best practices, and a gradual back feeding of modelling experience into the regulatory standard approach.

There is the desire that groups should be allowed to focus on capital adequacy at group level. There should be a main regulator co-ordinating with other regulatory bodies.

Moreover, it has been mentioned that new solvency requirements must on average not lead to rising capital requirements for the insurance industry.

BPV

There needs to be transparency and an open risk culture within the company so that the internal model is continually discussed within the company.

The methodology of the internal model has to be disclosed publicly (e.g. in the form of a seminar etc.) in sufficient detail such that there can be an informed public (academic) discussion about the underlying framework.

There needs to be documentation of the model on different levels (for the actuaries within the company having to deal with model on a day-to-day basis, for the CRO, for the CEO.)

BaFin

BaFin's current working standard consists of the "BaFin White Paper on Internal Models – Key Issues" and the "Basic Principles for the Use of Internal Risk Models in Insurance Companies for the Improvement of Financial Supervision", Suggestion from the German Insurance Association, 12.12.2001. These will likely be developed further in the upcoming discussions between BaFin and GDV.

5 Glossary

An important step towards comparing the internal models is to lay down a glossary and a common formal setup. We are well aware of the different accounting systems and the complexity inherent in determining the capital structure. However, as a smallest common denominator for current **economic capital adequacy** purposes we shall propose the following terminology underlying the following simplistic framework. We are focussing on methodological aspects here.

The basis of insurance business is setting up the available risk capital as difference of the values of assets and liabilities, i.e.

$$AC = \text{value of assets} - \text{value of liabilities.}$$

Now, the main methodological differences concern

- Capital adequacy
- Valuation of assets and liabilities
- Risk modelling and measurement.

Capital adequacy is about the viewpoint taken when determining the AC. It can be distinguished between a

- Solvency point of view: economic, regulatory, rating agency
- Level point of view: group vs. sub-unit
- Capital point of view: policyholder vs. shareholder

Valuation of assets and liabilities is about market consistency (market consistent valuation vs. statutory valuation). In this report market consistent valuation of liabilities (e.g. by best estimate) is to be understood as a synonym for economic valuation.

Default (insolvency) of the company happens when AC becomes negative. *Risk modelling and measurement* is about calculating (from the AC) the capital necessary to prevent default with a certain level of confidence. The methodologies comprise

- scenario based models
- static factor models
- covariance models
- stochastic factor models.

Other aspects are: time horizon (also important for the valuation, as the AC is time dependent), the applied risk measures (e.g. VaR, TailVaR) and the aggregation method (diversification effects and fungibility issues).

In the following we list up the terminology used in this framework, referring to the separate sections for a more detailed discussion.

Assets: Include cash, bonds (government, corporate), loans, mortgages, equity, real estate, investment funds: equity, real estate, bond funds, and others.

(Sect. 7.1)

Liabilities: Anything that gives rise to cash flows on the insurance side (life, non-life, health; the granularity can range from a single insurance policy to an entire book of insurance business). Pension schemes or some form of debt might be excluded.

(Sect. 7.1)

Available Risk Capital (AC): Essentially the difference between the value of the assets and the value of the liabilities. In practice there are different turnouts for AC depending on the view on capital adequacy or the notion of “value”, respectively. Synonyms in use: available capital, available economic capital, risk-bearing capital, fair value.

(Sect. 6.2)

Total Balance Sheet Requirement (TBSR): Total capital (in form of assets) the company has to hold in order to meet solvency requirements with a certain level of confidence.

(Sect. 6.4)

Required Risk Capital (RC): Capital that the company judges it requires in addition to today’s value of the liabilities in order to meet solvency requirements with a certain level of confidence; in this approach the RC is the difference between the TBSR and the value of the liabilities including possibly a risk margin. Synonyms in use: economic capital, risk based capital, required economic capital, economic risk capital

(Sect. 6.4)

Best Estimate (BE): Expectation of discounted future cash flows with policyholder behaviour, embedded options and guarantees taken into account.

(Sect. 7.3.1)

Risk Margin: The risk margin as add on to the best estimate (or as part of the RC) is reflecting prudence concerning future capital costs in a market consistent way, e.g. (by SST definition) covering the hypothetical cost of regulatory capital necessary to run-off all the insurance liabilities, following financial distress of the company.

(Sect. 7.3.2)

Backing Assets: Assets which are supporting the liabilities.

(Sect. 10)

Free Assets: Assets which are not supporting the liabilities.

(Sect. 10)

Solvency Point of View: Including or not including regulatory or rating agencies’ requirements and viewpoints into the definition of AC.

(Sect. 6.2)

Level Point of View: Group solvency vs. sub-unit solvency. May include transferability restrictions between sub-units and group in determining the (group) AC.

(Sect. 6.2)

Capital Point of View: Taking policyholder or shareholder viewpoint in the definition of AC and RC.

(Sect. 6.2)

Scenario Based Model: Risk capital calculation is based on measuring the impact of (company) specific scenarios to the total P&L distribution.

(Sect. 8.2)

Static Factor Model: Risk capital calculation is based on a linear combination of static factors (“risk weights”) multiplied with company specific size measures with no stochastic cash flow modelling.

(Sect. 8.2)

Covariance Model: Risk capital calculation is based on an aggregation of single risk numbers by simple sum or square root formulae.

(Sect. 8.2)

Stochastic Factor Model: Risk capital calculation is based on an aggregated P&L distribution.

(Sect. 8.2)

Value at Risk (VaR): Quantile of a distribution (e.g. P&L distribution).

(Sect. 10)

Tail Value at Risk (TailVaR): Conditional expectation, conditioned on the tail of the distribution (e.g. P&L distribution). Synonym in use: expected shortfall.

(Sect. 10)

Diversification: Compensatory effect (stochastic or deterministic) on aggregation of capital reducing the capital needs in comparison to standalone measurement. It is stemming from the assumption of having not fully dependence between the objects (risk types, sub-units), or by opposite portfolio sensitivities on the risk factors.

(Sect. 9)

Fungibility: Unrestricted flow of capital between sub-units (or between group and sub-units) in case of financial distress. Fungibility is the justification for the application of diversification.

(Sect. 9.2)

Market consistent Value of an asset: The observed market price, or marked to model.

Market consistent Value of a liability: Amount an arm's length transaction in a liquid market would require the transferring insurer to pay the party taking over the liability. Here the best estimate plus a risk margin if no such market is available.

Economic Value of a liability: The present value (allowing for time and risk) of all future cash-flows (*The Institute of Actuaries of Australia, GN 552*). Economic value is the same as market value when the financial instrument in question is tradable in an active, frictionless market; else there may be factors like recent transaction benchmarks, political and economic events, etc. affecting the market value that are not necessarily encompassed within an economic valuation process.

6 Capital adequacy

The objective of any capital adequacy model is to find a portfolio structure that asserts the continuation of the existing business up to a given time horizon where assets and liabilities are assumed being capitalized.

Essentially all participants agree that the economic view of the world provides the most accurate picture of the risk profile and capital adequacy. However, it is also recognised that in a realistic model there are regulatory and rating agency constraints to be met. Moreover, as an interim measure, liabilities are sometimes estimated from their statutory values. E.g. some participants are estimating economic life liabilities from European Embedded Value models. At least 4 participants mention explicitly to base their capital calculations on a mixture of economic and statutory principles. E.g. cash flows considered are driven by each unit's statutory (regulatory) constraints.

We recommend that for a realistic view of the world, regulatory constraints are taken into account, and statutory values may serve as interim variables if needed (see e.g. fungibility, Section 9.2).

We have been asked to pay attention to currency aspects. Based on our observations we recommend that currency risk is divided into structural (or functional) and translation currency risk (see Section 8.1.1 Market Risks). Functional currency risk may have a material effect on capital adequacy if the currency matching is low. The translation currency risk matters to the extent that capital is assumed to be fungible between sub-units. We recommend that translation currency risk is further studied in relation to group capital fungibility issues.

We recommend that for comparability of the capital adequacy between the companies, more consistency between their internal methodologies and concepts is achieved. At the moment, there are still considerable differences, which is due to the different accounting systems and the complexity inherent in determining the capital structure. This study attempts to classify these discrepancies. However, we recommend that further effort is done towards convergence of the various methodologies.

6.1 Risk tolerance

For all participants, the overall risk tolerance is reflected in the confidence level underlying the risk measurement. The risk tolerance may be linked to the group's rating ambitions. However, it is usually not measured using rating agencies' models. Rather, the probability of default, which is an internal concept, is calibrated to meet the rating agencies' default probabilities of target rated bonds.

The resulting capital requirements depend on the initial composition of the portfolio. The group may take out "free assets" from the assessment. This can nominally result in lower capital requirements. As a consequence, stand alone required capital figures are not comparable across companies if not reported relative to the backing up available capital.

6.2 Available risk capital

Synonyms in use: available economic capital, risk-bearing capital, fair value (not IFRS).

Throughout, the available risk capital is formally defined as difference between the value of assets and liabilities. In practice this depends amongst others on the following points of view:

Solvency point of view:

- Economic (market-consistent) view: There is no concept of core and secondary capital. Available risk capital is the market consistent value of assets minus liabilities. Values are in principle fully fungible.
- Regulatory view: Tiered capital counts. Hybrid Tier 1 type instruments are included as available risk capital.
- Rating agency view: Here the rules of e.g. S&P or Moody's apply. Subordinated debt may qualify as hybrid capital included as available capital.
 - 10 participants take an economic point of view for their solvency assessment.
 - 3 participants do not solely take an economic point of view. This can be as proxy for economic modelling for some business units. However, it has been mentioned that the ultimate aim is to get both the regulators and rating agencies to accept the capital based on economic internal models as the "correct view of the world".

Level point of view: group vs. sub-unit. Some participants (at least 2) take account of transferability restrictions between sub-units and group to determine the group available capital. This implies a non pure economic concept of value at group level. Pure economic values are fully fungible. We recommend that this aspect is further studied in connection with the fungibility/diversification issue.

Capital point of view: policyholder versus shareholder. It can be expected that the regulators will require the policyholder point of view for admissibility of the internal model. From a draft solvency II directive (MARKT/2507/05: Article N1: Objective of supervision): "The main objective of supervision is to act for the protection of policyholders."

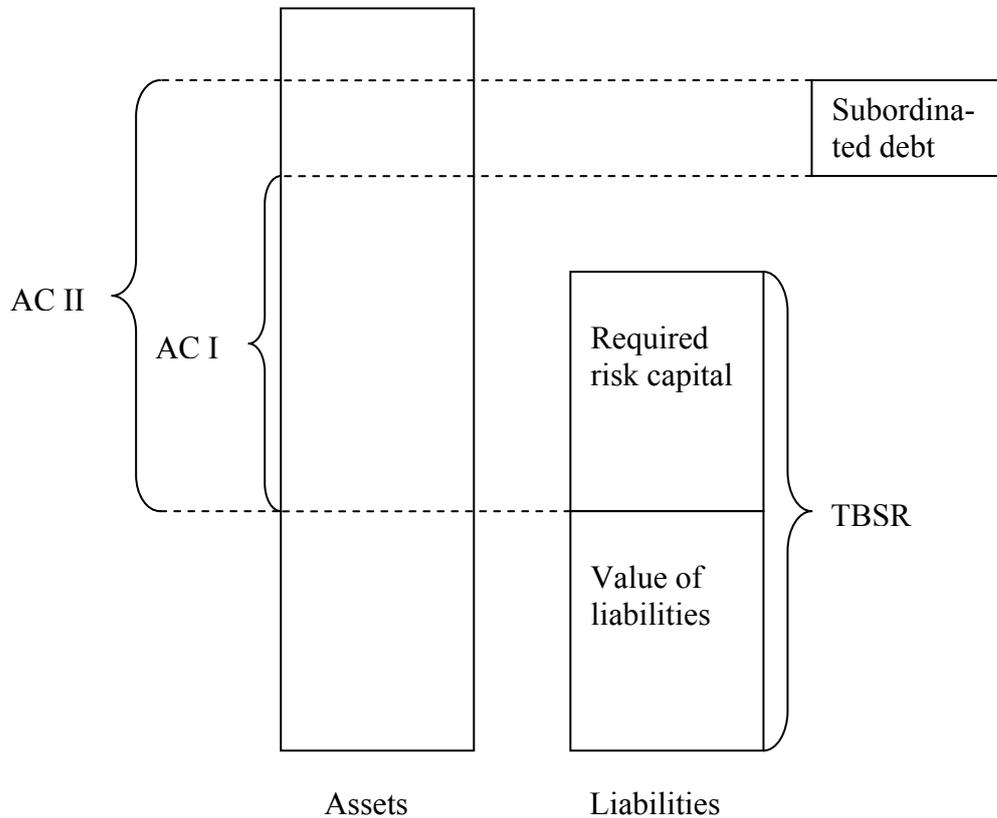
- From the policyholder point of view, the insurance cash flows should be asserted and hence discounted by the prevailing risk-free rates. If more appropriate, e.g. for the sake of data reliability, the risk-free rates are approximated by the swap rates. Moreover, intangibles, such as deferred tax assets and liabilities, are not necessarily on the balance sheet.
- From the shareholder point of view, the insurance cash flows are discounted with the prevailing target rating risk-adjusted rates (e.g. AA swap rates plus some company specific spread, to account for implicit default options) plus appropriate adjustments, e.g. for netting of the costs inherent in insurance cash flows. Deferred tax assets and liabilities become material and are taken into account.
 - 2 participants use shareholder point of view.
 - 11 participants use policyholder point of view

The available risk capital further depends on:

- The selection of assets that are considered for bearing risk (e.g. the "backing assets", as opposed to the "free assets").

- The underlying accounting system, which is the basic input which is then economically modified for the valuation, throughout. These modifications, however, remained opaque during this study.
- The liabilities that are considered for protection. This may include subordinated debt, but in most cases it does not, which is tantamount to saying that subordinated debt is part of risk-bearing available capital.
 - 3 participants do not count subordinated debt as available capital. It is either off-balance sheet or treated as liability (one case only), see ACI in the figure below.
 - 10 participants count subordinated debt as risk bearing available capital, as far as admissible by regulators, see ACII on the figure below.
 - 3 of them only at group level. Sub-units do not issue subordinated debt.
 - 3 of them capture interest payments on subordinated debt as a (group-level) expense
- The value that is assigned to these liabilities. Main factor: does this value include an explicit or implicit risk margin or not. See Section 7.3 “Liability valuation principles”.
- The assessment of ring-fenced funds, e.g. participating funds, to reflect the non-fungibility of capital from these funds. We recommend that participating funds are valued in terms of the guaranteed participation considered as a liability, to achieve a consistent assessment within an economic context.

An alternative would be to treat subordinated debt as a liability on a full economic basis, i.e. as a short position in a defaultable bond. Consequently, its value drops in case of financial distress of the company. The effect on the economic balance sheet is that both available and required risk capital are reduced. This is essentially equivalent to including subordinated debt as available capital.



DNB

Determining actual available capital

In determining solvency, capital that does not serve to cover foreseeable liabilities is a residual item (surplus). The amount of this can be derived from the difference between the realistic value of freely disposable assets and the realistic value of total foreseeable liabilities.

If financing instruments consist entirely or partly of elements of a foreseeable liability (contractual or moral), these parts have to be valued as a liability in line with the realistic value principles, allowing for the creditworthiness of the institution. This generally applies for all liabilities other than those under pension or insurance contracts.

BPV

Market value of assets – best estimate of liabilities (where best-estimate means risk-free discounted expected cash flows) + valuation of all relevant options and guarantees. Some assets are not accepted for SST purposes (e.g. goodwill).

6.3 Solvency and default

The definition of group solvency is a complex issue. In realistic terms it may depend on transferability constraints of capital from sub-units to others. Capital transfers occur if sub-units have capital in excess of their own local solvency requirements, capital injections are necessary in order to prevent sub-unit's default according to local solvency requirements. The definition of solvency can and does have an impact on the capital requirements.

The definitions are as various as the business and legal structures of the participating groups. We can classify our observations as follows:

- Group solvency:
 - 9 participants define group solvency on an economic value basis. Some take fungibility aspects into account.
 - 4 participants define group solvency on a statutory basis. This involves a classification of capital by tiers.
- Sub-unit solvency:
 - 4 participants mention that their definition of solvency for (large) sub-units reflects local solvency requirements. E.g. if a sub-unit has its own rating.

In all models (13 participants), default of sub-units does not play a role for the group capital adequacy assessment. That is, all liabilities are taken into account in the same way, and put options on sub-units are not valued. Possibly different target rating requirements for group and sub-units are based on the diversification effects on group level. Credit risk (shareholder point of view) is exclusively taken into account at group level, if at all.

DNB

Solvency is assessed at the level of the licensed entity. For solvency calculation purposes, default is the situation in which the surplus – as defined above – is less than zero.

BPV

Default is defined by breaching the Solvency 1 (based on statutory principles) requirement (actually, this is not default but regulatory action will be taken). SST requirement (= risk bearing capital exceeds target capital) is not a solvency requirement but a pillar 2 requirement.

6.4 Required risk capital

Synonyms in use: economic capital, target capital, risk based capital, required economic capital, economic risk capital

According to the IAA, an effectively defined capital requirement serves several purposes:

- Provides a rainy day fund, so when bad things happen, there is money to cover them
- Motivates a company to avoid undesirable levels of risk (from a policyholder perspective)
- Promotes a risk measurement and management culture within a company, to the extent that the capital requirements are a function of actual economic risk
- Provides a tool for supervisors to assume control of a failed or failing company
- Alerts supervisors to emerging trends in the market
- Ensures that the insurance portfolio of a troubled insurer can be transferred to another carrier with high certainty

The IAA defines economic capital as what the company judges it requires for ongoing operations and what it must hold in order to gain the necessary confidence of the marketplace, its policyholders, its investors and its supervisors. Economic capital can be considered to be the minimum amount of equity or investment to be maintained in the company by its owners (shareholders) to ensure the ongoing operation of the company. Since a company's net income is often measured as a rate of return on investor equity, many companies are

motivated to maintain actual capital as close as possible to economic capital in order to maximize return on equity.

This is in general different from the target regulatory capital that a company is required by its supervisors to hold as a condition of being granted a licence or to continue to conduct the business of insurance in a jurisdiction.

The total balance sheet requirement (TBSR) is defined as the sum of the value of the liabilities and the required risk capital. The IAA Working Party believes that solvency would be best defined in terms of the TBSR. This approach allows capital adequacy assessment relatively independent of the accounting system. One obtains the solvency capital requirement as the difference between the TBSR and the liability requirements.

The present study focuses on the internal group capital adequacy point of view. We observed that required risk capital on top of the insurance liability value is a target value for the current portfolio to be able to avoid potential default or absorb potential losses within a given time horizon, measured with respect to a predetermined overall risk tolerance (confidence level). This may involve in particular a sound set of assumptions concerning future new business and management actions. The objective is throughout based on the individual internal concept of solvency.

DNB

The question is how one can achieve that there will be enough resources at the end of that year to cover the realistic value of the technical provision of the remaining contracts? The answer is of course that the insurer will need to hold additional capital at the start of the year. There needs to be a high degree of probability that after one year the realistic value of the technical provision of the remaining contracts will still be covered by the resources available at that time. The solvency surcharge is to be calculated in such a way that this degree of probability is achieved. The solvency on top of the realistic value of the technical provision is needed to make sure that the total level of assets after one year is higher than the realistic value of the technical provision after one year (with a probability of 99,5%).

BPV

The required risk capital is the expected shortfall of change of risk bearing capital during one year.

BaFin

The output of the internal model is a probability distribution. The regulatory capital is somehow derived from that distribution. It is clear that the risk of a portfolio depends on the base currency. This will be EUR for Solvency II purposes.

7 Valuation of assets and liabilities

7.1 Considered assets and liabilities

It is understood that those assets and liabilities are considered for capital adequacy purposes which

- are material from an economic point of view (policyholders' or shareholders')
- are expected to give rise to cash flows
- influence future cash flows from an economic point of view, independently of their balance sheet treatment.

Assets and liabilities are split into classes such that risk factors and risk exposures relevant for the risk calculations are adequately captured. There is no clear trend regarding granularity: some companies assess insurance liabilities on an aggregate level (e.g. by guarantee level, line of business, out of embedded value runs, etc.), some consider policy levels (especially, for life insurance).

Assets include cash, bonds (government, corporate), loans, mortgages, equity, real estate, investment funds: equity, real estate, bond funds, and others.

Significant insurance subsidiaries should have their own internal capital model based on a consistent group-wide methodology, but implemented locally to ensure full embedding within the management of the business unit, and integration into the risk management framework. Small insurance subsidiaries are taken at net asset value.

Strategic shares (shares held for strategic reasons) should be given a particular treatment due to concentration and illiquidity risk.

Intangibles (such as deferred tax assets, deferred acquisition cost, goodwill) are in the majority of cases subtracted from the accounting balance sheet (i.e. are given zero economic value), except for a few participants (at least 3), in particular, those who take the shareholders' point of view.

The pension scheme liabilities/employee benefits are not yet fully considered in all models. Some participants allow for pension liabilities or subordinated debt at group level only. It is recommended that internal models should be able to take into account the full spectrum of liabilities.

We recommend in line with the FTK consultation document (October 2004) that any institution must consider whether financing instruments will result in foreseeable liabilities. These are part of loan capital. Under the going concern assumption, a subordinated loan may be seen as a foreseeable liability if the issuer is morally or legally obliged to make payments to the holder of that loan. This obligation will lapse in the event of bankruptcy.

This study does not enter a detailed discussion about expenses. The IAA Working Party recommends that solvency assessment of insurers should also consider the risks involved with

the expenses of a company. Henceforth we suppose that any cost be implicit part of the liabilities.

7.2 Asset valuation principles

Throughout the companies, assets are valued on a market consistent basis. That is, assets are marked to market if a market value is available and otherwise marked to model (e.g. using an arbitrage-free multi-currency economic scenario generator, such as Barrie and Hibbert).

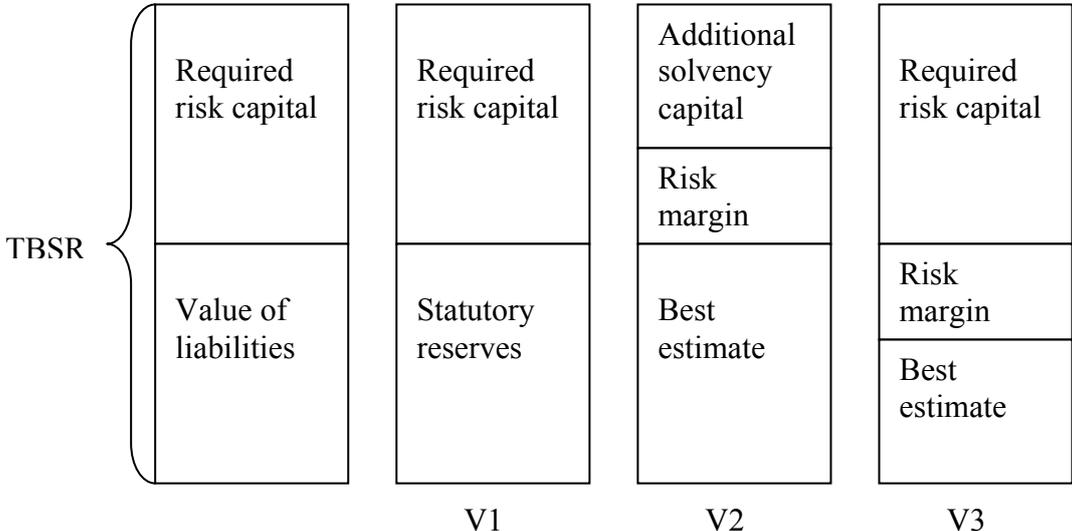
Foreign exchange risk is supposed to be an integral part of the risk assessment for all methods used. However, it is not always fully taken into account yet.

Future prices of assets and liabilities are modelled with and without drift. Clearly, the latter is a more prudent approach. Statistical estimation of a drift is known not to be reliable on specific (short term) time horizons. See e.g. Embrechts, P., Kaufmann, R., Patie, P.: Strategic long-term financial risks: single risk factors (ETH Working paper, 2004).

7.3 Liability valuation principles

There is currently no industry standard for liability valuation. We observed the following basic approaches:

- 5 participants define the value of insurance liabilities as best estimate, letting the (implicit) risk margin be part of the required capital (V2).
- 4 participants compute and add an explicit risk margin to the best estimate for the value of insurance liabilities (V3).
- For 3 participants their models are (partially) based on statutory values (V1); for example, as a proxy for economic values for some business units. As a side effect, this takes into account “realistic fungibility” of capital, any statutory solvency requirements and valuation rules.



It was also mentioned that, in a multi-year model, if no intermediate balance sheets are needed, the initial liabilities may be valued by assessing the initial amount of assets required to cover in full the claims and expenses over the entire run-off.

As for market consistency of liability valuation, we got the following answers:

- 9 participants use or are aiming at (by e.g. approximations) market consistent valuation
- 3 participants use different concepts: (mixture of) regulatory/statutory demands. These participants coincide with the above 3 with (V1).

Stochastic simulation models introduce technical difficulties when applying nested “stochastic within stochastic” valuations at each point in time. Some participants have agreed with the local regulator upon simplified, approximate gross up factor approaches to long term liability valuation. Here we recommend the adaptation of the method by F.A. Longstaff and E.S. Schwartz (UCLA): Valuing American Options by Simulation: A Simple Least-Squares Approach, Review of Financial Studies vol. 14 (2001). The idea of the method is to approximate the conditional continuation values with linear regression.

A possible realistic approach towards statutory intermediate solvency assessment is to apply the respective regulatory demands. This partly captures the current fungibility of capital at group level. Note that the surrender value of life insurance liabilities may be higher than a market consistent value.

Mostly, cash flows are (intended to be) modelled net of reinsurance. If reinsurance programs are dealt with at group level, then local cash flows are taken gross of reinsurance, and reinsurance is taken into account on an aggregate level, e.g. as an asset which is subject to default risk.

DNB

The insurance undertaking should determine the expected value (of each component), i.e. a central estimate, of the technical provision for each individual homogeneous risk group. In order to cover unavoidable risks and uncertainties inherent in the insurance liabilities, the realistic value of the insurance liabilities should contain a 'central estimate' as well as a suitable risk margin. The risk margin, added to this central estimate, is set in such a way that it complies with a target level of prudence (V3).

BPV

The value of liabilities is given as market consistent best estimate (V2).

BaFin

Valuation should approximate a “fair market value”, which includes an appropriate valuation margin. Mark to market where possible; mark to model otherwise.

7.3.1 Best estimate

For the majority of the participants the best estimate is based on

- Expectation of discounted cash flows
- Policyholder behaviour taken into account as realistically as possible

- Embedded options and guarantees taken into account
- Discounted by risk-free (policyholder point of view) or risk- and cost-adjusted (shareholder point of view) yield curve

The degree of application of the above principles varies within the groups by lines of business. A few participants follow explicitly a different approach, such as

- The present value (discounted by the realized rates of the asset fund) of the cash flows emerging in a best estimate scenario
- Expected nominal ultimate claim size for non-life business

We recommend that the best estimate of the insurance liabilities comprises any market consistent value with no explicit margin for insurance technical risk (such as mortality level risk). This may, for instance, be approached by a replicating portfolio, modelling all policyholder liabilities and interactions with the financial markets on a stochastic basis and using discounting methods (deflators) and/or scenarios (risk-neutral) which ensure market consistency. Market consistency would require to taking into account policyholder participation and all embedded options and guarantees subject to market risk. A risk margin, reflecting prudence in a market consistent way, may be added on top of the best estimate.

DNB

See comments at the beginning of Section 7.3.

BPV

The best estimate is the discounted cash flow + valuation of options and guarantees

BaFin

Expectation under the statistically estimated probability measure.

7.3.2 Risk margin

We observed the following definitions of the explicit risk margin:

- present value of expected future capital costs (this may include risk capital cost, regulatory capital cost, and tax capital cost), or
- based on a quantile (75% to 90%) of the P&L distribution. This can be defined as the outcome of particular regulatory-predetermined scenarios (market, credit and insurance risk).

Both approaches are equally often used by the participants.

We recommend that the risk margin is an add-on to the best estimate, which is to be distinguished from any additional solvency capital required for e.g. a target rating. This margin should reflect prudence explicitly in a market consistent way. It could consist of future risk and/or regulatory and/or tax capital cost. We do not recommend that the risk margin is defined as a quantile of some loss distribution without linking it to an economic argument.

The sum of best estimate and risk margin could for instance be linked to the IASB “entity-specific value” or “fair value” concept.

DNB

Until some theoretical and practical issues regarding the market value margin will be resolved – no markets exist in which transparent price setting occurs in relation to the transfer of liabilities between institutions; a situation of imperfect information and information asymmetry exists; in addition, sufficient market data have not been available for all sectors and branches for a model-based valuation of insurance liabilities – the insurance undertaking could approximate this margin for unavoidable risks using the 75% confidence level. This confidence level regards the probability distribution of the present value of all cash flows arising from the insurance contracts during the lifetime of the insurance contracts.

BPV

Cost of capital for the present value of future target capital necessary for the run-off of the portfolio, where one can assume that the assets are moved to an optimal replicating portfolio taking into account liquidity constraints

BaFin

The value of insurance liabilities may be composed of best estimate and explicit risk margin, if “derivative-like” valuation under the risk-neutral measure is not possible for the specific asset or liability. Risk margin is defined as some estimate of the risk premium, which will be related to the non-diversifiable part of the risk of the asset.

7.3.3 Discounting of future cash values

As for the discounting of future cash values for the valuation of assets and liabilities,

- 5 participants discount insurance cash flows by the currency specific risk-free rates. This contains the replicating portfolio valuation method in particular.
- 5 participants use (AA) swap rates instead. This is either to i) approximate the risk-free rates by more reliable swap rates (5 participants), and/or ii) to express the option to default on the insurance liabilities (shareholder’s point of view) (1 participant)
- 3 participants use different discounting factors, such as statutory reserving rates, returns of invested assets or risk- and cost-adjusted rates (shareholder point of view).

For the market consistent bond valuation on the asset side, the rating’s appropriate discount rates are used.

DNB

An institution’s insurance liabilities are valued by discounting the associated cash flows using a term structure of interest rates which has to be based on the zero coupon yields on default-free capital market instruments. The expected value of pension and insurance liabilities can be estimated in this way if their realistic value cannot be observed directly in the market.

The creditworthiness of the supervised institution and the yields on the underlying investments, therefore, has no effect on the valuation of the liabilities. This relationship only has to be reflected in the valuation if the contractual terms of the liabilities have a direct link with specific investments of the institution, such as unit-linked insurance where the institution does not bear the investment risk.

DNB intends to publish a nominal term structure of interest rates for discounting pension and insurance liabilities denominated in euros to be used to determine the realistic value of the expected cash flows. For this, DNB intends:

- to use information from the market for interest rate products (including interbank swaps) in deriving the term structure of interest rates;
- to estimate the term structure of interest rates frequently, using the above methodology, and to publish the results.

Discounting approximation method

Various responses to the Solvency Test White Paper expressed a concern that it would be difficult for smaller institutions in particular to meet the terms of the FTK. A valuation method is, therefore, proposed for pension and insurance liabilities which approximates the valuation of explicit cash flows using the term structure of interest rates.

Under this approach, the present value of pension and insurance liabilities is calculated from the present actuarial/administrative valuation techniques in the institution's records using the most suitable discount rate. The institution must first estimate the maturity characteristics of the underlying liabilities at each reporting date. It has to obtain the interest rate appropriate to this maturity from the term structure of interest rates prescribed by DNB. The institution can estimate the expected value of the insurance portfolio using this interest rate. The advantage of this is that this method is in line with the institution's probable actual actuarial/administrative techniques.

Despite the disadvantage that there can be significant differences between the valuation of cash flows under the term structure of interest rates and valuation using the approximation method, this approach may remain an option for a few years for smaller institutions in particular, provided certain conditions are met:

- There needs to be a valuation for each homogenous risk group;
- The value thus established must have an additional surcharge because of possible shortfalls compared with the expected value of the liabilities based on the term structure of interest rates. DNB will set this margin at least once a year. The amount of the margin will be derived in part from the curve of the term structure of interest rates at year end. This surcharge will also encourage institutions to make the effort to establish the realistic value based on the term structure of interest rates.

BPV

The discount factor is the risk-free rate.

BaFin

We expect the EUR swap curve to be used as the benchmark curve in discounting. Swap rates are available up to 50 years time to maturity in Bloomberg.

7.3.4 Embedded options and guarantees

To the question whether embedded options and guarantees are taken into account for the valuation of insurance liabilities, 9 participants answered with a straight "yes". That is, they use market consistent methods for the valuation of embedded options and guarantees, such as risk-neutral Monte Carlo simulations of future cash flows. Moreover,

- 11 participants take policyholder behaviour into account

- 8 participants take management actions (e.g. bonus cutting) into account (partially only approximately or in parts of the business).

Exceptions/special cases are due to

- Embedded options in non-life (e.g. special termination or extended discovery clauses) are claimed to be non material and difficult to model, and are neglected
- The European Embedded Value project is sometimes used as basis for valuing embedded options. However, embedded value has a limited ability to capture embedded options adequately (e.g. deterministic assumptions on asset returns, technical discount rate, etc).
- Multi-year models face a technical problem in determining future liability values (nested Monte Carlo within Monte Carlo simulation). They use approximations such as closed form solutions to value embedded options. This can only make partial allowance for management actions and policyholder behaviour.
- In some multi-year risk assessment models, the embedded options and guarantees are not valued at time 0, but the cash flow impact of options and guarantees is taken into consideration in each of the years in the projection period. Market values are not so relevant since the model aims at total balance sheet requirement. Simple rules apply if the option is in the money.

DNB

Each embedded option must be valued. This is an option available to the issuer or holder of an instrument that is built into the investment.

Prudential supervision requires the realistic value of the pension and insurance liabilities to be established by a suitable method applied consistently and uniformly. The principle in this is that DNB does not prescribe a technique, but checks that every institution applies relevant methods that are widely recognised internationally.

BPV

Embedded options and guarantees have to be modelled, methodology has to be disclosed to the regulator. If policyholders are assumed to behave sub-optimally, the evidence for this behavioural assumption has to be shown.

BaFin

We expect the most important options and guarantees to be modelled in both the valuation and the risk models.

7.3.5 Time horizon

In principle, valuations take into account the full life of the contracts (up to 120 years). For practical purposes this life span can be truncated. The remainder of the cash flows is either neglected since minute or summarized in a terminal cash flow.

- 5 participants consider complete run-off
- 7 participants truncate at 25 to 65 years.

DNB

The time horizon used for valuation purposes equals the maturity of the liabilities.

BaFin

In principle, all future cash flows affect the valuation.

7.3.6 Going concern vs. run-off

Taking anticipated new business into account may lower the current value of (future) insurance liabilities, if the anticipated new business is assumed to be profitable. A going concern without assuming new business does still take into account future premiums of in force business.

- 11 participants take no more than one year of new business into account. That is, the in force business at the measurement date is run-off without considering new business. However, where relevant (e.g. short tailed non-life), anticipated new business or renewals are accounted for.
- 2 participants take two to four years of anticipated new business into account

DNB

The valuation of the assets and liabilities are based on going concern assumption. For the determination of the realistic value new business is not taken into account.

BPV

New business during one year

BaFin

The valuation of the assets and liabilities are based on going concern assumptions.

7.3.7 Level of valuation

There is no clear trend with regard to the level of valuation. Many internal models run on business unit levels and are not uniform across business units. Their scope and complexity depend on the size of the business unit and the software platform available. In general terms, we observed the following valuation levels in use

- Assets:
 - instrument level (e.g. bond coupon payments for immediate annuities)
 - grouped by asset classes (e.g. government bonds, corporate bonds, equity, etc)
 - grouped by business segments or geography
- Liabilities:
 - Contract level
 - Grouped by issue quarter/year
 - Grouped by technical rate, minimum guarantee, profit sharing mechanism
 - Homogeneous groups of risk types
 - Short tail, long tail business
 - On replicating portfolio basis

Note: If the valuation is based on expectation, then it should be additive, hence aggregation level invariant. However, this does not apply for the risk margin in general.

DNB

Valuation at the level of homogeneous risk groups.

BPV

The level of valuation is up to the company.

BaFin

Since the mathematical core of valuation is an expectation (under the risk neutral measure if risk premia/valuation margins are explicitly considered) valuation is additive. Hence the aggregate result is independent of the aggregation level. Valuation is essential for P&L-attribution. Thus every business unit that is to be risk controlled needs to have valuation and P&L-attribution.

7.3.8 Equalization reserves and future potential catastrophic losses

All participants consider equalization reserves as part of the (risk bearing) shareholder equity capital. Future potential catastrophic losses (of in force liabilities) are captured by the risk model and charged accordingly by required capital. Multi-period run-off risk assessment models capture in principle future potential losses beyond a one year time horizon, which makes equalization reserves an implicit part of required capital.

DNB

The overall aim of the proposal is to provide a more transparent, more risk sensitive and more comparable starting point for regulators and firms to assess a firm's capital needs.

Within the proposed valuation principles one of the main objectives is to achieve a realistic valuation of the liabilities. Within this valuation context equalization provisions will be non-existing.

Within the standardised method of the Solvency test catastrophic risk is not included. For firms applying the standardised method catastrophe risk should be dealt within Pillar II simultaneously with the judgement of the re-insurance program.

BPV

Equalization reserves are risk-bearing capital.

BaFin

The risk modelling should be consistent with the way equalization reserves influence P&L. We expect valuation to be influenced by the prices of reinsurance contracts. Natural catastrophes with reliable statistical data should be considered as risk drivers in the risk model if the company is exposed to those risks.

8 Modelling of risk variables and dependencies

From a note of the European Commission to the Solvency Subcommittee (Markt 2085/01):
“A risk-based capital system is a system in which the minimum capital requirement is based on the risk – or risks – facing an insurance company. This is thus a very broad definition. It may include the European minimum margin rule: using simple indicators, this rule seeks to set a capital requirement in terms of the business fluctuations that occur once a company has set aside sufficient technical provisions and holds appropriate investments.”

We believe that an internal risk-based capital adequacy system should go beyond absorbing the normal business fluctuations. The sources of randomness are uncertain cash flows and future asset and liability values, which again are caused by more fundamental underlying random risk factors.

There are many definitions of risk. A useful one was published in 1995 by Standards Australia and Standards New Zealand:

“Risk – the chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood.”

This definition implies that risk may entail both upside as well as downside impacts.

The mathematical model is a random variable (quantifies “consequences”) defined on a probability space (quantifies “likelihood”). Risk is quantified by applying a risk measure to the resulting (e.g. P&L) probability distribution.

8.1 Risk classification

The IAA Working Party categorizes risk under the four major headings market risk, credit risk, insurance risk (underwriting risk), and operational risk.

Each risk type is further decomposed into three components

- Volatility risk: random fluctuations due to chance; the diversifiable risk component. In fully efficient markets, volatility is not market-valued, since investors can diversify their portfolio. However, insurance policyholders cannot diversify this component away and therefore need protection against volatility. Examples: chance (random) fluctuations in both numbers of claims (frequency) and amount of claims (severity); normal day to day fluctuations of market values.
- Uncertainty risk: uncertainty about model parameters due to sampling error and uncertainty in modelling the future. Cannot be diversified. Examples: mis-specification of models for frequency and severity (model risk); parameters in selected model (parameter risk); use of incorrect or mis-calibrated model for market value or interest rate movements
- Extreme event risk: risk of large common-cause event; calamity, high-impact, low-frequency risks. Models may not capture all aspects of extreme risk especially if no extreme events appear in the historical data used to develop models. Examples: catastrophe with multiple claims; market crash or extreme interest rate movements.

Quantitatively assessed risks lead to capital charges; qualitatively assessed risks do not explicitly lead to capital charges but affect the management processes.

8.1.1 Market risks

The prevalent risk drivers are

- Principal components of the yield curve
- Equity indices
- FX rates
- Real estate indices
- Etc

Market risk types (e.g. interest rates) apply across different economic zones and need to be cross-correlated.

For FX there is a distinction between functional FX risk (the potential FX mismatch between liability cash flow and its backing asset portfolio) and translation FX risk (the potential FX mismatch between different asset/liability sub-portfolios).

Functional FX risk matters for capital adequacy: when liabilities and backing assets or supporting capital are not currency matched (structural risk), FX movements can lead to less capital supporting the same liabilities.

Translation FX risk does not matter for capital adequacy: when liabilities, backing assets and supporting capital are currency matched, movements in capital occur (translation risk) but the relation between risk and capital remains the same.

Several methods have been proposed to take these aspects into account (see e.g. Artzner P., Delbaen F., Koch P.: Risk measures and efficient use of capital, ETH Working paper 2005).

Multi-year risk assessments capture the functional currency mismatch risk by explicit dynamic modelling of the FX rates.

For 10 participants, currency mismatch leads to a capital charge. If a replicating portfolio is used for valuation then the currency mismatch is included in the asset risks. Otherwise, simplified methods are applied, such as flat percentage charges.

The mentioned reasons for not charging currency mismatch risk with capital are: it is not considered a material risk or it is qualitatively assessed in a separate framework.

It is recommended that functional mismatch is being eliminated. A participant observed: where a business unit has only small amounts of foreign investments they may ignore them. Often the additional exchange risk is more than offset by the diversification benefit of investing in a different economy

DNB

For market risks, the scenario approach in the standardised method for the solvency test applies. See Section 8.4.1 “Formal definitions in use”.

Currency mismatch does not play a role in the valuation of assets and liabilities. The standardised method determines the desired solvency for foreign exchange risk in a scenario. For the total foreign currency position, and taking account of the applicable investment policy, the institution has to determine the effect on the surplus of a fall in value of all other currencies against the euro of 25%.

BPV

Market risks are assessed by RiskMetrics methodology. Currency risk is taken into account.

BaFin

We expect a variety of models and are open to innovations. FX rates should be a risk driver if P&L is affected by FX.

8.1.2 Credit risks

The investment credit risk is modelled in a sophisticated way, which is consistent with the banking standards. Default, migration, spread and spread volatility risks are considered. Industry standard models in use are: KMV, Credit Risk+, S&P. Some participants mention that these standard models may be too conservative, since they do not allow for future rebalancing (e.g. selling bonds) of the portfolio.

Often the economic scenario generator for market risks is also used for investment credit risk.

The reinsurance default risk is quantitatively assessed, with only a few exceptions among the participants, where this risk is claimed not material. For the quantitative modelling, in house developments (stochastic factor models, implemented by Monte Carlo method) are in use.

We recommend that the dependencies between reinsurance defaults, market risks and catastrophic losses are taken into account.

DNB

Credit risk is expressed in the credit spread. This is the difference between the effective yields on a collection of cash flows whose payment depends on the creditworthiness of counterparties and the effective yields on the same collection of cash flows as if they were certain to be paid. Generally, bonds of a highly creditworthy government are regarded as default free. In practice, therefore, the credit spread of, say, corporate bonds is derived by comparing the effective yield on a corporate bond with the effective yield on a government bond. As well as corporate loans, a claim on counterparty, for example, a re-insurer, intermediary or counterparty in a private derivatives contract, may also carry credit risk.

The standardised method does not determine the desired solvency for every different investment with credit risk or claim on a counterparty. The desired solvency is derived by changing the observed credit spread on the investment portfolio (including claims for example, on re-insurers or intermediaries) by a certain fixed factor. This means that the shock is lower in absolute terms if the credit spread observed at the reporting date is low. The extent to which an institution is sensitive to the shock in the credit spread depends on the maturity characteristics of the cash flows and claims in the portfolio.

As a rule, credit risk distinguishes between systematic and non-systematic risk components.

Systematic credit risk refers to regular market movements in credit spreads. Non-systematic credit risk plays a role if the change in credit spread comes from a change in the issuer's credit rating. Non-systematic credit risk is also known as idiosyncratic credit risk. Other than concentration of risks (for example, a large claim on a re-insurer), it is likely that the idiosyncratic credit risk for individual pension funds and insurers is limited. It is also plausible that these institutional investors have a preference, under mandate restrictions, for loans with high creditworthiness (for example, at least investment grade). Consequently, the scenario for credit risk has a simple design.

The standardised method determines the desired solvency for credit risk in a scenario. Given the total investment portfolio, claims on counterparties and taking account of the investment policy, the institution has to determine the effect on the surplus of an immediate increase in credit spreads of 60% [pension funds: 40%] compared with the actual credit spread at the reporting date. For example, if the observed spread is equal to 100 basis points, the solvency test has to calculate the effect of an increase to 160 basis points. The effect on the surplus of a rise of 60 basis points is the desired solvency for credit risk. An approximation using information already available to compute the realistic value may be used in determining the desired solvency for credit risk.

BPV

Credit modelling: Basel II or full internal model

BaFin

We expect a variety of models and are open to innovations.

8.1.3 Insurance risks

For life insurance, the typical method is factor based. The main risk drivers mentioned throughout are mortality, morbidity, persistency and lapse risk. Market risk drivers, such as interest rates, should be modelled top down and across business units to capture the systematic impact of such risks. Local risk, such as mortality, can be modelled at lower levels. When there is partial functional dependence between risk factors (such as lapse rates depending on interest rates), then this should be captured appropriately. E.g. interest rates drive lapse rates according to some formula, taking into account some statistically significant residual risk.

At least 2 participants mentioned to just shocking these insurance parameters: the stressed parameter result gives required capital ("worst case"). 6 participants use a full stochastic factor model life insurance risk, 3 participants use a variance-covariance method.

A general remark of a participant is remarkable and should be guideline for any internal model: "Our internal capital assessment approach is evolving. This means that the balance between stochastic modelling and deterministic stress tests (downside estimates) is changing constantly, as our understanding and confidence in our stochastic models improves."

For non-life insurance the IAA recommends special consideration of

1. Heterogeneity of risks: requires the forming of homogeneous risk groups, such as lines of business and the distinction of basic, large, cumulative and catastrophic claims losses, short and long tailed business.

2. Substantial effects of correlation between different non-life insurance risks: requires an appropriate dependency structure in the stochastic model.
3. Difference between reserving risk (outstanding claims liabilities) and premium risk (inherent in unearned premiums): requires separate modelling of reserving and premium risk.
4. Annual renewal for the vast majority of the business: going concern (including anticipated new business) vs. run-off (no new business taken into account).
5. Significant role played by reinsurance (especially in relation to concentration of risk): effect of reinsurance and default of reinsurance.

A great variety of models are in use, complying more or less with the above IAA aspects 1-5. We recommend that compliance with these IAA aspects is improved. In particular, that

- premium risk is adequately modelled. E.g. basic losses: modelling of loss ratio distributions (scaling by premium), triangulation data is included in modelling process where necessary. Large losses: collective models (frequency scaling by premium). Natural catastrophes: collective models (severity scaling by probable maximal loss measure) using geoscientists expertise.
- the risk of under-reserving and cost inflation is appropriately assessed.
- the dependencies between lines of business and premium and reserving risk are captured.

DNB

An institution has to maintain capital for underwriting risks. Solvency for these risks is desired for abnormal negative variations in underwriting results within a year, given the provision at realistic value. The desired solvency is determined for each risk group to be reported. The life and non-life sectors are separated for this. The same risk groups are used as for market value margins in the context of the realistic value.

Where applicable, some degree of diversification between the risk groups is allowed for when aggregating the solvency results for the risk groups to the total desired solvency for underwriting risks. Annexe 4 of the FTK consultation document provides details for determining the desired solvency for underwriting risk using the standardised method.

BPV

Life: Covariance approach, P&C distribution based model

BaFin

We expect a variety of models and are open to innovations.

8.1.4 Operational risks

We recommend that a clear and standardized sub-classification of operational risks is developed as a first step towards a systematic quantitative assessment. Objective of any standards should be to provide behavioural incentives towards greater understanding and management of such risks. Operational risks should be in Pillar II until there is sufficient industry data available to build sound statistical models.

- 7 participants use a flat percentage rule (10-20% of either available or other risk capital, possibly separate rates per line of business) for the operational risk capital add-on charge.

- 3 participants are using stochastic operational risk models.
- 3 participants mentioned other methods to estimate the (e.g. aggregate) annual cost of operational risk (e.g. based on historical data, or by a qualitative analysis).

Moreover, at least 2 participants are developing stochastic operational risk models.

The following observations could serve as benchmarks for further developments:

- The model incorporates a bonus/malus system based on portfolio reviews with the aim of not only quantifying but reducing operational risk.
- Taxonomy: operational risks that are already captured in the main model (either by required capital or as a liability), or for which capital is not the appropriate response are filtered out.
- Frequency-severity model:
 1. The main operational risks are captured in each business unit through scenario analysis with senior business and risk managers. The scenario analysis process includes defining the 'story' behind each risk scenario and determining frequency and severity parameters. These assessments are based on a wide range of information, including existing risk reporting, audit reports and plans, relevant external losses from the Fitch F1RST database and other sources, such as ORX, other business units' scenarios, external-consultant experience and the BIS II event type taxonomy.
 2. Some industry-standard distributions are then fitted to each scenario's frequency and severity parameters.
 3. Dependencies between different operational risks and other risk types are captured through careful definition and vetting of the scenarios.
- Simple add-on models: an aggregate operational risk charge is determined by combining the anticipated costs for the identified operational risks, assuming a degree of correlation and a confidence level.

DNB

Comprehensive consideration of all relevant risk factors is needed for operating risk. Institutions have to identify value and report operating risk. DNB proposes to assess and discuss these findings with the institution. It also wants to issue a report on this at an aggregated level along with the industry. In this way, DNB intends to raise understanding of operating risk to a higher level and, on the basis of this, to develop simple rules for the standardised method of the Solvency test.

BPV

Operational risks: in Pillar 2.

BaFin

We expect a variety of models and are open to innovations.

8.1.5 Intra-group risks

The hypothetical netting of intra-group risks (participations, loans, retrocession, etc) at group level requires fungibility of capital and may be restricted by regulatory minimum capital requirements. This aspect is further discussed in connection with aggregation and diversification of risks (see Section 9.2 “Fungibility of capital”). From a purely frictionless economic point of view, however, intra-group risks do cancel out at group level.

- 8 participants do not consider intra-group risks at group level (netting out assumption). Some of these participants mention to consider this pure economic approach as a starting point to be further developed.
- One participant models explicitly capital transfers and cash-flows from business units to group and vice versa and across business units, taking into account fungibility constraints.
- Some participants are reviewing this aspect at this time.

At legal entity level, intra-group debt should be given highest seniority to avoid double gearing.

We recommend that internal models are developed towards capturing the real side effects of intra-group transactions, at least qualitatively, say by a 3-4 year cash-flow test.

DNB

Not specifically addressed within the FAF.

BPV

Participations are modelled like a share (but with 25% more volatility, fully correlated to share index).

BaFin

In general, the supervisor is to be informed about intra group transactions. Intra group transactions are neutralized in the consolidated group report, however, and hence do not effect the solvency requirement and the available capital. (Basis for the available capital of the group is the consolidated balance sheet.)

8.1.6 Model uncertainty

According to the IAA proposal, each risk type is split into: model uncertainty, volatility, extreme event (calamity) risk. Hence model uncertainty is captured quantitatively as “model parameter uncertainty”.

Qualitative assessment of model uncertainty is through actuarial judgement where parameter estimates or model appropriateness is in doubt.

Quantitative assessment can be through

- The choice of a very high confidence level or holding a minimum amount of excess capital (mentioned by 2 participants)
- A conservative choice of the model parameters, e.g. as a result of downside stress tests (mentioned by 3 participants)
- Implicit modelling of parameter error, comparable to the IAA proposal (mentioned by 2 participants)

At least 3 participants mentioned that quantitative internal assessment methods are being (further) developed.

In summary, there is no clear trend and homogeneity among the participants. We recommend, in a first step, that model uncertainty is qualitatively assessed (e.g. through plausibility and

sensitivity checks, statistical back-testing where available, etc.). Important is to know the sensitivity of the results towards variations of the key parameters. See also the BaFin comments.

BPV

Model uncertainty is not taken into account.

BaFin

We expect parameter uncertainty to be taken into account “automatically” in the sense that the predictions of the model are continuously compared to realizations in the P&L attribution process. The scale of the residual, unexplained P&L is measured out-of-sample instead of in-sample and thus contains the noise stemming from parameter/estimation uncertainty. The “sensitivity analyses” have the goal to test the influence of certain model assumptions and quantify weaknesses of the model. (See point 5.4 in the BaFin White Paper.)

8.1.7 Quantitatively assessed risks

All participants (including the regulators) are consistent with the IAA major risk classification. The major categories are further split into risk-types, which vary across the participants, such as

- Market risk: FX, equity, interest rates, real estate, inflation, GDP, etc
- Credit risk: counterparty default (reinsurance or derivative), migration, spread, etc
- Insurance risk: life (mortality, morbidity, persistency, etc), non-life (per line of business, basic (attritional) losses, large losses, cumulative losses, etc), health
- Operational risk: Business, Compliance, Fraud, Legal, Administration, Staff, Physical Assets, Systems, Tax, etc, but also model parameters such as mortality, morbidity and persistency rates are mentioned under operational risks

Operational risks are either quantitatively modelled or qualitatively assessed, and may or may not lead to a capital charge, see below.

A few participants consider concentration risks, both in investment and insurance exposure.

8.1.8 Qualitatively assessed risks

As for the qualitatively assessed risk types

- 9 participants mention operational risks (4 of them charge capital according to a flat percentage rate of both, available and required capital)
- 3 participants mention liquidity risk
- 2 participants mention strategy and reputation risk
- Regulatory, reinsurance counter-party exposure risks are mentioned each by one participant, respectively

8.1.9 Pillar I or II

There is consensus among the participants that all quantifiable risks should be under Pillar I, preferably based on the internal models.

Operational risks impose a challenge, for insurers in particular, because of the current general lack of sufficient quantitative data. According to the IAA, there can be no experience-based explicit Pillar I requirement for insurers at this time.

This view is shared by the majority of the participants: 8 participants mention operational risk explicitly as part of Pillar II. 3 of them consider particular sub-types of operational risk also to be in Pillar I. Only 2 participants see operational risk exclusively under Pillar I at this time.

The IAA gives a particular hint to liquidity risk (exposure to losses when a company has to borrow unexpectedly or sell assets for an unanticipated low price). They recommend a qualitative assessment that is subject to Pillar II. According to some participants, companies should demonstrate that they have a strong liquidity position via comprehensive group-wide liquidity modelling. This can be a supervisory issue but not capital.

DNB

All risks mentioned above should be included in pillar I.

BPV

The mentioned risks are in pillar I.

BaFin

BaFin views operational risks to be covered by Pillar I in Solvency II. This might be computed in a crude way (similar to the basic method in Basel II) for the standard formula as a place holder for future improvements. Statistical OpRisk modelling in the internal model should be linked to the risk management process through performance indicators and quality criteria of business processes.

8.2 Model classification

Based on the analysed internal systems we found the following model classification appropriate:

Scenario based model

The risk capital calculation implies measuring the impact of (company) specific scenarios to the total P&L distribution. These scenarios are distinct from stress tests (sensitivity analysis, shocks) where individual risk drivers are varied. A scenario is a description of a complete alternate state of the world. This includes generic scenarios such as earthquakes or windstorms.

Examples: SST (see below). DCAT (Dynamic Capital Adequacy Testing, OSFI Canada): the company's activity is projected through the model for some specified future period (3 to 5 years). These projections are made under a variety of scenarios of possible future experience. The scenarios are usually chosen on a deterministic basis. In some circumstance, scenarios may be chosen stochastically, but only where appropriate probability distributions of relevant experience factors exist.

Static factor model

The risk capital calculation is based on a linear combination of static factors ("risk weights") multiplied with company specific size measures. No stochastic cash flow modelling is made.

Static factor models are simple and can be calibrated to an average (small) insurer. However, they are too simple to be truly risk specific. Diversification benefits or reinsurance effects are difficult to integrate.

We recommend that the internal risk models do not incorporate static factor models, unless they refer to the “normal business fluctuations” and are in-house recalibrated on a continuous basis.

Examples: Solvency I, Basel II

Covariance model

The risk capital calculation is based on an aggregation of single risk numbers by simple sum or square root formulae. Also called: “VaR model”, “variance-covariance model”, “RBC model”.

The sensitivity of the total P&L with respect to the risk factors is portfolio specific and determined by a first-order sensitivity analysis (estimating the “Deltas”). Each single risk driver is then “shocked”, that is, put at its predetermined quantile value. This quantile value is a multiple of the standard deviation, which is derived from historical time series or model based. The resulting portfolio values are recorded and aggregated according to a correlation matrix. This is the DNB standard “scenario approach” described in Section 8.4.1.

The covariance method implicitly assumes a linear dependence of the total P&L on multi-normal (or Bernoulli) distributed risk factors. This method is therefore of limited suitability for large movements of the risk factors (heavy tailed distributions) and non-linear instruments (e.g. options). The accuracy of the covariance method can be improved by using the IAA sub-risk classification including the risk components volatility, uncertainty and calamity.

The covariance model does not behave associatively when it comes to aggregation across different hierarchical levels, which may cause temporal instability of the results (see Henk van Broekhoven, “How to calculate diversification”, March 17, 2005). See also the example in Section 9.1.1 “Allocation methods in use”.

Examples: RBC models, S&P, Risk Metrics, ICA (Internal Capital Assessment) models

Stochastic factor model

The risk capital calculation is based on an aggregated P&L distribution:

1. Identification: the relevant risk drivers (risk factors) are identified.
2. Sensitivity analysis: each individual risk driver value is varied over a reasonable range to determine the functional dependency of the portfolio value on this factor. This results in a Delta (proxy for the first derivative), Gamma (proxy for the second derivative), or a scenario vector (evaluation of portfolio at several knot points, for highly non-linear functional dependency.)
3. Joint distribution of risk drivers is modelled. This includes dependency modelling between the single risk factors via copulas or correlations (for multi-normal distributions). For individual risk factors, many possible models from actuarial science, finance and economics are available.
4. The resulting P&L distribution is aggregated across all risk types, leading to its full stochastic distribution.
5. The risk capital is given by applying a risk measure to the total P&L distribution.

The full stochastic factor model can be dynamically implemented using economic scenario generators (such as the commercial tool of Barrie and Hibberts). This is often the basis for the valuation of insurance liabilities. It may include a dynamic implementation of business strategies: e.g. rules that determine the portfolio composition as a function of the simulated sample path.

However, for the risk assessment, most participants use a stochastic factor model on a one-year time horizon. It has to be emphasized, though, that one-year changes of certain risk factors can have an impact on the entire cash flows beyond that one year. An example is the lapse rate, which can change due to new information coming in over the year (such as market forecasts) and which then affects the anticipated future lapses underlying the liability value at the end of that year.

The covariance model can be seen as a special stochastic factor model, with multi-normal (and/or Bernoulli) distributions, first-order (Delta) sensitivities and VaR as risk measure (which in this case is a multiple of the standard deviation).

Examples: SST (partly), internal models

The SST includes a hybrid of stochastic factor and scenario based modelling. Scenarios are specified and given weights. The conditional P&L distributions given the scenarios are determined and aggregated according to the weights. Scenarios thus have an immediate effect on the resulting aggregate P&L distribution. Double counting is avoided by weighting the scenarios.

Generally speaking, the modelled distributions are intended to be objective (empirically estimated) and not to be stressed. However, since no participant is able to model all risks stochastically, they do incorporate deterministic stress tests (“downside scenarios”: e.g. on lapse rates, calibrated to an appropriate confidence level) into their stochastic models. This means that the distributions can e.g. include some shift to represent the effect of these stresses. A technical committee has to choose these parameters in a consistent way.

It is interesting to observe that many participants start with calibrating a stochastic factor model, and translate it in a tabular form, which is then practically used as a covariance model. This is claimed to serve for better communication between the risk management unit and the rest of the staff. We believe that this is a matter of culture and education, which can be improved and adapted if necessary.

It is difficult to give a clear count of how many participants use which of the above models. The above classification is not exclusive, a covariance model (and even a simple factor model) can in principle be seen as a stochastic factor model which is translated in a tabular form. Most participants use different models at the same time, e.g. at different levels. However, we can roughly say that

- 5 participants use a covariance model
- 8 participants use a stochastic factor model (3 of them on a multi-year time horizon)

We recommend that the aggregate P&L distribution is considered in any case, since only then one can answer the following important stability questions:

- How does the required capital depend on the confidence level (varying the confidence level)?

- Given the available capital, what is the corresponding confidence level (finding the maximal confidence level)?

DNB

The principle in this is that DNB does not prescribe a technique, but checks that every institution applies relevant methods that are widely recognised internationally. Distributions could be based at the level of homogeneous risk groups.

BPV

Hybrid of stochastic factor and scenario based model.

BaFin

We view it as the defining property of a risk model that it generates a statistically estimated probability distribution of losses and future asset and liability values, on the top and at least one lower level.

8.3 Dependencies

Dependencies between market, credit, insurance and operational risks are considered throughout. The following aspects mentioned by the participants are worthwhile to be listed:

- Dependencies between loss ratios of different business segments, across different business units, to incorporate the premium cycle.
- Dependencies between large non-life losses and natural hazards across geographic regions.
- Dependencies between insurance losses and market risks. E.g. through price inflation, or lapses linked to credited rate, credited rate linked to market conditions, actual surplus, etc.
- Major scenarios are assessed with a view towards identifying cross impact effects. In this respect the 9/11 event has brought cross impacts to greater awareness, and dependencies that before that event had been identified but considered negligible, have received a new assessment.
- Dependencies between reinsurance defaults, world equity markets (USD as a proxy) and catastrophe losses.
- Dependencies between market risks within as well as across geographies.
- Dependencies between operational risks: scenarios are carefully defined and vetted so as to capture all closely (cor)related events within one scenario.
- Inter-temporal dependencies between e.g. asset returns.

We recommend that dependencies are consistently modelled across different levels:

- Central simulation of market risk factors, applied uniformly to all business units
- Central modelling of specific catastrophe events taking account of the geographic reach of such catastrophe events
- The covariance method should be based on the correlations across the lowest possible levels (see Henk van Broekhoven, “How to calculate diversification”, March 17, 2005).

As to how dependencies are modelled, a mixture of correlations, copulas and tail adjustment are in use.

- Copulas: in partial use by 6 participants. At least 2 participants use copulas for back-testing their covariance models.
- Correlations: obviously the exact method for jointly normal distributed risk factors. Hence in partial use by all participants.
- Tail adjustments: expert opinion based judgement on dependencies where empirical data basis is not available. Enforced importance sampling, can be used in connection with Monte-Carlo sampling, setting “manually” a few additional sample points in extreme regions on the diagonal. (see e.g. Mueller, Blum, Wallin: Bootstrapping the economy”)

We recommend that the shortfall of correlation aggregation is mitigated:

- Using “tail-correlations” (=stressed correlations, based on expert opinion), back-tested by full stochastic models including copulas
- Replacing a stand alone VaR by a TailVaR where appropriate (e.g. for very heavy tailed marginal distributions, to capture the potential losses beyond the quantile)

Dependencies should be based as much as possible on empirical data, but this is often inconclusive in which case management judgement needs to be applied. This judgment is based on various combinations of specifically constructed stress assumptions, reasonableness-testing and sensitivity analysis.

It is also conceivable that the exact form of a joint distribution is known for other, say, scientific reasons (see e.g. Juri, A., Wüthrich, M. V., 2002. Copula convergence theorems for tail events. Insurance: Math. Econom. 30, 405-420.)

8.4 Scenarios

8.4.1 Formal definitions in use

We have observed the following four basic formal definitions of a scenario (there have been multiple mentions):

Event/hypothesis (mentioned by 2 participants): a description of a complete alternate state of the world. These scenarios are often given a probability weight and are thus distinct from stress tests (sensitivity analysis, shocks) where one single risk driver is varied. They can also be expressed as compound Poisson distributions (frequency/severity). A good practice is if frequency and severity parameters are defined by experts and senior business and risk managers from each business unit and group risk management. These scenarios can also be the basis for a risk analysis where empirical data is missing and expert judgement is needed, e.g. for operational risk.

The event/hypothesis scenarios focus on the tail of the risks (e.g. a specific airplane crash, or an operational risk scenario).

Event/hypothesis scenarios are used in the SST. It is an open problem how the SST aggregation formula for scenarios (weighted mixture of distributions) compares to the compound Poisson distribution (frequency/severity) modelling.

Deterministic projection (mentioned by 4 participants): the company's activity is projected for some specified future period. The scenarios are chosen on a deterministic basis, based on expert opinion. Used for qualitative assessment (e.g. "stress tests"), such as the DNB continuity test or the DCAT.

Deterministic projections may constitute an essential part of the calibration process.

Randomly generated sample path (mentioned by 7 participants): one of many sample paths generated in a stochastic simulation (Monte Carlo simulation) to approximate the probability space. They are drawn from pre-defined, calibrated distributions (e.g. stochastic differential equations) implied by a random generator. This requires the specification of dynamic risk factors and their joint distribution across time. Dependencies are incorporated using e.g. hierarchical structures.

Randomly generated sample paths do not exclusively contribute to the tail range of the risk factors (unless importance sampling is applied, which is in use by at least 2 participants). In part this is because what might be a good outcome for one business unit might be a bad outcome for another, or indeed the whole group. For instance, in some businesses the capital falls if interest rates rise, while for others it falls if interest rates fall. A further reason for considering the full range of outcomes is the desire to use the stochastic models for other business purposes, such as valuation and value-based management. This requires a full distribution of outcomes, and an understanding of the correlation with market behaviour, to assist with the valuation of uncertain cash flows.

Sensitivity or stress test (mentioned by 5 participants): a single risk factor is varied and the impact on the portfolio value determined. A sensitivity/stress test is used to get an approximation of the risk exposure. It is in particular applied in connection with the covariance model, where the scenarios are by definition (e.g. 99.8% VaR) tail events of empirical and/or modelled distributions of the risk factors.

DNB

One could describe the method as a single event approach. The scenario approach in the standardised method for the solvency test applies to the market risk and credit risk categories. Market risk consists of interest rate risk, inflation risk, equity risk, real estate risk, raw materials risk and foreign exchange risk.

This scenario approach is based on the technical assumption of a shock occurring in one risk factor immediately after a reporting date and the resulting revaluation of balance sheet items remaining unchanged until the end of the year. All volume effects, such as a sharp fall in capital market interest rates bringing about early repayment of mortgages, are assumed to take place immediately. The scenarios, therefore, ignore the passage of time.

The scenarios are defined as shock based changes in risk factors, reflected in differences from the actual balance at each reporting date: for example, a fall in the interest rate by a certain factor compared with the reporting date. The size of the shock, such as the size of interest rate changes, is a given. The extent to which the surplus (the balance of assets and liabilities at realistic value) changes as a result is established for each scenario. This simulated change in the surplus is equal to the desired solvency for that risk. For example, if there is an assumed fall in the stock market of 25% and the surplus declines by 1,000,000, this amount is the desired solvency for equity risk.

The extent to which an institution is sensitive to certain risks is determined by the nature of the institution, its liabilities and its investment policy. For example, an institution which has bought put-options on the equity portfolio has a lower desired solvency for this reason than an otherwise identical institution without this risk hedge.

An institution must determine whether and the extent to which the various scenarios are relevant. It has to be able to estimate the financial consequences of the scenarios realistically and consistently over time.

DNB sets the parameters in the scenarios below. Based on these fixed parameters, an institution can make a solvency plan for the future.

BPV

A scenario is considered as a specific or generic event. Conditional on the scenario there results a stressed P&L distribution (e.g. induced by stressed correlation matrix). Either a new distribution is calculated (for some market risk scenarios) or the ‘basis distribution’ is shifted by loss under a given scenario. The resulting distributions are aggregated by a weighted mix. Scenarios mainly contribute to characterize potential tail events (“extreme scenarios”).

BaFin

One should distinguish scenarios that are merely used to get an approximation of the risk exposure (e.g., scenario vectors and scenario matrices in the sense of Jamshidian and Zhu (1997)) on the one hand and scenarios that are used to approximate a probability space (e.g., Monte-Carlo scenarios) on the other hand.

A method where scenarios mainly contribute to the tail range of the risks would be called importance sampling. It may be, but need not be used.

8.4.2 Risks types and entities covered by scenarios

All risks that are quantitatively assessed, and therefore all lines of business and geographic areas, have a scenario component. This applies in particular to those risk types which are randomly sampled (e.g. using an economic scenario generator on the asset side).

The event/hypothesis type scenarios are mainly used to cover operational and catastrophic event risks. Specific events on the liability side are available for significant perils and regions.

DNB

The scenario approach in the standardised method for the solvency test applies to the market risk and credit risk categories. Market risk consists of interest rate risk, inflation risk, equity risk, real estate risk, raw materials risk and foreign exchange risk.

BPV

All types of risks can be covered by scenarios. The appointed actuary has to define scenarios which are relevant for the company.

8.4.3 Number of scenarios

Stochastic simulations include a mentioned range of 1000 to 1,000,000 random samples. It has been mentioned further that as few as 1000 simulations can give stable results for life

businesses without embedded options, while up to 100,000 may be required for a stand-alone P&C business with extreme catastrophe exposures.

It is remarkable that some participants keep the number of scenarios as low as possible and that only a few of them determine overall risk. There is an obvious trade-off between robustness and reasonableness of the risk assessment and the theoretical accuracy of stochastic models.

We recommend that for a stochastic simulation model enough random samples are drawn to ensure accuracy of the risk measurement. For the practical problems of estimating high quantiles see e.g. McNeil AJ and Saladin T: The peaks over thresholds method for estimating high quantiles of loss distributions. Proceedings of 28th International ASTIN Colloquium.

The covariance model requires two scenarios per risk factor (up and down) per business unit, resulting in about 1000-3000 scenarios in practice.

A typical value for a historical time series VaR calculation is 2300 sample points.

BPV

20+

8.4.4 Generation and weighting of scenarios

Apart from those participants using a covariance model,

- 7 participants use random number generators, including commercial products such as Barrie and Hibbert for economic scenarios, TAS P/C, Remetrica for P&C activity scenarios, etc.
- 2 participants mention expert assessment
- 3 participants use historical time series, bootstrapping methods.

All randomly generated sample paths within a stochastic simulation are equally weighted.

Event/hypothesis scenarios realized by frequency/severity models are weighted according to their frequency and severity. Moreover, the dependency assumptions between the scenarios and the group's portfolio exposure towards the scenarios determine the resulting contribution to overall capital requirements.

DNB

The FTK scenario approach is based on the technical assumption of a shock occurring in one risk factor immediately after a reporting date and the resulting revaluation of balance sheet items remaining unchanged until the end of the year.

The extent to which an institution is sensitive to certain risks is determined by the nature of the institution, its liabilities and its investment policy. For example, an institution which has bought put-options on the equity portfolio has a lower desired solvency for this reason than an otherwise identical institution without this risk hedge.

An institution must determine whether and the extent to which the various scenarios are relevant. It has to be able to estimate the financial consequences of the scenarios realistically and consistently over time.

DNB sets the parameters in the scenarios below. Based on these fixed parameters, an institution can make a solvency plan for the future.

BPV

Scenarios are either historical, generic, or specific. Weighting is with the probability of event.

8.5 Risk modelling principles

8.5.1 Going concern vs. run-off

Consistently with Section 7.3.6,

- 11 participants take no more than one year of new business into account (but consider the in force business on a going-concern basis). Typically, in life business the balance sheet is cut off at the measurement date; whereas in non-life, the risk of the anticipated new business/renewals within the first year is taken into account.
- 2 participants take two to four years of anticipated new business into account.

New business becomes less material the higher the frequency of calculations (e.g. quarterly).

New life business may dilute unrealised investment gains and hence reduce management flexibility. We recommend that separate multi-year (stochastic) growth studies are performed, such as the FTK continuity test.

DNB

No new business is taken into account in the FTK Solvency Test, other than renewals or arising from existing embedded options in the present insurance contracts. However, new business is taken into account within Continuity analysis.

BPV

Anticipated new business during one year is taken into account, effectively renewal of existing business.

BaFin

Anticipated new business should be included as risk driver, if it materially affects P&L.

8.5.2 Time horizon

According to the IAA, there will be some time delay between the date the supervisor can take appropriate action with respect to an unacceptably weak or insolvent insurer and the date the published financial statements of the insurer are produced. Therefore, from a supervisory point of view, the time horizon for the risk assessment should be one year at least.

On the other hand, there is a trade-off between capturing the material risks associated with the run-off and the effects of sampling error on the accuracy of the measurement.

We have observed that

- 10 participants assess their risks on a one year time horizon (at least one participant is planning to move from a one-year to a multi-year DFA assessment).
- 3 participants assess their risks on a multi-year (5-30 years) time horizon.

A participant mentioned that if units show to measure and react more frequently, then the time horizon for the risk assessment could be reduced to e.g. 6 months, reducing the amount of capital needed. This is, however, in conflict with the IAA recommendation from a supervisory point of view.

We recommend that, beyond the one year risk assessment, (stochastic) multi-year studies are performed, such as the FTK continuity test.

DNB

The used time horizon is one year.

BPV

1 year

BaFin

1 year

8.5.3 Embedded options and guarantees

Within a one year risk assessment, today's value of options and guarantees has to be compared to the corresponding value in a year, which can depend on primary risk drivers, such as stock prices or interest rate levels, but also on implicit variables such as the future (implied) volatility of the primary drivers, or the future lapse rate assumptions.

Within a multi-year risk assessment, the stochastic nature of all future asset returns is taken into account by the internal model. The corresponding risk therefore is captured by their impact on the future policyholder cash flows. Intermediate balance sheet solvency assessment requires the valuation of embedded options at any future time point. This causes technical difficulties due to the complexity of nested stochastic simulations. Here, either a simple formula proxy has to be applied or we recommend the adaptation of the Longstaff-Schwartz algorithm (see Section 7.3).

- 9 participants do currently assess these risks explicitly.
- The other participants are developing their models towards capturing these risks.

DNB

Analogously to the two interest rate movements, the effect on the desired solvency margin of an increase or decrease of 25% in interest rate volatility (implied volatility) has to be computed from the starting situation. This applies to interest rate options and/or interest rate dependent embedded options in the pension and insurance liabilities. The greatest loss is included when determining the desired solvency.

BaFin

Risks arising from embedded options and guarantees assessed should be assessed, if material.

8.5.4 Cash flow-matching/liquidity aspects

For multi-year assessment models, cash flows are at the core of the model. However, liquidity aspects have to be taken into account to reflect the fact that the full value of the assets may not be realised if a sale is forced to meet liquidity demands.

As for the cash flow matching (synonym for ALM or mismatch risk), 10 participants take this risk quantitatively into account (including those who use a multi-year assessment), by e.g. referring to the replicating portfolio and/or determining key rate sensitivities with respect to yield curve movements.

All participants do a qualitative assessment of liquidity risk; we have not observed any capital charge. More specifically,

- 3 participants perform liquidity tests based on the outcome of the internal risk model. E.g. the premium income and coupon payments over the next 2 years are compared to liability cash flows.
- 5 participants mention a qualitative assessment in a broader risk management framework. E.g. within the treasury process, or the portfolio consists mostly of liquid instruments.

Some participants mentioned deep short-term borrowing facilities (e.g. syndicate of banks) to manage potential liquidity crunches (for example P&C businesses potentially faced with catastrophe losses), and the on-going costs of these facilities are captured in the expense base

We recommend that a comprehensive qualitative group-wide liquidity test is performed on a time horizon which allows for realistic refinancing programs (e.g. 2-4 years).

DNB

Risks associated with liquidity are reflected, at least in part, in the valuation. For example, limited negotiability of debt securities (such as private debt) is reflected in the observed credit spread. Liquidity risk is not separately addressed further in the standardised method.

BPV

The SST is cash flow based

BaFin

Exposure to interest rates should be available either through scenario vectors or sensitivities.

8.5.5 Diversification over time

A diversification effect across time for the required risk capital is captured in a multi-year assessment where subsequent asset returns are aggregated across time. The modelling assumptions (independence or mean-reversion of returns) are crucial and the resulting capital can be very sensitive with respect to these assumptions. We recommend that further studies are done in this direction. See e.g. Embrechts, P., Kaufmann, R., Patie, P.: Strategic long-term financial risks: single risk factors (ETH Working paper, 2004).

On a one-year time horizon, this diversification effect is inherent in the best estimate asset return assumptions. E.g. when historical simulations are used for VaR calculations. See also the above mentioned paper.

8.5.6 Market-cyclical effects

Our observations are:

- 3 participants do not assess market cyclical effects (but it is currently being investigated)
- 6 participants account for market-cyclical effects in their best estimate assumptions concerning asset returns and anticipated market conditions. This can be based on over-the-cycle historical estimates and expert opinion.
- 4 participants account for market-cyclical effects in the variability of the asset return and loss ratio distributions. This is achieved through
 - Enhanced correlation between asset returns and loss ratios
 - Historical VaR calculations
 - Explicit multi-year pricing level cycle modelling

We recommend that market-cyclical effects are explicitly taken into account by appropriate modelling and economic expert opinion.

DNB

It is assumed there is a perfect correlation of risks within variable-yield securities. The correlation between interest rates and shares (and variable-yield securities) is unstable over time; consequently, the standardised method uses a robust estimate, allowing for the parameter uncertainty in that correlation. A degree of diversification is assumed between variable-yield securities and interest rates, being a correlation rho of 0.8 between the effects of the interest rate scenario and the scenarios for variable-yield securities. Full diversification (a correlation of zero) is assumed for all other risk factors.

BPV

Market-cyclical effects are not taken explicitly into account; however, market risk model is updated / recalibrated yearly.

BaFin

Econometric evidence seems to support the various market efficiency hypotheses. In this sense, we do not expect valuation or risk models to make optimistic assumptions of the flavour “after three bad years there must come a good year”.

8.5.7 Policyholder behaviour

Policyholder behaviour impacts, amongst others, lapse rates, paid-up rates, exercising of options (e.g. guaranteed annuity options) and the timing of claims reporting.

- 7 participants take relations between market (i.e. interest rate) movements and some of the aforementioned policyholder behaviour explicitly into account; in particular lapse rates. The degree of sophistication varies between full rational behaviour assumptions and a mixed formulaic link based on past observations.
- 5 participants use static best estimate assumptions for the lapse rates, without explicitly linking them to market factors.

We recommend a sensitivity analysis with respect to changed policyholder behaviour to determine those behavioural aspects that should be dynamically modelled as risk drivers.

DNB

For valuation purposes, policyholder behaviour should be modelled on the basis of the most realistic parameters. The insurer should be able to give the assumptions with respect to policyholder behaviour a solid ground.

Policyholders behaviour e.g. regarding embedded options should be modelled according to most realistic estimations.

BPV

Policyholder behaviour is taken into account for the valuation of liabilities (for options and guarantees) and also for the target capital (sensitivity w.r.t. lapsation and other policyholder behaviour is an explicit part of the life model)

BaFin

Some options like choosing a lump-sum instead of the life annuity are not optimally exercised by policy holders. If the variability in the policy holder behaviour materially affects the P&L, then it should be considered a risk driver.

8.5.8 Surplus participation

The IAA mentions profit sharing related to actual and/or historical asset returns under market risks. They differ between three types of profit sharing

- Fully based on external objective indicators of the market performance (e.g. a stock market index). The company may or may not actually be holding these benchmark assets in its portfolio.
- Linked to the performance of the company's investments. The management may be entitled to declare the bonus rate.
- Linked to locked-in fund at the policyholder's discretion, e.g. unit linked products.

All participants take policyholder surplus participation into account, both for valuation and risk assessment, to a more or lesser extent. The SST takes a pure policyholder point of view and requires only the guaranteed liabilities to be considered.

We recommend that the risk model must recognize the conditional and unconditional profit sharing linkages between asset and liability cash flows. See also the DNB comments.

In multi-year risk models, bonus and crediting rates have to be based on the rules that are expected to apply in practice, based on the investment results specific to each simulation.

DNB

With-profits benefits (profit-sharing) can be conditional or unconditional. They are distinguished as follows.

A with-profits benefit is unconditional if the amount of the benefit is linked only to an objective financial event so that the amount can be ascertained immediately. In modelling the cash flows, an institution must take account of the fact that the amount of the benefit depends directly for example, on corporate profits, investment yields or objective external returns. An

example of such an option is the guarantee of minimum annual returns for with-profits insurance. Another example is the right to extend the contract on pre-agreed terms and/or rates. Such options may affect the cash flow from an obligation and thus have a value. There are customary methods and techniques for the valuation of such unconditional with-profits liabilities, such as option valuation techniques.

A with-profits benefit is conditional if its amount is determined wholly or partly by a decision of the board. A conditional cash flow for insurers is the profit sharing that depends on a board decision on allocating operating profit to policyholders. It is generally specified that there is profit sharing but the amount is not certain in advance; usually, of course, there is a link with actual investment results. But the relationship between these results, the profit sharing and the timing of the allocation is not set out unambiguously.

In order to be able to value these conditional with-profits benefits, the insurer must specify its level of ambition. The level of ambition reflects the objectives the institution is aiming for with these liabilities to the counterparty. The specified level of ambition is reflected initially in the contract between the customer and the insurer. The customer needs to know when and to what extent he is entitled to something. The break-down is also a vital management tool and important for prudential supervision.

The level of ambition need not be formulated in strict quantitative terms: it may be a benchmark or a formula with parameters. The level of ambition must be consistent with:
contractual terms and conditions;
expectations created by the insurer (in the policy terms, proposals, brochures or other forms of communications);
the policy as shown from actual conduct (consistent or otherwise).

An 'en bloc' clause in the policy terms allows the insurer wide scope to make changes. These may affect premiums but also involve changes to the cover. The cash flows arising from these clauses must be stated at realistic value under DNB.

The question of whether an insurer can alter the premium income from the existing insurance portfolio can play a role in valuing 'en bloc' clauses. This cash inflow depends on the policy that the insurer applies. It is, therefore, a conditional cash flow. An intention to adjust premiums has to be made explicit by the insurer, and allowance must be made for the limited ability of increasing premiums in a market. It can then value the associated conditional cash flows so that it can also report the difference with normal premiums to DNB.

BPV

Not taken into account.

BaFin

Valuation should be consistent with risk modelling.

8.5.9 Management actions

In the multi-year models, management actions are explicitly modelled based on asset returns and the overall solvency situation. E.g. in business units with participating funds, the reversionary bonus and or asset mix is reduced by a certain percentage if statutory solvency falls below a certain threshold.

- 5 participants do not quantitatively assess impacts of management actions, but for 3 of them this aspect is being investigated. 2 participants do a separate qualitative assessment.
- 5 participants take account of management actions in the valuation of the insurance liabilities which includes projecting cash flows and asset returns. This is achieved through limiting bonus cuts by policyholder expectations, or through smoothing cuts across time, or a capital charge for the operational risk due to management actions.
- 3 participants do a full multi-year assessment of the risk inherent in management actions.

We recommend that the underlying assumptions in the stochastic simulations are checked for reasonableness in extreme situations. However, we expect that statistical back testing is usually difficult for the lack of data.

DNB

For valuation purposes, management actions, other than arising from contractual obligations, do not play a role. Management actions, such as risk limits, stop loss limits etc., may be included in the internal models method, but not in the standardised method of the FTK Solvency Test.

BPV

Management actions are not taken into account.

8.5.10 Regulatory actions

Regulatory actions, or better restrictions, may become material in connection with fungibility of capital, such as mentioned by the BPV below.

- 10 participants do not take regulatory actions into account (yet).
- 3 participants take account of regulatory actions, for instance in operational risk tests in cases such as compliance failures or mis-selling. Or, in a multi-year context, by including a regulatory solvency margin in the definition of default in the rules applied to determine capital transfers from/to the group.

DNB

For valuation purposes, regulatory actions, other than arising from contractual obligations, do not play a role.

BPV

Regulatory actions are taken into account at the group level, if group-level diversification benefits are to be allocated to legal-entity level target capital.

8.5.11 Tax effects

Tax effects (e.g. tax relieve in extreme loss cases) may be considered as risk reducing factors. However, it is doubtful that hypothetical deferred tax assets (in respect of future losses) do

have any value in stressed conditions. We recommend that any tax assumption leading to material risk reducing effects is carefully validated.

- 11 participants take quantitative account of tax effects in valuation. Mostly using a simple flat rate rule. Accurate tax modelling is not thought necessary. At least 3 participants apply more explicit tax modelling across time.
- At least 6 participants explicitly mention not to take account of the risk aspect of tax effects.
- 2 participants do not take quantitative account at all, but qualitative, or it is being investigated.

DNB

Tax claims should be valued at realistic value.

BPV

Tax effects are not taken into account.

8.5.12 Others

From a policyholder point of view, the ability of paying future shareholders dividends is not considered to be protected by risk capital.

8.6 Risk mitigation methods

8.6.1 Hedging market and credit risks (dynamic and static strategies)

All participants include static hedging in their models. A typical example in life is holding long dated swaptions for a static hedge of guaranteed annuity options. The most frequent derivatives in use are plain vanilla put and call options on equity and interest rates, futures and forward contracts on FX, credit default swaps. No more exotic instruments have been mentioned.

Dynamic strategies that involve matching assets to liabilities at infrequent intervals (e.g. annual or quarterly rebalancing) could be incorporated into the multi-year risk assessment models. However, where the samples that are used to build the strategies are also used to test them, there might result an underestimation of the residual hedging risks.

We observed that, usually, only the cash flows of derivatives are taken into account but not their the asset values (no “implied volatility” risk is considered as such).

BPV

Can be introduced via sensitivities or modelling of the risk transfer.

BaFin

Reinsurance and other methods of risk transfer induce counterparty credit risk.

8.6.2 Securitization/ART

- 8 participants mention not to have engaged in securitisations/ARTs, hence there is nothing to be modelled. However, half of them claim that this would potentially be possible.
- 4 participants model the effects of securitization/ARTs.

We recommend that the economic benefits of any risk transfer are given credit subject to the (counter-party) risks involved.

BPV

Can be modelled, no prescription, but has to be disclosed.

BaFin

Reinsurance and other methods of risk transfer induce counterparty credit risk.

8.6.3 Reinsurance

- 11 participants take (passive) reinsurance into account for risk mitigation.

We recommend that the following observations may serve as guideline:

- Insurance cash flows have to be modelled net and gross of reinsurance to test for the credit risk exposure.
- If no easy netting of local cash flows is possible or meaningful (e.g. if the entire reinsurance program is written at group level), then reinsurance can be accounted for on the asset side.
- Large reinsurance programs are modelled explicitly, with appropriate underlying stochastic models of the gross losses. Smaller programmes, working layers and proportional contracts may be modelled on a coarser basis, but any approach must be able to identify the recovery explicitly to allow testing credit risk exposure.

BPV

Has to be modelled, no prescription but has to be disclosed.

BaFin

Reinsurance and other methods of risk transfer induce counterparty credit risk.

8.6.4 Default of reinsurance

- 10 participants take quantitatively account of reinsurance default. This is mostly based on the internal credit risk model using the credit ratings of the reinsurers.
- 2 participants do a qualitative assessment only.
- At least 3 participants claim that reinsurance (default) is not significant for their overall portfolio risk.

We recommend that

- Reinsurance default is correlated with equity markets and catastrophe losses.
- Reinsurance concentration risk is minimized by diversification.

BPV

Target capital has to be calculated assuming that all reinsurers default. The probability of this scenario is given by the default probability of the reinsurer to which most risks are ceded. This scenario is then aggregated with the results of the models and the other scenarios.

BaFin

Reinsurance and other methods of risk transfer induce counterparty credit risk.

8.7 Calibration/Lack of data

Methods to deal with lack of data that have been mentioned include:

- 8 participants mention: Expert opinion, provided in-house by e.g. geoscientists, senior business managers, or externally by reinsurance brokers
- 4 participants mention: Appropriate model design. Examples: The model is designed in such a way, that the missing parameter has a natural interpretation (like tail dependency in contrast to linear correlation). Or a reduction of the number of model parameters, e.g. by limiting to a unique correlation coefficient for all basic loss distributions in non-life. Take published research into account.
- 2 participants mention: Implicit prudence: use conservative estimates.
- 7 participants mention: External data pools, such as Fitch F1RST, ORX operational loss databases, or ICFRS non-life trend volatility data base, and other (commercial) external data provider.

We recommend that anything from actuarial estimates to external data pools, expert judgements or special projects to gather the missing data is employed.

BPV

We accept - and live with – the lack of historical data.

BaFin

We expect data pools to be used extensively.

9 Aggregation and diversification

Diversification of risk is a statistical fact and the economic basis for the existence of the insurance industry. Diversification manifests in the following ways:

- Statistical diversification – The pooling of many independent individual risks results in a low coefficient of variation of the total P&L (ratio of standard deviation and expectation). On a larger scale, independent risk types (such as market and technical insurance risks) have a statistically compensatory effect on the relative total P&L variability. Statistical diversification in a final consequence stems from the fact that stochastic factors do, with high probability, not all vary beyond a normal range at the same time. This does not mean that such events cannot occur. The degree of certainty to which capital shall absorb such events is measured by the confidence level that underlies the risk assessment.
- Compensation of opposite effects – A risk type variation can have an opposite effect on different portfolio segments. This is not a statistical effect, but caused by opposite portfolio sensitivities. For example, a perfect asset liability matching can immunize the portfolio against interest rate movements.

These diversification effects are captured by any reasonable risk measurement method. It is known, however, that VaR has some theoretical shortfalls in this regard.

The general principle of diversification ultimately results in less capital being needed to support a combination of sufficiently independent risks than it would be needed to support the same risks but each on a standalone basis.

As a consequence if diversification is applied to a group with several legal entities, at least one legal entity would end up with less capital than if it were capitalised on a standalone basis. The regulator of that legal entity may be concerned that in case of distress of that legal entity capital may not be transferred from the other entities. Reasons for this could be:

- Regulatory risk: regulators may prevent capital to be transferred from the legal entities under their jurisdiction
- Unwillingness of the companies management to provide the necessary capital injection.

Thus, for diversification to really work at a group level it needs to be ensured that if capital is held in several legal entities it will be able to flow freely from one legal entity to the other in case of need (fungibility).

9.1 *Diversification benefits and their allocation*

All participating financial conglomerates take full account of diversification benefits between insurance and banking business at group level (even negative correlation has been mentioned).

All participants, but (partly) one, measure diversification benefits between their local entities.

We recommend that fungibility restrictions are taken into account as realistically as possible. The difference between purely economic and realistic diversification benefits has to be made explicit.

Systematic risks, such as global market factors, should not lead to cross entity diversification benefits.

9.1.1 Allocation methods in use

- With a covariance model, the allocation is either done with proportional method (1 participant) or marginal method (“Euler scheme”) (4 participants).
- Other allocation methods in use are: marginal methods in connection with TailVar and simple flat percentage discount rules.
- 5 participants do not allocate diversification benefits to sub-units, but keep them at group level. This may lead to a higher group rating than for local entities (mentioned by 1 participant).

Both, hierarchical and one-step lowest level to top group level (correlation factors set at lowest level, no nested covariance aggregation) aggregation/allocation methods are in use. We recommend that further research is done for a better understanding of the pros and cons of these aspects.

Here is a pitfall that we have encountered: the capital requirement for an individual risk class does not necessarily decrease with increasing level of diversification. For example, consider three entities with stand alone required capital of 100 m euro each. The correlation matrix is

$$\begin{matrix} 1 & 0 & 1 \\ & 1 & 0 \\ & & 1 \end{matrix}$$

Aggregation of the first two (independent) risk positions and subsequent allocation using the marginal method gives $100/\sqrt{2} = 70.71$ m euro diversified capital requirement for entity one. The fully diversified capital requirement for entity one however is $200/\sqrt{5} = 89.44$ m euro. While the independence of the first two entities leads to a considerable capital relieve, the high correlation (could be less than 1, the example still would work) between entity one and three results in a higher capital requirement for entity one.

9.1.2 Sub-units considered for diversification

There is a trade-off between diversification of regulatory risk and capital mobility in the choice of sub-units: subsidiaries as sub-units allow for a greater variety of regulators (no concentration on one “bad” regulator), on the other hand, branches allow for more capital mobility.

Throughout, the internal risk analysis is based on business units (operating entities, profit centres) and lines of business, which are different from legal entities in general.

We recommend that – for the sake of comparability of regulatory and economic capital structure – a legal entity compatible diversification allocation model is developed.

BPV

If a group would not measure diversification effects to the legal entity level, no benefit for target capital would be given. The allocation method is not yet fixed and might actually be at the discretion of each group. We are exclusively interested in diversification effects from group to total legal entity.

BaFin

The broad picture is that every legal entity in a group that is a bank is subject to the banking rules and every entity that is an insurer is subject to insurance rules.

9.2 Fungibility of capital

From the Policy Statement 04/16 of the FSA:

“For many groups the risk assessment function and capital planning will be performed at a group level or along business lines rather than legal entity lines. We do not want to discourage such an approach as we see considerable benefits in regulatory capital assessments being integrated with the management processes used within a business. However, the approach must result in an assessment of each firm’s adequate capital level. We stated that we will take into account any detailed evidence that demonstrates that diversification has reduced risks, though this would depend on transferability of capital within the group and whether any group member faces higher risks because of its membership of a group.

In presenting their ICA, firms will have the opportunity to explain how features such as parental support and diversification benefits might provide grounds for a lower level of group ICG and solo ICG. But lower ICG will only be appropriate if we are satisfied that capital would in practice be transferable within the group in conditions of financial stress. We consider it unlikely that groups adopting an approach that is based on a group-level capital assessment (i.e. assuming full, unrestricted, transferability as if the group were a single legal entity operating in a single jurisdiction) and then allocating the result to undertakings would be able to satisfy us that the group risks and transferability issues had been adequately considered. We expect groups (and firms within groups) to be able to present an assessment of the capital that each firm would consider adequate were it not part of the group, against which we can evaluate the transferability issues. “

To take credit for fungibility one has to recognise that, if one business unit is stressed, sufficient surplus capital must be available in other business units to cover the deficit, and that one can release the capital somehow. In many cases this will be possible via the simple payment of dividends and redistribution through high-level legal entities. Where dividend payments are restricted, for example because of local regulatory restrictions, rules on distributable surplus, etc., then one must demonstrate alternative approaches to releasing surplus capital upstream.

- 6 participants use a pure economic view: the primary objective of the internal model is to test and demonstrate that from an economic perspective the group is solvent. This is carried out without requiring that legal entities hold capital in excess of the existing

legal minimum (Solvency I) capital requirement. Arguments supporting a pure economic view are:

- This view is consistent with rating agencies building on consolidated account.
 - To allow for fungibility restrictions could constitute building margins on top of margins, and so be overly conservative.
 - In stressed situations there could be a number of ways of releasing shareholder value from one business unit to use in another e.g. the sale of business.
 - A coherent view of risks would be distorted by any particularly severe local restrictions.
- At least 3 participants do (or intend to do) a qualitative assessment of fungibility. Example: fungibility should be taken into account by a separate, 3-4 year continuity test: i.e. cash flow scenarios to be covered by asset portfolio. If this additional test can be passed, the group is in good shape. The time horizon 3-4 years corresponds to the time a group needs to refinance its business.
 - 6 participants do take quantitative account of fungibility in their internal models. Examples:
 - The internal group capital is larger than the added up Solvency I required minimum capital requirements for the stand alone legal entities.
 - Where capital is held in a participating (with-profits) fund then it is assumed that one can only access a proportion of that capital, being the shareholder owned part.
 - Where capital would be subject to a tax charge on realising a profit and transferring it, this is taken into account in dynamic cash flow models.
 - The fungibility is taken into account in the form of transferability constraints on the available capital, e.g. any ring-fenced estate is excluded from group available capital.

We recommend that fungibility of capital is assessed under financial distress situations. This should be part of the risk model. Taking only into account the transferability constraints on the available capital under normal situations may underestimate the risk of illiquidity.

We observed the following methods on group level to assert that risk capital may flow freely between sub-units in case of need:

- Fungibility/liquidity/cash flow tests are conducted outside and in addition to the internal risk model (e.g. by a 3-4 year scenario analysis)
- The restriction on capital transfers is taken account of by transferability constraints on the available capital.
- Excess capital is transferred to the group every year. It is held at the holding company.
- Internal risk transfers, reinsurance/retrocession
- Distinction of core strategic sub-units
- Parental guarantees
- Finance Department undertakes detailed planning of all subunits to ensure that their capital needs from a regulatory or rating agency perspective can be met via the efficient deployment of liquid assets. This is done on a continuous basis.

Since fungibility restrictions seem to have never been a practical problem for the participants, we recommend that a case study of fungibility issues under financial distress is performed.

BPV

Fungibility of capital has to be taken into account. We distinguish between two risks:

a) Regulatory risk: The risk that regulators from other legal entities might freeze assets (SCR or MCR) and the remainder of the group then is in a worse financial situation (fungibility of capital).

b) The risk, that the group might let subgroups (in particular the legal entity in the scope of the SST) be sent into run-off.

We would expect a group to quantify at least both risks. The group can take into account guarantees given towards its subgroups. We would expect a group to model its behaviour in a rational way, i.e. under the assumption of being able to shed-off parts of its group if the situation deteriorates. We would also assume that the model has to take into account the behaviour of regulators in different legal entities. This means in particular that the group level model needs to be able to model the relevant legal entities (e.g. US, European, Swiss business).

The group needs to show that it has guarantees between the sub-units and that the regulators would allow the flow of capital. But this has to be modelled either via scenarios or stochastically; the simple assumption of perfect fungibility would not be acceptable for the SST.

9.2.1 Rating agencies' restrictions

- 9 participants do not, currently, take rating agencies' restrictions on capital transferability into account. Reasons that have been mentioned are:
 - Simplicity: Believe that rating agency capital models are limited in scope and overly simplistic.
 - Complexity:
 - Testing capital adequacy by rating agency standards at each point of the simulation could quickly become a difficult task.
 - It is not possible to steer a business by managing all different rating agencies' constraints.
 - S&P's, Moody's and other rating agencies' models do not yield fundamentally different results than the internal group capital models:
 - Ratings are based on the group solvency.
 - Rating agencies make comparable fungibility assumption by taking consolidated accounts as the basis for their models.
- 4 participants do take rating agencies' restrictions on capital transferability into account. Examples:
 - Finance Department undertakes detailed planning of all subunits to ensure that their capital needs from a regulatory or rating agency perspective can be met via the efficient deployment of liquid assets. This is done on a continuous basis.
 - Each business unit has to be capitalized to meet rating agency's requirements.
 - Transferability constraints for determining group available capital.

We recommend that for realistic risk modelling, rating agencies' restrictions should be taken account of.

BPV

We would expect a group to be able to model the effect of down-ratings in case of capital transfers.

9.2.2 Regulatory restrictions

There are mild regulatory restrictions on capital transferability for reinsurers at this time. In case there is one group regulator, fungibility of capital is achieved via active capital management and internal retrocession. Lack of capital mobility does not impose a barrier to diversification benefits if the financial resources can be made available to back policyholder and other creditors' claims as they fall due.

- 7 participants do not, currently, take into account regulatory restrictions on capital transferability (this includes the reinsurers). Reasons for not doing so are:
 - Regulators shall adopt the view of shareholders and management: group is seen as one single entity
 - It is complex when part of a group falls under another regulator, in particular outside of the Solvency II regime. This is still under discussion, also in CEIOPS.
 - Inconsistency of business and legal structure: Ideal would be a view on the business that is acceptable for regulators and usable for internal steering. For instance, a regulator should concentrate on all the business written in his country. The overall Group risk supervision should be done by a lead supervisor.
- 6 participants do (partially) take into account regulatory restrictions on capital transferability. Examples:
 - Model specified solvency rules that steer the flow of capital, such as maximal annual transactions limited by 3% of total asset value, or minimum stand alone capital requirements.
 - Holding excess capital at the group for imperfect mobility due to regulatory restrictions.
 - Modelling of the shareholder's fund and dividend distribution policy.
 - Transferability constraints for determining group available capital.
 - No diversification benefits between legal entities.

We recommend that on the regulator side minimum capital requirements (MCR) for legal entities are formulated. Stand alone SCR can be funded by contingent capital notes (special contracts/instruments to capitalize legal entities) from the group. This requires further studies for the valuation of such contingent capital notes.

BPV

The fact that there is a lead supervisor alone does not guarantee at all that other regulators would not restrict capital flows. Of course, if the lead regulator can show legal agreements between regulators of different jurisdictions of allowing free capital flow, then these can be used in the model.

10 Risk measurement

We can classify the risk measurement methods in use by

Time horizon

- one year:
 - value changes and cash flows are modelled over one year
 - value changes are instantaneous, size of changes is calibrated to one year confidence level, cash flows are disregarded (“shocking the balance sheet”)
- multi-year: value changes, cash flows and balance sheets are modelled over a multiple of years (25 to 30 years), e.g. until insurance liabilities have run off

Risk measure

- VaR or TailVaR of discounted P&L: the deviation of discounted future realized from current net values of the liabilities and backing assets is measured. This may or may not include discounted cash flows. The objective is to assert that assets exceed liabilities (including a risk margin to allow for continuation of the business in the one-year assessment) at the end of the period. In a multi-year assessment, recursive procedures to take account of inter-temporal insolvencies are included (e.g. if future asset values fall below a minimum statutory value then recapitalization is simulated). Discounting of future (and terminal) values is done by the realized asset portfolio returns. The measurement yields the value of the minimal acceptable backing assets.
- VaR or TailVaR of deviation of future realized from expected value: the realized nominal values are subtracted from the expected nominal values. No discounting necessary. The objective is to absorb potential downside deviations from the expected result with some certainty. However, this method disregards the risk inherent in losses relative to the current values. It replaces the actual current values with the expected future values.
- Target ruin probability: based on dynamic stochastic simulation. The minimal required initial assets backing the liabilities are determined in a recursive procedure such that inter-temporal default happens for a target percentage of paths (e.g. 4%). The required capital is the value of the minimal acceptable backing assets. Cash flows are discounted path-wise by the randomly generated future asset returns, usually not risk-free. Risk-free discounting of cash flows applies to (future) liability valuation, though. The objective is to exclude intermediate or terminal insolvency with some probability.

A remarkable combination of the above components (multi-year, VaR) is the risk measurement based on two consecutive 99% VaR losses.

Another combination of these basic components is to assess the asset risk on a one year time horizon and the insurance liabilities until run-off. That is, the value of insurance liabilities at the end of year one is replaced by the ultimate claim size.

It seems to become an industry standard to calibrate target confidence levels to annualized VaR. That does not mean, in our opinion, that VaR shall be the ultimate risk measure. However, we recommend that the internal risk models produce aggregate P&L probability distributions, so that their risk measurement can easily be benchmarked with the standard annualized VaR.

Pros and cons for multi-year risk measurement:

Pros:

- It is virtually the only feasible way to model complicated financial processes on a cash flow basis.
- Provides deeper understanding regarding dynamic risk exposures, measurement of embedded risks and their corresponding processes
- Allows for a high degree of detail including analysis of the reinsurance program, business cycles, regime changes and other inter-temporal aspects.

Cons:

- Difficult to adjust the confidence level to a rating agency's target level (e.g. 99.96% VaR for a AA Moody's rating)
- Error propagation: the result is very sensitive towards model assumptions, in particular on anticipated management actions
- Number of parameters and risk factors to be modelled may contribute significant amount of process and parameter risk: bigger and more complex is not necessarily better.

We recommend that non-transparent “black box” models are avoided. Simpler and smaller models tend to be more in line with basic intuition, making it easier to assess and understand the impact of specific variables.

A VaR (or TailVaR) measurement of the P&L distribution gives the maximum possible (or to be expected) loss in value of the initial portfolio within the chosen confidence range and time interval. This implies that the required capital becomes larger if extra assets are added to the initial portfolio, which seems counter-intuitive if required capital is considered for policyholder protection only. But this fact is inherent in any monetary (value-based) risk measurement.

The IAA recommends that “backing assets”, those assets which are supporting the liabilities' requirements, are distinguished from those assets which are “free assets”. Regulatory required capital in turn need not be determined for free assets. However, changing this allocation will change the required capital. It is therefore a vital aspect of the risk management process to identify explicitly and consistently which assets are required and which are free. We recommend that in any case, required capital is always reported with respect to the corresponding available capital, which obviously is the value of the backing assets chosen.

The target ruin probability approach determines the minimum required assets backing the liabilities in a recursive stochastic procedure. This procedure may be implemented in such a way that it directly results in an allocation of required and free assets. Therefore, the target ruin probability approach for a one-year time horizon is different from a VaR measurement in general. An alternative may be a scaling of the initial asset composition such that the target ruin probability is met. We recommend that the regulator is informed in detail about such aspects.

10.1 Confidence level

The range of internal annualized VaR calibrated confidence levels at group level range from 99.6% to beyond 99.99% (in brackets the number of participants):

99.6% (1), 99.75% (1), 99.8% (1), 99.9% (1), 99.95% (2), 99.97% (3), 99.98% (1), beyond 99.99% (1)

The remaining 2 participants do not calibrate their confidence level to an annualized VaR at this time.

- All of the 8 participants within the confidence range of 99.8% to 99.98% claim to aim at an “AA” rating. Apparently, these confidence levels are not the only factor driving the rating.
- 3 participants do not link their confidence level to a rating agency or regulatory requirement.

DNB

See comments in Section 6.4.

BPV

99% expected shortfall, fully in-line with regulatory requirements

BaFin

We expect regulatory capital requirements (SCR) to be lower than own economic capital requirements, except for ailing insurers.

10.2 Time horizon

Different time horizons have traditionally been applied to different risk measures (e.g. 10 days for market risks versus one- or multi-years for credit and insurance risks).

Research results of some participants suggest that there is value in risk modelling beyond one year (in order to capture long-term economic risks) but that a full run-off projection may not be required. On the other hand, it was mentioned two participants that they found that their multi-year total asset method tended to underestimate the required capital or the ruin risk within the observation period, respectively.

We recommend that more research is done to assess the trade-off between the modelling error of a multi-year assessment and the potential underestimation of risk on a one-year time horizon.

- 9 participants use a one-year modelling time horizon for the risk measurement
- 3 participants use a multi-year modelling time horizon for the risk measurement (25 to 30 years)
- 1 participant uses a mixture (one year for market risks, run-off/ultimate claim size for insurance risks)

The calibration of an annualized confidence level to multiple years is done by a power rule. Example: if 99.5% is the annualized confidence level, then $99.5\%^{10} \approx 100\% - 10 \cdot 0.5\% = 95\%$ is the confidence level on a 10 year time horizon (may be risk exposure duration based).

In some cases shorter time horizons (e.g. 10 days for market risks in banking) are extrapolated to one-year by using the square root of time method (e.g. scaling the VaR by $\sqrt{(250/10)} = 5$.)

We recommend that further research is done to assess the quality of the various scaling rules in use.

The one-year time horizon seems to represent a reasonable convention, striking a balance between robustness in risk measurement and the average time required to manage a portfolio of risk exposures. However, the emergence of the one-year horizon as the industry standard does imply that a one-year horizon should also be used in addressing issues such as product pricing, credit provisioning, risk monitoring or limit setting.

Note that annual changes of market factors may have a long term effect of valuation (e.g. interest rate shock has dramatic effect in long-tail business).

We recommend that, for one-year risk measurements, an explicit risk margin is included to assert the continuation of business after a one-year financial distress. This risk margin should be calibrated such that it accounts for the cost of capital to run off the liabilities in a going concern context. Example: SST risk margin.

DNB

See comments in section 6.4.

BPV

1 year

BaFin

1 year

10.3 Risk measures

To assess their initially required capital

- 9 participants use VaR as basic risk measure,
- 2 participants use TailVaR as basic risk measure,
- 2 participant use a target default probability.

Combinations of disparate risk measures are in use. Often TailVaR is used in the covariance model for heavy tailed insurance risks such as catastrophes for reinsurance.

Arguments for VaR

- the tail of the distribution is difficult to determine in practice and TailVaR is more sensitive with respect to the analytical tail modelling assumptions than VaR
- easy to communicate to management

Arguments for TailVaR

- coherent risk measure, no shortfalls with aggregation
- captures potential losses beyond VaR

Arguments for target ruin probability

- is based on the aggregate distribution of future values and cash flows

DNB

There exists a difference between the standard approach and the internal model approach. Within the standard approach the practical arguments should be leading, while in an internal model also the more complicated elements should be addressed. This leads to a preference for the VaR like risk measure within the standard approach and in an internal model the TailVaR will be the more appropriate risk measure.

BPV

Expected shortfall is used.

BaFin

The model is about distributions, not risk numbers. Risk limits, monitoring and reporting may be based directly on exposure data (i.e. scenario vectors and sensitivities) or different parameters of the distributional forecast provided by the model (like VaR and standard deviation).

10.3.1 Aggregation of risk measurements

As to how the different risk measurements in use are aggregated,

- 6 participants derive an aggregated P&L distribution (e.g. aggregated cash flow distribution at group level) and then apply a risk measure
- 6 participants aggregate stand alone risk numbers (using e.g. the covariance method)

At least 2 participants use a combination of the two.

We recommend that the focus of the risk modelling is more on aggregate distributions than on risk numbers. This allows for more flexibility in the assessment, allows for better communication with externals and provides superior information to e.g. regulators and rating agencies.

BPV

It is determined at the end of the calculation. The only exception is credit risk which has to be added at the end of the calculation.

BaFin

See section 4 in the White Paper.

10.3.2 Pitfalls of the covariance method and VaR in general

In the bottom-up covariance model the first step is to calculate stand alone required capitals by risk type and/or business units. Diversification benefits are often explained by the statistical fact that “not all the worst case scenarios will happen at the same time”.

This argumentation disregards the risk that arises from the sheer combinations of potential losses per risk type beyond worst case. Indeed, adding up different positions may increase the probability of material losses. It is well known that VaR, which underlies the covariance approach, does not capture this effect appropriately. We shall illustrate this with a simple example: suppose two independent risky positions X and Y, each bearing the possibility of a

loss of 1 bn with probability 0.03%. The maximal possible gains of both X and Y are assumed to be 100 m each. The 99.95%-VaR of both X and Y is 400 m. That is, the 99.95%-VaR does not capture the possible losses of 1 bn on a stand alone basis. However, adding the two positions, X+Y bears now the possibility of a loss of at least $1 \text{ bn} - 0.1 \text{ bn} = 0.9 \text{ bn}$ with probability $2 \cdot 0.03\% = 0.06\%$. The 99.95%-VaR of X+Y is thus at least 0.9 bn, which is even greater than the sum (that is, even after disregarding all diversification benefits) of the stand alone capitals of X and Y.

This pitfall can be overcome by either applying a coherent risk measure, such as TailVaR, or by aggregating distributions instead of numbers.

TailVaR of X+Y is always captured by the sum of the stand-alone TailVaRs of X and Y. However, TailVaR of X is very sensitive towards the shape of the full tail of the distribution of X, which causes serious statistical problems when it comes to estimating this tail (McNeil AJ and Saladin T: The peaks over thresholds method for estimating high quantiles of loss distributions. Proceedings of 28th International ASTIN Colloquium). In the extreme case, TailVaR of X may depend on the statistical modelling assumptions rather than on the empirical data underlying X.

We acknowledge the practical aspects of the covariance approach. However, we recommend that the entire information which is included in the distributions of the stand-alone risk types and/or business units is carried forward by aggregating distributions (numerically or analytically) rather than aggregating risk numbers. If the statistical characteristics of any stand-alone or the aggregate distribution points towards the above mentioned difficulties (e.g. is fat-tailed, skewed, etc), then a more sophisticated capital aggregation procedure is advisable. This applies to group capital assessment in particular. Research of some participants shows that e.g. for natural catastrophes the deviation from the “true” overall risk capital and the covariance aggregated VaR numbers is significant. We recommend that – at least partially – an aggregation model based on frequency/severity or scenario modelling is used for such risk types.

A practical solution could be to use simplified covariance formulas on low levels, and more sophisticated methods on higher levels (e.g. use TailVaR instead of VaR or aggregate distributions instead of numbers).

10.4 Mathematical implementation

The following methods have been mentioned:

Analytic approximation (e.g. normal distributions, covariance aggregation)

- Basis for the covariance model: the risk factors are assumed to be jointly normal distributed. The stand alone required capitals are then summed using covariance aggregation
- Also used for valuation in life insurance: e.g. group life, proxy formulas for embedded options

Monte Carlo simulation

- Globally integrated Monte Carlo simulation for the multi-year risk assessment:

- each sub-unit runs a Monte Carlo simulation, conditional on the centrally generated economic sample paths, to output the cash flows for the unit considered
- the cash flows can then be aggregated at group level and risk measurement be performed on cash flows (at all levels).
- Also used to value complex embedded derivatives and guarantees that cannot be valued with closed form solutions

Numerical aggregation of discretised distributions

- Non-normal non-life loss distributions (mainly large and catastrophic losses) are numerically aggregated
- Hierarchical dependence structure: simulated distributions of sub-units taken as input marginal distributions for next level, choice of copula and MC simulation to derive numerical distribution on this level, etc.

Others: historical simulation – historical VaR of certain risk types (market risks) is directly derived from time series.

Analytical approximations and Monte Carlo simulations are the major mathematical techniques in use (mentioned explicitly by 10 participants), followed by other numerical aggregation methods for discretised distributions (4 participants).

DNB

The principle in this is that DNB does not prescribe a technique, but checks that every institution applies relevant methods that are widely recognised internationally.

BPV

It can be implemented in whatever way a company finds suitable. Parts of the calculation are done on a spreadsheet which has to be used by all companies

BaFin

There should be no limits on methodologies, just statistical quality criteria that weed out substandard techniques

11 Risk steering and capital allocation

11.1 Structures for allocation of risk capital

There is a great variety of group structures, and different objectives call for different structures. E.g. regulatory capital requirements require legal entity (or country entity) scheme. Performance measurement requires business unit (or line of business) allocation scheme. Internal models should be able to combine these various aspects consistently for the approval of the results by the regulators

The risk capital allocation is done according to the business structures of the groups. Deviations between legal and business structure are possible in both ways (business units may include several legal entities and a business unit might be spread over different legal entities). Ideal would be a view on the business that is acceptable for regulators and usable for internal steering.

The smallest entities that are mentioned are individual contracts (for premium risk). This is not typical, though. The predominant granularity for allocation is given by geographic markets and lines of business. Main obstacle for high granularity is data availability.

On the banking side, Basel II requests a drill down of the total required capital to country legal entity, which amounts to a downscaling in terms of size.

We recommend that a legal entity version of the internal model and its interplay with business entity version is developed. A workable compromise may be a segmentation by countries (see remark BPV), since this view would allow a regulator to concentrate on all the business written in his country (there are exceptions, e.g. for reinsurers the business structure – with specialised lines of business such as natural perils – is less geographically localized as for retail insurance). Some participants already do so, and others mention that it is simple to obtain legal entity capital allocation from internal results, since their business units are almost identical to legal entities.

BPV

The SST takes a legal entity view. However we would also expect breakdown to country level. Further breakdown of target capital is not necessary for supervisory purposes

BaFin

See section 7 of the White Paper.

11.2 Allocation of risk taking capacities

The implemented risk capital allocation method (e.g. marginal contribution, see Section 9.1.1) provides information about the risk contribution of a sub-unit to the overall risk. A capital adequacy target ratio for the allocated risk capital and the local available capital may suggest the capacity for risk with respect to the overall risk tolerance.

However, the majority of the participants are not in the position of using their internal model in isolation for allocation of risk taking capacity. In practice, the risk taking capacity is limited by different solvency criteria: economic, rating and regulatory. Local regulatory and rating agency views of capital are important (“It is our intention that an economic view of risk capital becomes the norm for external monitoring as well as our internal approach. However, in the short-term we have to recognise that local regulatory and rating agency views of capital are important”).

Setting risk taking capacities is a strategic function of the group risk appetite, taking into account the sub-unit’s existing risk profiles and strategic growth plans (“It is intended that overall risk limits be set within the group’s risk appetite. Internal consolidated review processes ensure that aggregate risk levels remain within overall tolerances.”). E.g. value-based management includes prioritization of available capital. Overall risk tolerance is merely a benchmark for the aggregate risk capacity limit. (“Risk taking capacity is only roughly linked to overall risk tolerance. It is rather linked to the goal to create a “balanced” well-diversified portfolio and the avoidance of risk concentrations.”)

There is an important difference between top-down models build only at group level and ones which take input from bottom-up models build within the business units. The risk features can vary significantly for the local products or markets. This is partly due to culture and local demand but also to variations in local tax laws, business conduct, regulation and contract laws. Therefore, a group wide model will need to take into account the thoroughness of the bottom-up approach if it is to be used for risk appetite decisions rather than just high level capital allocation and performance measurement.

There is no clear trend as to whether diversification benefits should be taken into account for the allocation of risk taking capacities. At least 5 participants allocate diversification benefits from group to sub-units, either in full or where appropriate. At least 2 participants do not at all take diversification benefits into account (“We are trying to limit any one risk from a concentration and discipline perspective. Risk policies drive diversification and not the other way around.”)

BPV

There is only allocation of risk capital from group to legal-entity possible. However, stand-alone calculation has always to be done

BaFin

See section 7 of the White Paper.

11.3 Allocation of risk capital costs

We have not observed major differences between the business structures for risk taking capacity and capital cost allocation. Business unit management may break down the group allocated risk capital to smaller units according to local keys (local diversification benefits may or may not be allocated).

The allocation keys in use are marginal contribution methods (Euler principle, covariance method). As for the cost of capital there is no trend, some use fully diversified allocated risk capital and a fixed rate for cost of capital, others take local factors (such as management

ability, market conditions, local solvency requirements, stand alone risk capital etc.) into account.

As described in Section 3.2 “Areas of application of internal models”, 4 participants do not use their internal model for performance measurement at this time (but they intend to do so).

BPV

Granularity: legal entities. The allocation method is not yet fixed, but perhaps can be left to the companies as long as the allocation is done consistently.

BaFin

See section 7 of the White Paper.

12 Model implementation and infrastructure

In a draft outline of a Solvency II Framework directive (Annex to document MARKT/2507/05) the following commission staff proposal to Article N2 (Internal Control and Administrative Organisation) can be found:

“The Home Member State shall require every insurance undertaking to have robust governance arrangements, which include a clear organisational structure with well defined, transparent and consistent lines of responsibility, and to have internal control mechanisms. The internal control mechanisms should be adequate for the nature and scale of the insurance undertaking’s business and should include sound administrative and accounting procedures.”

And from the IAA WP report we quote:

“The insurer must demonstrate that the internal model operates within a risk management environment that is conceptually sound and supported by adequate resources. It also needs to be supported by appropriate audit and compliance procedures. ... There should be clear lines of responsibilities and reporting and the company should have well-established and articulated operating rules and procedures.”

From this, we see that model implementation and infrastructure will be a big issue for the regulators which are likely to prefer a partial model with methodological drawbacks but which is truly embedded in the management process showing a clear model implementation and infrastructure to a perhaps technically refined “window model”. We found that it is also a big issue for the companies, very demanding with respect to human resources and still a broad field for improvement. Since it typically varies very much across the participants, it is not easy giving overall proposals but we would like to point out some guidelines here. For Solvency II purposes, we think it is important to

- perform a regular (we propose at least a half-year) assessment (where back-testing should be compulsory)
- have the internal model continually developed (also methodologically)
- have a detailed documentation available on different levels (for the actuaries, the CRO, etc. if necessary) including risk management responsibilities and organizational structures.
- have a public disclosure of the methodology e.g. at seminars or conferences (this is not to be compulsory, but desirable)
- strengthen the independent risk management unit
- have a transparent IT reporting system established involving the senior management showing clear lines of responsibilities
- successfully deal with data and data management problems.

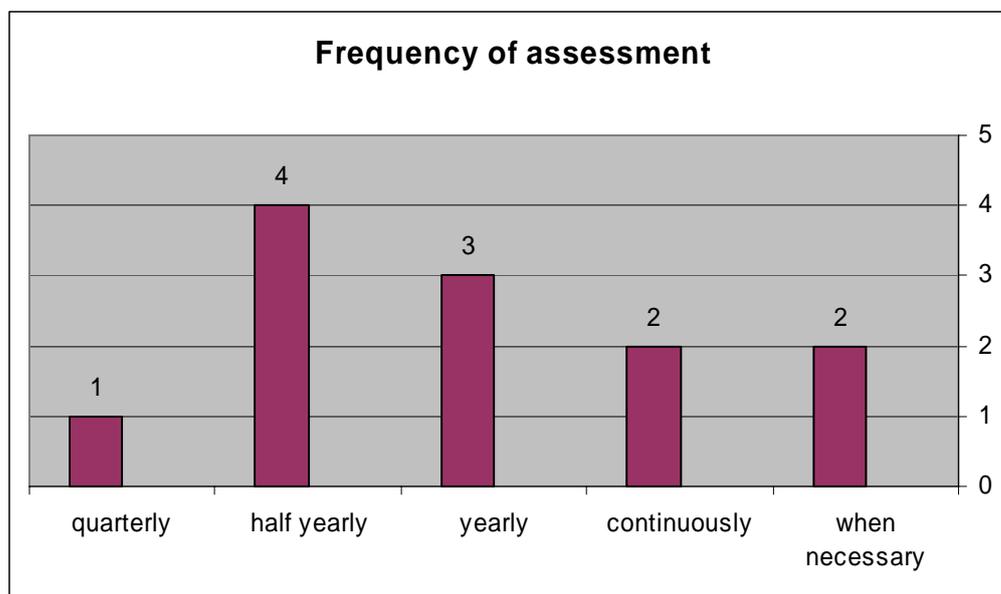
The overall aim is to establish an open and transparent risk culture on which basis the internal model can continually be discussed within the company as well as with the regulators

With some questions we like to include in addition some excerpts from the SPECIFIC CALL FOR ADVICE FROM CEIOPS: REQUEST N° 1 (14 July 2004), the IAA and the FTK document.

12.1 Model Assessment

12.1.1 Frequency and methods

All participants assess their internal models on a regular basis; more than half of the participants perform a half yearly or yearly assessment;



The internal model is in particular assessed when the risk-capital calculations are done (run of the model = assessment); most participants perform extra assessments e.g. according to review plans or when new input-information becomes available.

Internal model assessment (by (order of) the companies):

When being accepted for usage, a model should be subject to back testing to ensure that its capabilities remain subject to the original specification and the model is performing as expected (this process should be carried out by persons independent of the day usage of the model to ensure the integrity of the validation process).

Only a small number of the participants confirmed performing back testing; reasons for not doing so are:

- Not possible since extreme events are involved
- Very difficult over an annual time horizon
- No satisfactory method of back testing established yet
- Model still under development
- Not enough data available.

Other methods for assessment mentioned were: onsite visits, technical reviews, external consultants. Also stress testing was given an explicit mentioning (by only some of the participants; however, at least half of the participants perform some sort of stress tests, if only to some smaller extent or on special sub-units).

External model assessment:

For the participants the external audit role still needs to be clarified. One opinion mentioned was that external auditors are best placed to opine on inputs to the model and to calculation processes where these are linked to the areas already covered by external audit, while the task

of doing model assumption and output validation would be best subjected to some form of independent (rather than external) assurance (see also Section 12.1.3, External reviews). Some participants expressed the idea that the audit role of the regulators should comprise a stay with the company for a longer period (up to 3 months) to understand the working of the model where stress testing is expected to be performed!

We would suggest a half yearly assessment together with some stress and back testing. Some sort of check list for the assessment (perhaps supported by the regulators) could be useful. Stress testing results should be included into model validation procedures.

CEIOPS

Stress testing is regularly conducted, including both scenarios and sensitivity tests.

BaFin

We expect quarterly P&L attribution (“back testing”) and ongoing sensitivity analyses.

IAA

Stress testing is a supplement to risk management. It does not replace a capital requirement but complements it. In a number of implementations, the object of the exercise is to verify that the company will be able to satisfy its regulatory capital requirements under a variety of future adverse scenarios.

12.1.2 Model documentation

Here

- 9 participants affirmed that a detailed documentation of the internal model exists
- 4 participants answered with “yes, but...”

The “buts” were...

- the documentation has been created over the years without guidance nor standards given, it is not suitable for distribution
- the documentation is available (to different extent) only at sub-unit level.

Nearly all participants seek for (or already have available) a complete and unified documentation of their internal model, including also risk management responsibilities and organizational structures. This is vital for the regulatory review process.

FTK

The documentation of the internal model must give detailed information on the theoretical basis of the models and the empirical evidence. The institution must describe which risks and activities do and do not form part of the internal models. The documentation must contain an analysis of the risk mitigating measures taken. The institution must set out its policy on the use of hedges, guarantees, collateral and derivatives as risk-mitigating instruments. It must also document the process of statistically validating the results of the internal model. The documentation provides information on the stress testing process and contains an indication of the circumstances in which the models are not sufficiently reliable.

BaFin

Model documentation is required.

12.1.3 External reviews

Here

- 7 participants have already had their internal model reviewed externally, 3 of them by a consulting firm
- 6 participants have had no external review yet; however, 3 of them are planning to have one.

We recommend that an independent review of the model (validation and reconciliation of the data, calculations to check for compliance with the documented methodology, etc.) should be carried out on a regular basis thus increasing the trust and the confidence of the regulators in the integrated internal model. This external review has to be carried out by an independent, competent 3rd party (e.g. a consultant, university, different auditors, etc.), thus substituting and complementing the regulatory review at regulator's discretion, e.g. if the regulator does not have the resources to support such a review.

BaFin

Examination by the supervisor will be prerequisite for the use of the model for regulatory purposes.

IAA:

Independent peer review of a company actuary's work (by an experienced reviewer) has been found in some jurisdictions to increase the quality of that work as well as the supervisor's confidence in the company's result. ... The periodic actuarial peer reviews act in concert with capital requirements to enhance the protection of policyholders.

12.1.4 Publication and presentations

Here

- 7 of the participants had their internal methodology published in expert-reviewed journals or presented at conferences.
- 6 of the participants have not had it reviewed or presented yet (4 of them only partially or on a very high level).

It is interesting to note that the answers to this and the preceding section are highly correlated: 6 of the 7 participants who had their internal model reviewed externally have also had their underlying methodology published or presented.

Publications and presentations of the methodology at seminars or conferences will not be compulsory, but still should be encouraged.

BaFin

A publication of the methodology of the integrated internal model in expert-reviewed journals or a presentation at conferences is not required.

12.2 Processes

According to the IAA principles, internal models should be accepted by the regulators only if they can prove that approximate risk management processes and reporting is in place.

Some jurisdictions (e.g. Swiss, Dutch) explicitly state that an internal model will only be accepted if the company can provide sufficient evidence that these models are actively used in the internal risk management processes and reporting.

Thus an independent risk management unit and proper and appropriate reporting lines up to the senior management are VITAL for the regulatory process.

12.2.1 Risk management unit

As a model is developed it should be subject to independent checks and challenges to provide senior risk management (and supervisors) with some comfort that a review, independent of those responsible for the use of the model or its development has been carried out. This may be performed by either the internal or external audit function, or if it is sufficiently independent, the risk analysis and assessment department.

We have observed that an independent risk management unit exists with (nearly) all of the participants, where independence is understood in the sense of having no business responsibility. The main tasks and responsibilities of the risk management unit were described as

- being responsible for the design, implementation and development of the risk model
- setting up parameters, scenarios etc. for the sub-units
- performing tests on the model
- supervising the performance of the risk model in the sub-units
- collecting data from the sub-units
- aggregation work
- reporting duties.

The majority of the participants considered the collection of the sub-units' data, including data validation, concern for data quality, different data formats and IT platforms etc. the most challenging and time consuming part of their work, together with the tough timelines for presenting risk numbers set by the management board. It were only a few participants who did not complain about this.

The size of the risk management units varies among the participants and is not necessarily related to the size of the company but more to its "philosophy" and its organisational structure. We have witnessed risk management units consisting of less than a handful people up to groups of 30 people or more. Considering the tasks that are set up for them also by the regulators we would suggest that the risk management unit should include members responsible for risk management in the sub-units, for model improvement, and for reporting and testing purposes plus a CRO.

In this study we concentrated on the central (integrated) risk management unit which is located between the company's sub-units and the company's management board. In most cases the management board is backing up and supporting the risk management unit. In many cases the greater problem is bringing the risk management unit's ideas down to the sub-units.

As a rule, we have not observed separate internal risk controlling units, beside the risk management units, among the participants; we believe it could be done by the company's independent risk management unit in accordance to the company's management being actively involved in the risk controlling procedure and acting as a "final control instance".

CEIOPS

Strict separation between risk management and risk controlling.

FTK

The institution must have an independent risk management function, responsible for the design, implementation and maintenance of the institution's internal model. The staff responsible for this work must be independent of the commercial activities and report directly to the institution's senior management. These staff must critically review whether the models in use are sufficiently comprehensive, accurate and prudent. They initiate improvements in the model as necessary. They must include new activities and products in the risk analyses promptly and adequately. They also ensure that there is an independent assessment of all processes with a material effect on the model improvement, partly by regularly comparing the model results against new internal and external information on the modelled risks.

BaFin

An independent risk management unit is expected.

IAA

The insurer should have an independent internal risk management unit, responsible for the design and implementation of the risk-based capital model.

12.2.2 Involvement of management in the risk controlling procedure

The senior management should be responsible for the modelling process – from the initial development, to its practical daily use, and to its verification and any modification or development of the model. It is not regarded as sufficient to leave the subject to “back room technicians”. (Annex 2 to MARKT/2515/02)

The involvement of the company's management in the risk controlling procedure is an important issue in the regulatory process. Although some of the answers to the questionnaire have been somehow vague (“The company management has an appropriate level of awareness of risk and risk management”), for all participants the management plays an active role concerning risk controlling: managements take key strategic and financial decisions having regard to the economic, regulatory and rating agency perspectives on the basis of risk management reports. Reporting to senior management is standard for all participants. More than half (at least 7) of the participants have established processes and institutions for risk reporting and discussion, e.g. committees (“risk management committee”, “ALM committee”) with members from both the risk and the senior management side in it with regular (up to monthly) meetings.

It might be interesting to get an analysis on the following topics:

- Degree of involvement:
- risk numbers reported or discussed
 - risk methodology reported or discussed (especially operational risks)
 - model checks and tests (stress testing) reported
- Methods of involvement:
- reports
 - committees with regular meetings
 - members of risk management unit in the board.

We recommend that the reporting methods are well documented and that stress testing results should be included as part of regular management reporting (as suggested in Annex 3 to MARKT/2515/02).

CEIOPS

Reporting to management is comprehensive and adequate.

BaFin

The management is involved by translating the business strategy into risk limits and compensation schemes on the one hand and receiving regular risk reports and responding to limit breaches on the other hand.

IAA

The insurer's Board and senior management should be actively involved in the risk control process, which should be demonstrated as the key aspect of business management.

12.2.3 Formal sign-off process for models and developments

Once developed models rarely remain unchanged, but are subject to regular refinement and development. This process needs to be subject to senior management and regulatory review and to stringent controls. As a consequence we have to distinguish between an internal sign-off process and a sign-off by the regulators. The later will distinguish between amendments that will be accepted as a normal part of the model and changes that will be treated as so fundamental that the model must be reviewed again as though it were a new application for model recognition. An established and well documented internal sign-off process might help increasing the confidence of the regulators in the model.

We observed that

- 7 participants have a formal sign-off process for their model (some of them by a committee, some have one appointed person doing the sign-off).
- 2 participants have a partially formalized sign-off process (in some major businesses only).
- 3 participants mentioned no formal sign-off process; but there is still some sign-off process going on, either only locally or informally by discussions.

We recommend that a formal sign-off process is considered important as it helps to clarify the internal risk management structures.

BaFin

Model change is an ongoing process that should be frequently discussed with the supervisor.

12.2.4 External consultants assisting the risk assessment

Here

- 8 participants stated that they use (or have used) external consultants in the risk assessment process, 2 of them for ongoing assistance, 4 of them only for some issues

(introducing the model, problematic issues or in some local sub-units). It is interesting to note that one single consultant firm is engaged by 4 different participants.

- 5 participants said they do not use external consultants.

BaFin

The use of external consultants assisting in the risk assessment process is not required.

12.2.5 Calculations done on group and sub-unit levels

Both, group and sub-units are involved in risk capital calculations. In most cases (approximately 80%) we observed the following:

Group providing/ responsible for:

- market parameter, market shocks, scenario generation
- aggregation and diversification work, capital Reallocation
- stress tests for solvency requirements
- dealing with operational risk.

Sub-units do...

- calculation of (standalone) risk capital requirement
- cash flow projections
- aggregation on sub-unit level.

A bottom-up approach is performed in most cases; this takes burden off the group, if the sub-units are acting according to the model and guidelines set up by the group (central risk management unit) and if the IT systems are harmonized. Models developed at the local level, in line with the group specifications, will be better placed to pick up risks and issues specific to the local markets and products. The group should keep the last word on model questions, usage of data and, of course, aggregation and diversification.

12.2.6 Frequency and Duration of the calculations

We have observed that

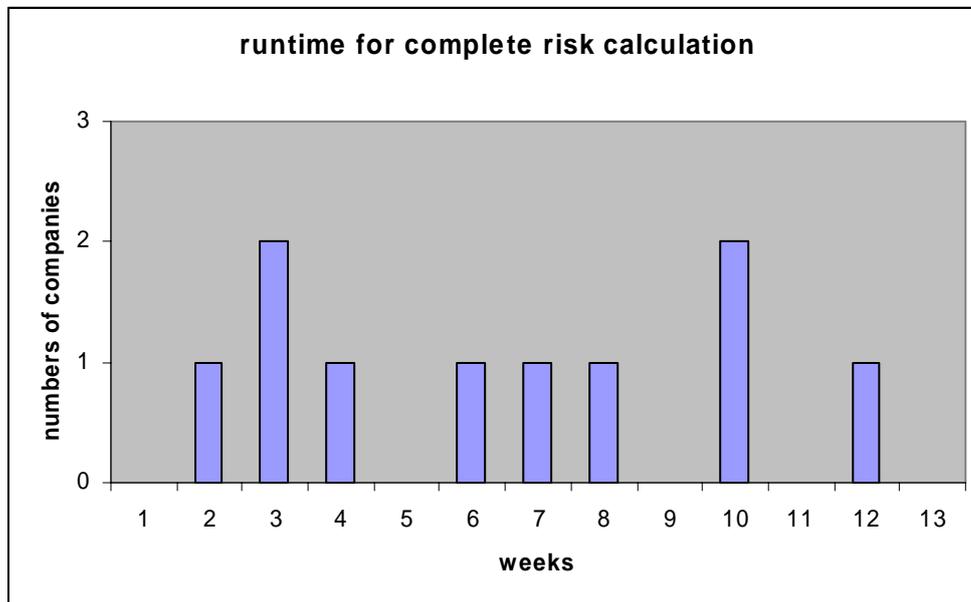
- 4 participants perform yearly calculations
- 4 participants perform half-yearly calculations
- 4 participants perform quarterly calculations
- 1 participant does monthly calculations.

It was mentioned by 2 participants that for some risk types (market risk and/or credit risk) risk capital calculations are done with a higher frequency (quarterly instead of yearly). A higher frequency of calculations on sub-unit level was not reported to us.

BaFin

We expect a quarterly requirement on higher levels of aggregation and higher frequencies for sub-portfolios that are more dynamically managed.

As for the duration of the calculations, we observed runtimes ranging from 2 weeks up to 3 months, most participants ranging uniformly in between (2 participants would or could not give exact runtimes) as seen from the following diagram:



For a complete group risk calculation the following problems slowing the speed of the calculations were mentioned:

- Update of data (present data not available, embedded value results not up-to-date...)
- Feeding the data, data review, plausibility checks
- Tough timelines for producing reports
- Technical and organizational difficulties in gathering data from the individual sub-units
- Governance processes.

Some participants stated that the tough timelines for reporting (closure of the balance sheet) set up by the company's management were one of the greatest hurdles.

To overcome some of the problems the following measures are taken or considered

- Missing data is estimated
- Run of the model with old (last year's) data to keep timelines
- Building an "approximation model" to speed up calculation
- Harmonizing the IT-(reporting) systems.

To expect an upper limit for the runtime of one day is completely out of question if one takes the whole process including the work done in sub-units into account, and not just the aggregation of a few spread sheet numbers by the central risk management.

BaFin

We expect an upper limit of one day.

12.3 Tools

We observed a clear picture: All the participants are using in-house developments (up to even their own scenario generator), and all (up to one) also use external software. But whenever external software is used, the participants prefer to operate them in-house rather than to depend on external resources (only one company would consider the latter as a possibility). Among the software tools used are the asset scenario generator by Barrie and Hibbert (widely used), Moses, Prophet, Remetrica, Moody's (KMV)...(see also Section 12.3.1)

An internal model is only well understood if it is worked by in-house resources (one company even mentioned that for this it has to be *developed* by in-house resources). There is a clear signal that the companies assign importance to working with adequate models, which they fully understand and control.

BaFin

The main requirement for outsourcing is that the management board must still be able to manage the risks and the supervisor has access to all the information he needs to examine the model.

12.3.1 IT platforms and infrastructure

To emphasize the variety of IT platforms and software tools in use, we provide excerpts of some of the answers given:

- Asset risk modelling is supported by the Barrie and Hibbert scenario generator; the overall calculations are done via Excel. Calculations are outsourced to MatLab or internal software developments
- Current tools employ Mathematica, MatLab, Visual Basic, Visual Basic for Applications, Excel and Access as well as C and C++ proprietary programs
- PCs with windows for hardware and Remetrica from Benfield are used as main tool, but also self developed pricing tools to fit liability models and own ESG developed in Visual Basic
- Usual IT structure (PC's) is being used, but new solutions are contemplated
- Models are mainly run on standalone PCs or networks of PCs. Some models are implemented in standard Office software (EXCEL, Visual Basic), for others, external proprietary software has been developed
- ESG (provided by consultancy Barrie and Hibbert), Prophet (in life modelling) . Aggregation done using Visual Basis and EXCEL
- EXCEL and Windows 2000
- Moses, Prophet and Atlas are in use for most liabilities. On the asset side there are many systems covering many asset classes
- Various platforms, mainly EXCEL spreadsheets are used
- Depending on the needs the appropriate hard/software is used
- The individual models are mostly EXCEL models. Some parts are on Access, KMV, RMS, or Igloo. Data storage and transfer to group center is done via an Oracle database
- S+ and EXCEL are used.

This may also give a hint as to a somewhat small degree of industry wide standardisation.

It seems that management information is still mainly done manually or by presentation and is seemingly not automatized. Not half of the participants seem to have a separate IT system for reporting.

Typical answers regarding IT systems used for reporting were e.g.

- IT systems used for reporting vary by business unit. At a group level reporting is bespoke, but management information is being developed
- The risk capital allocation on the sub-units and below is fed into the annual planning system. A management information system is under development and it is planned to include risk capital figures
- “Risk Dashboards” are planned in near future
- Visual Basic with EXCEL and Database technology is intended for use
- The output from the model is used for financial reporting and for financial management. As such the output is transferred into local IT systems
- There is no separate IT system for reporting. Each business has its own system. Different systems are used
- The data transfer to group center is done in a separate IT system. However, this is not linked to standard MIS system and reports are produced manually.

One could think of having a unified IT reporting system throughout the company:

Sub-units → risk management unit → company’s management

at least in the cases where the main calculations are done on the sub-units level. This would not only clarify the reporting process (also in the view of the regulators) but also strongly link the company’s management to the risk controlling procedure.

As one can deduce from the answers the first arrow seems to be automatized but not on a single system (though with some participants, yes), and the second arrow seems to be done manually or verbally (special spreadsheets, meetings, presentations...), at present.

BaFin

There are no requirements as to which IT tools are to be used. We expect separate IT systems for risk control, termed “middle office” in banking, which are separate from the “front office” systems used by traders and sales persons and from the “back office” systems used for contract settlement and accounting.

12.3.2 Harmonising the systems

We observed that for all participants different systems are in use for capital calculations.

This is largely due to

- The company’s history: taking over new business lines and units also may import new IT systems
- Without an integrated internal model and the sub-units more operating on their own there was less need to harmonise the systems
- Different IT systems seemed to be necessary for different LoBs.

Concerning harmonisation, we have observed all kind of answers, ranging from an eager struggle for harmonisation (“yes, hoping to harmonise the systems”), over a reserved

viewpoint (“harmonising the system where deemed appropriate”) to a deliberate rejection of any harmonisation work (“no plans to do any harmonisation”).

Although pulling together data from different database systems (sometimes even by “copy & paste”) is admittedly a source of error and at least time consuming, more than half of the participants are NOT intending to harmonise the systems in spite of the possible benefits.

As reasons for this were given

- because of the fast development of the methodology one does not believe in standardised monolithic software environments
- clear and precise definitions of outputs enable an easy aggregation of data, so there is no need for harmonisation
- there is a need for different IT platforms for different businesses.

Even if the majority of the participants seem to be satisfied with their status quo, we would like to propose harmonisation and integration of the systems being done whenever possible and appropriate.

BaFin

There is no requirement for harmonisation.

12.4 Data Management

Not all participants provided (exhaustive) answers here (“A wide range of data inputs and processes are in place in order to calculate all the required information used for the internal risk models.”), some are still in the building-up phase, some are somehow reluctant in giving information obviously considering it a delicate matter. In any case, from what we have seen from the participants, **data management and processing of the data is probably the most challenging aspect** (see also the comments in Section 4.3 “Major obstacles in development and use of internal models”).

12.4.1 Validation and reconciliation of input data

We observed different ways of data validation. Very common is the reconciliation of input data with previous period data followed by investigations whenever large changes are observed (if necessary this leads to a new evaluation of data sources in rare cases).

Validation and reconciliation may be done by applying set-up tests, case by case cross checks, additional plausibility checks ... or by human judgement based on experience.

Another way of data validation is the external check-off made by independent firms (e.g. the use of audited embedded value data).

Data may be collected, analysed and distributed by a central corporate referee group operating under the CFO or a Chief Operating Officer.

12.4.2 Setting and documentation of assumptions

In most cases central functional departments are responsible for the setting (and documentation) of assumptions. The documentation is then also done centrally and

documented separately or the assumptions are set and recorded within the computer programmes constituting the model. Concerning documentation see also Section 12.1.2.

12.4.3 Pre- and post-model data adjustments

Pre-model data adjustments occur following data integrity and data plausibility checks, correcting gross errors in the data. They are performed by some of the participants. Post-model data adjustments follow the review the input data on basis of the outcome of the model. The review is done in form of cross-checks, but data adjustments are as a rule not carried out with most of the participants.

12.4.4 Frequency of update

All the participants update their input data at least once a year (with the end-of year data), about 1/3 perform a half-year and about 1/3 even a quarterly update. Whenever possible an up-date is made prior to each calculation (see also Section 12.2.6). Naturally, market data (e.g. market value of different asset classes) are updated with a higher frequency (typically quarterly) than e.g. liability data (typically yearly).

12.4.5 Source of data (e.g. external data pools)

For nearly all participants the vast majority of data is provided by internal sources such as internal loss data, internal policyholders' data, internal frequency and severity estimations as well as expert opinion from internal economists. External sources were mentioned in connection with external loss databases (in connection with operational risk), estimation of investment markets' parameters (e.g. volatilities) calculated on basis of historical time series from financial information providers, insurance data from accounting or Embedded Value Systems or economic scenarios from external consultancy (e.g. Barrie and Hibbert).

12.4.6 Manual vs. automatic feed (e.g. automatic link to group databases)

Here the answer "mostly manual feed" was observed in most of the cases, only 4 participants mentioned automatic feed in connection with market parameters, data transformation from a data base into EXCEL, and automatic generation of input data.

It must be mentioned that manual data feed, although a common source of errors, is a deliberate choice within some participants and not going to be abandoned for the sake of learning, getting a deeper feeling and understanding of the model.

12.4.7 Storage

No clear picture obtained from the (few) answers here; in the extreme case everything, the model, the input data and output data are stored on a single local PC.

BaFin

Minimum quality of input data to the model as well as the quality of data verification processes is one of the requirements that will be checked in an examination.