The use of multi-year internal models for management decisions in multi-year risk management

Dr. Dorothea Diers,
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Overview

- Paradigm shift in insurance industry
- Internal models in non-life insurance - Structure and results
- Parameter risk in premium risk –a risk often ignored
- Multi-year models and multi-year risk capital
- Management strategies
- Iterative management process
- Summary and outlook

Paradigm shift in insurance industry

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- Ø Increase of natural catastrophes
- Ø Resulting: Increase of reinsurance premiums
- Ø Negative developments on the capital markets
- Ø Resulting: substantially altered risk situation for insurance industry
- Ø This led to a substantial decrease in total corporate capital resources in insurance industry.
- Ø Requirement for a higher level of transparency of the risk situation from
  - management
  - regulators (Solvency II)
  - rating agencies
  - insurance holders
  - ...

Paradigm shift in insurance industry

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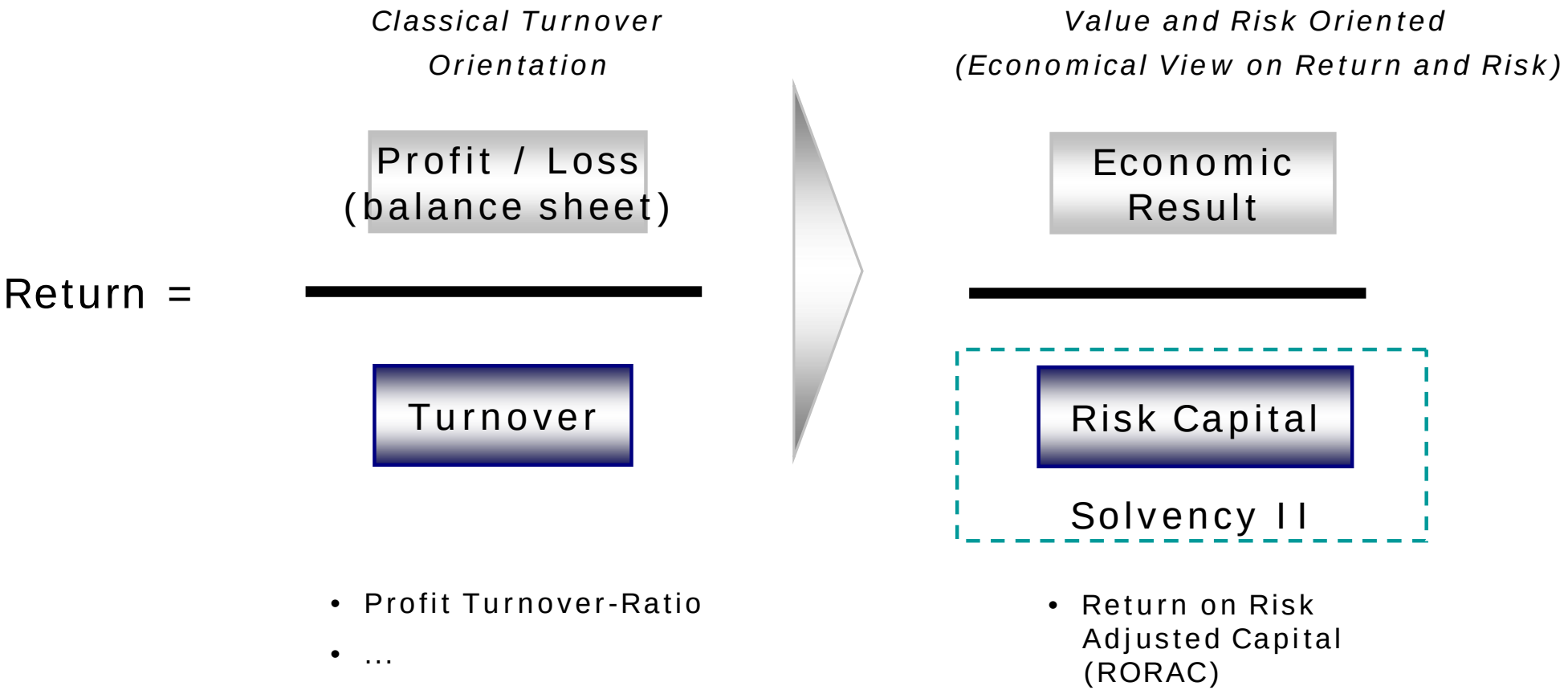
Management reacted to the altered prevailing conditions with a paradigm shift in corporate strategy developing from classical turnover orientation to *value and risk based management* in economic terms.



Source: Diers, Interne Unternehmensmodelle, ifa-Verlag Ulm, Germany

Advantages of internal models

Solvency Capital Requirements can be calculated either using the standard formula or an internal risk model.

Advantages of internal risk models:

- Ø Using an internal risk model the individual risk situation of the insurer can be modelled more exactly than using the standard formula, which is often more (too) conservative.
- Ø Adequate internal models allow the quantification of risk and return of all lines of business and asset classes. Moreover they can give a more detailed view of the risk and return situation e.g. of special risk types such as private or industrial business.
- Ø Internal models can be used as a base for strategic decisions in value and risk based management.
- Ø Internal models can be used to calculate adequate risk margins for premium calculation (pricing). The development of insurance products should also be adapted to the risk situation of the insurer. For example insurers should think about the introduction of deductibles or underwriting limits to reduce risk capital.

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Structure of an Internal Risk Model

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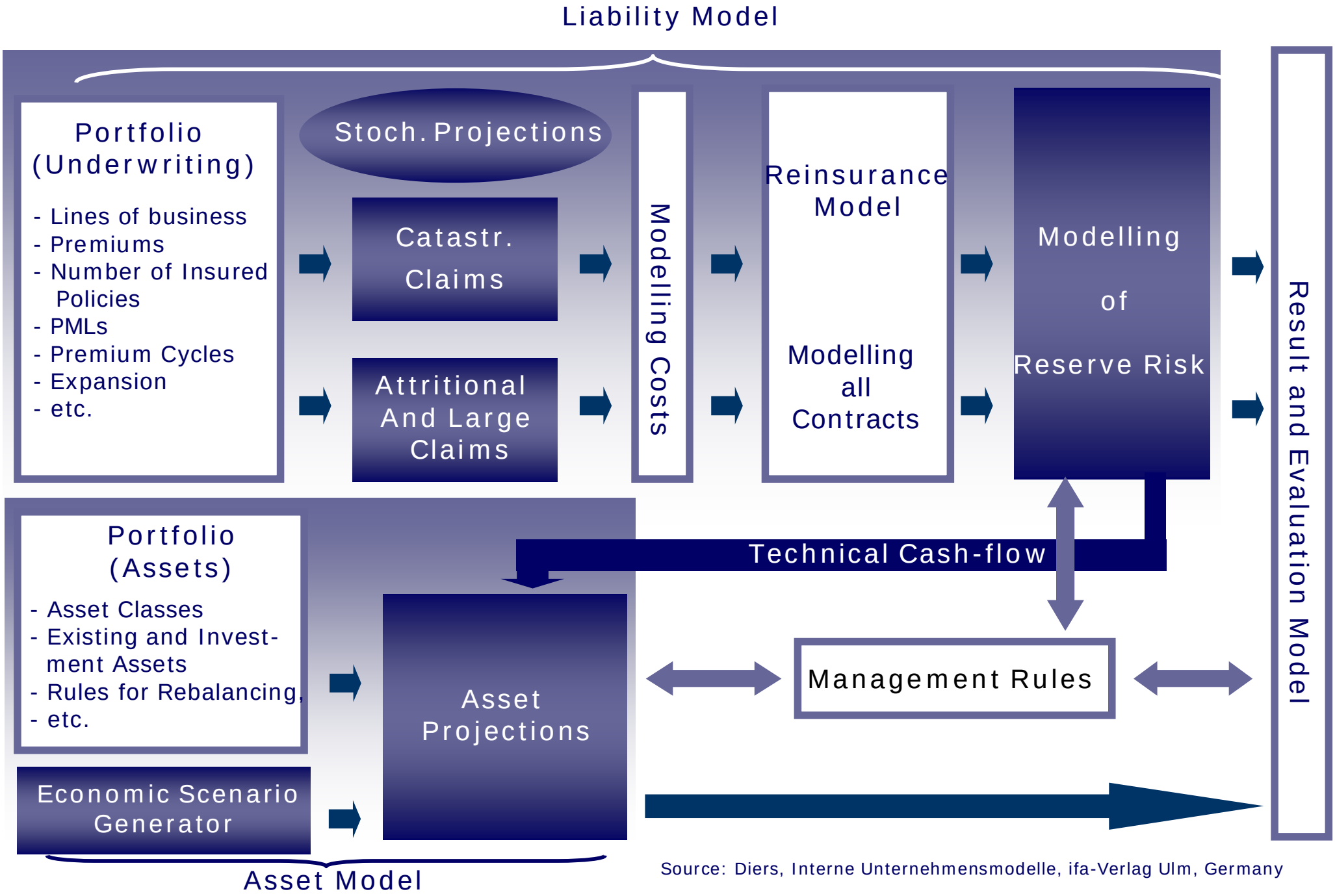

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Random variable of economical results

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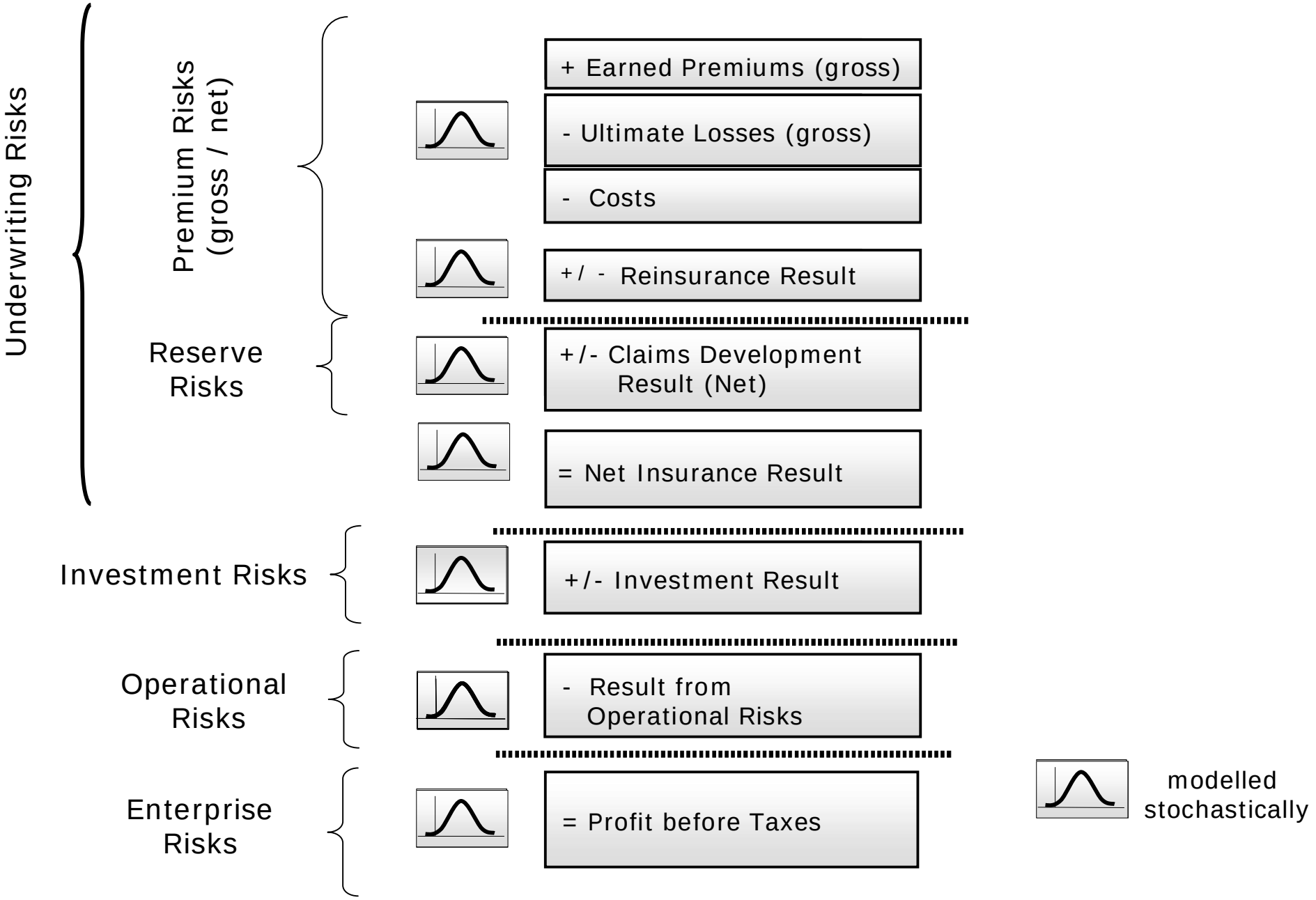

Risk modelling in internal models

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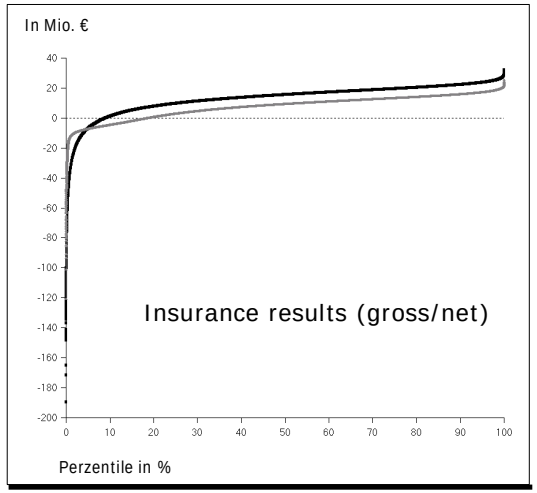
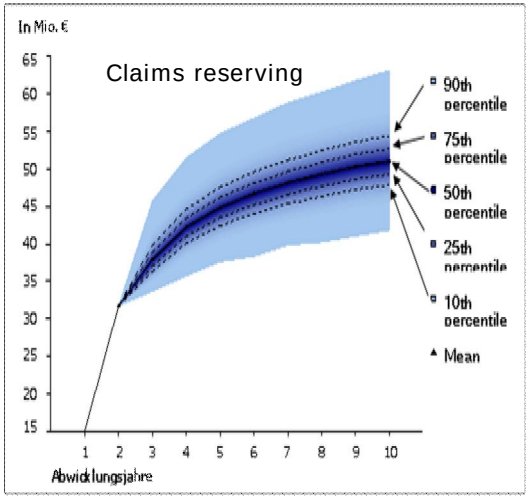
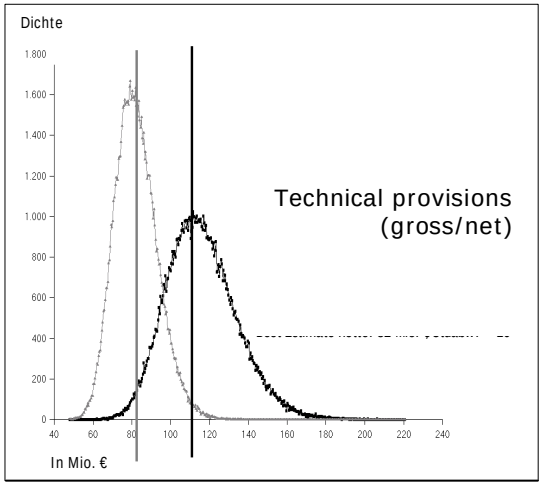
Risk modelling in internal models is based on a variety of mathematical and actuarial methods such as

- Ø Simulation methods
- Ø Statistics, extreme value theory
  (probability distributions, maximum-likelihood, statistical goodness of fit techniques, dependency structures)
- Ø Claims reserving methods, cost of capital approach
  for calculation the market value margin
- Ø Finance
  (for capital market modelling)
- Ø Geophysical models
  (natural risks models)
- Ø etc.







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Risk modelling in internal models

- Modelling in internal models is a kind of prediction process.
- This may give rise to different sources of uncertainty: model uncertainty, prediction uncertainty, which can be divided into parameter uncertainty and process uncertainty.
- Process uncertainty describes the uncertainty from the actual random process.
- Parameter uncertainty results from the uncertainty in estimating the parameters from the model.
- In premium risk parameter risk is often ignored, leaving only the process risk modelled. Some methods of modelling parameter uncertainty have been discussed in literature. In the paper we refer to two of these: bootstrap and Bayesian as described by Borowicz/Norman (2006).

Modelling the predictive distribution (long history of observed data)

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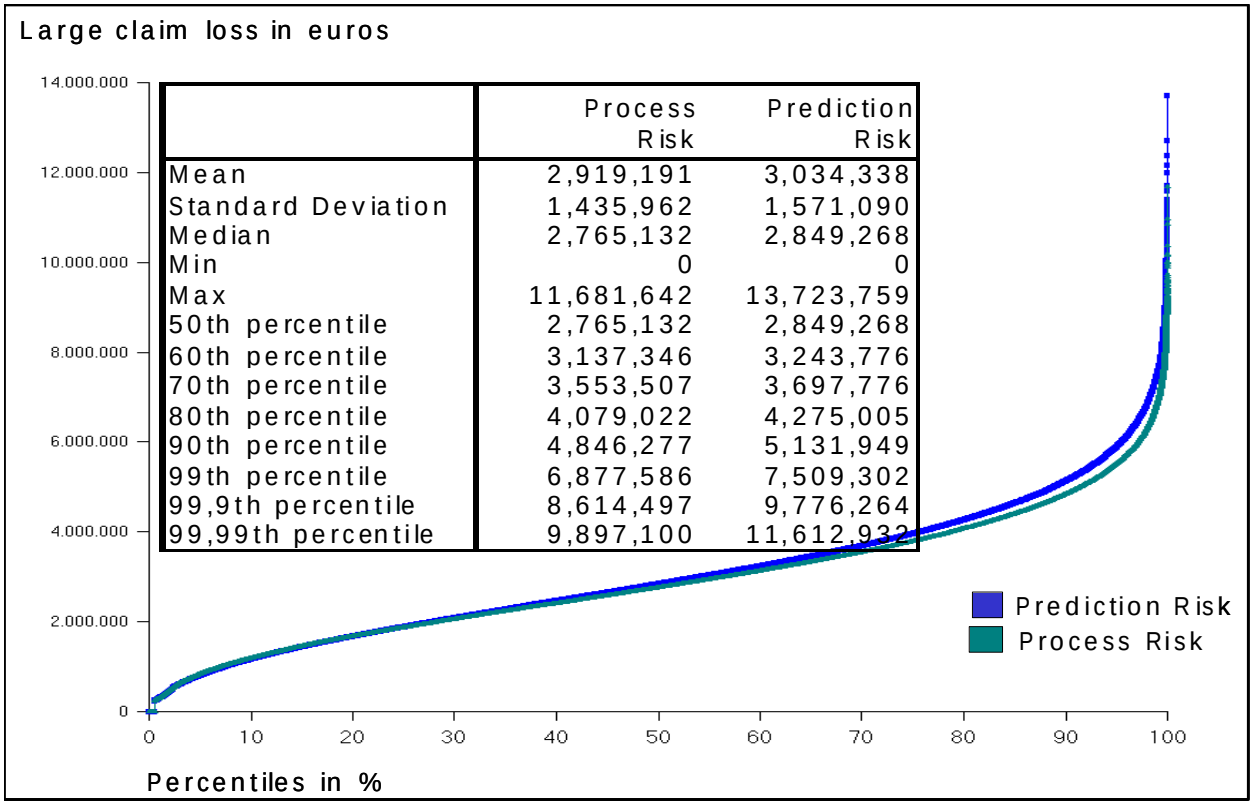
Ø After separately modelling large claim frequency und large claim severity (both including parameter uncertainty), we simulate large claim losses, assuming that the claim severities are independent and identically distributed random variables and that they are independent of claim number, thus fulfilling the condition of a collective model. (In this example we had a long history of observed data).



	Process Risk	Prediction Risk
Mean	2,919,191	3,034,338
Standard Deviation	1,435,962	1,571,090
Median	2,765,132	2,849,268
Min	0	0
Max	11,681,642	13,723,759
50th percentile	2,765,132	2,849,268
60th percentile	3,137,346	3,243,776
70th percentile	3,553,507	3,697,776
80th percentile	4,079,022	4,275,005
90th percentile	4,846,277	5,131,949
99th percentile	6,877,586	7,509,302
99,9th percentile	8,614,497	9,776,264
99,99th percentile	9,897,100	11,612,932

Modelling the predictive distribution

- The extent of parameter uncertainty depends strongly on the data volume observed. Few observations will usually lead to substantially higher parameter uncertainty compared to observed data based on a long history with lots of observations.

- To quantify these effects the following example is based on a segment with only 5 large claims as observed data instead of 65 in the above example. The next Figure shows the percentile graphs for large claim severity including and excluding parameter uncertainty compared to historical data.

Modelling the predictive distribution

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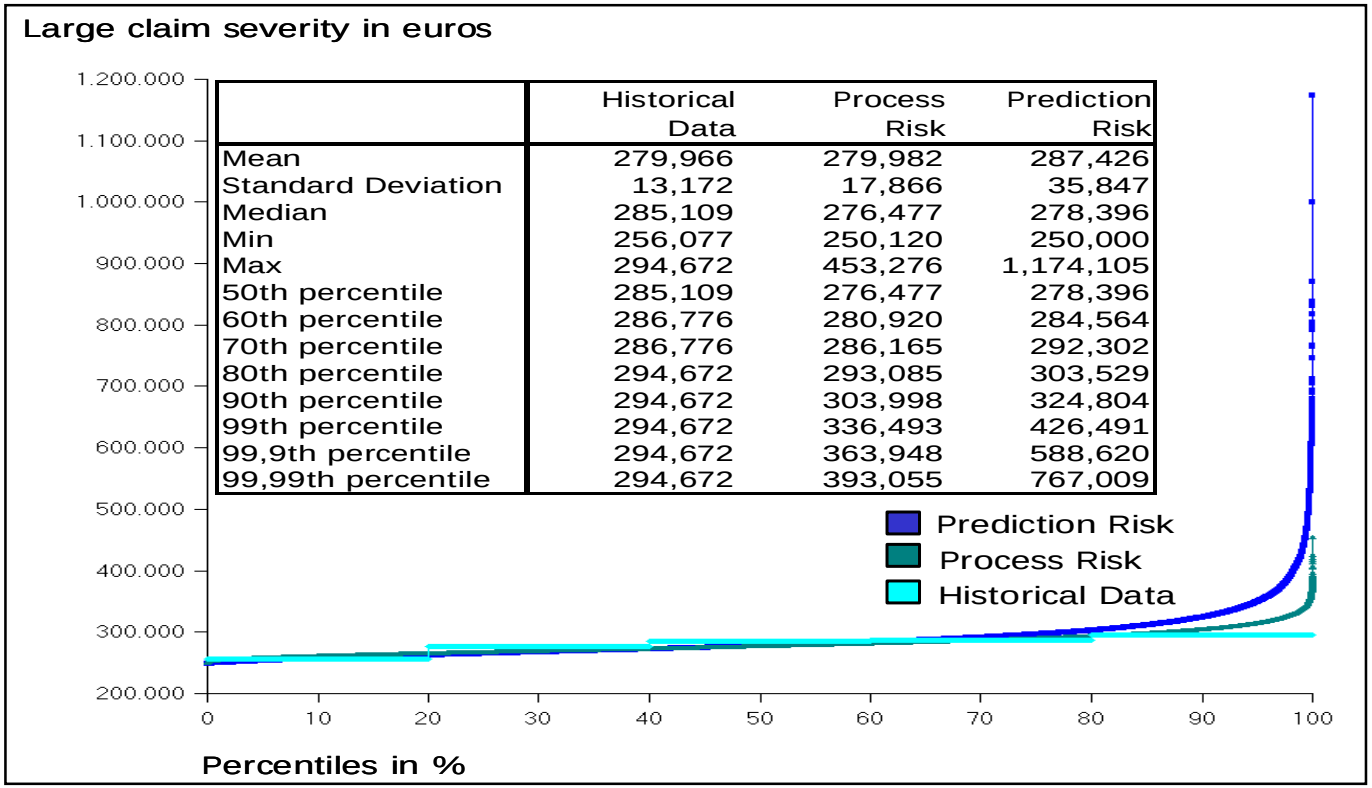

	Historical Data	Process Risk	Prediction Risk
Mean	279,966	279,982	287,426
Standard Deviation	13,172	17,866	35,847
Median	285,109	276,477	278,396
Min	256,077	250,120	250,000
Max	294,672	453,276	1,174,105
50th percentile	285,109	276,477	278,396
60th percentile	286,776	280,920	284,564
70th percentile	286,776	286,165	292,302
80th percentile	294,672	293,085	303,529
90th percentile	294,672	303,998	324,804
99th percentile	294,672	336,493	426,491
99,9th percentile	294,672	363,948	588,620
99,99th percentile	294,672	393,055	767,009

Ø This example (with only few historical claims) shows that ignoring parameter risk can lead to a sizable underestimation in risk-capital requirement. In addition a parameter uncertainty in dependency structures should be considered.

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Management rules in multi-year models

- Strategies, e.g. expansion in special lines of business, introduction of deductibles, higher limits in underwriting, etc.

- Increase of reinsurance premiums in simulations with preceding years of high claim losses

- Management strategies in simulations with high claim losses, in order to improve results and to avoid negative excess capital. This can be the case for example after scenarios with natural catastrophes or with negative developments at the capital markets. Possible strategies could be:

  - Stop expansion in building
  - Introduction of deductibles in building (to limit the effect of storm events)
  - Higher reinsurance protection
  - Change in asset allocation (lower risk profile)

Multi-year risk capital

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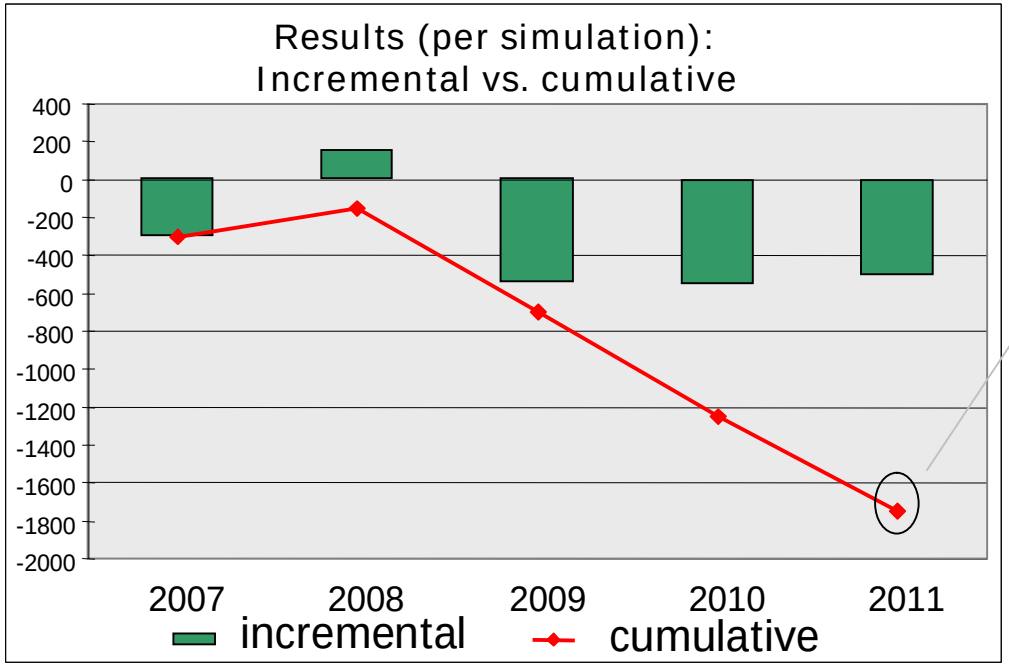
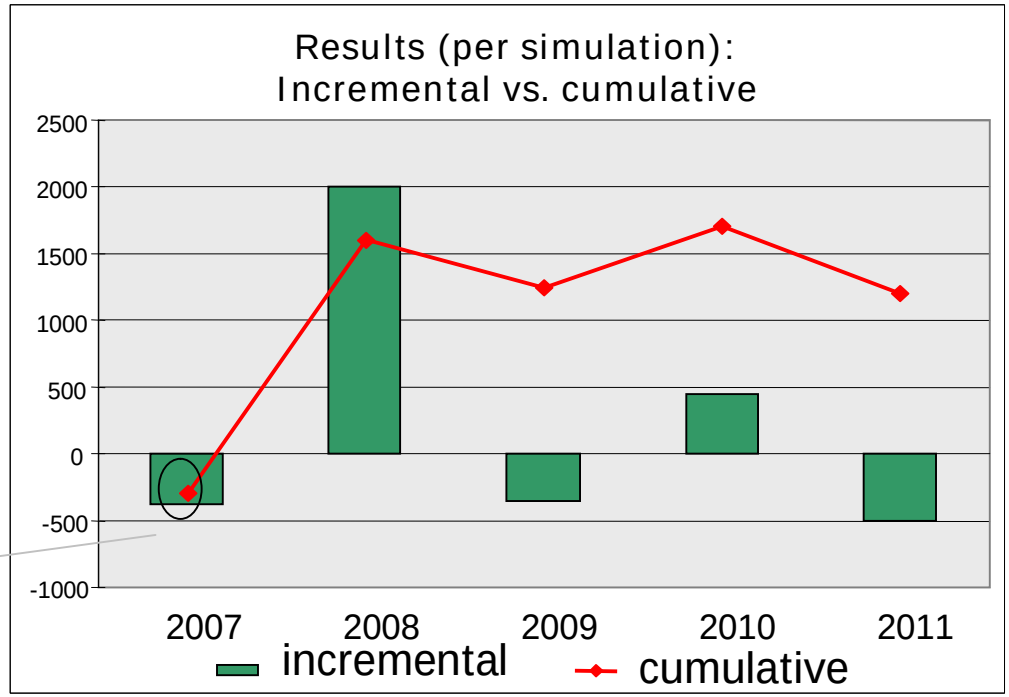
Defining multi-year results



Risk capital



Risk capital

Definition of multi-year risk capital

- Per simulation and per year *j* we define cumulative losses

- *Cum. Loss* (1) = *Loss* (1)

  Cum. Loss (*j*) = *Cum. Loss* (j-1) + *Verlust* (j)

- We define the maximum over the years:

  MaxLoss = *Max* {*Cum. Loss* (j)}

- *MaxLoss* represents the maximum of the amount that needs to be covered over the years for each simulation. This amount needs to be provided at $t=0$ in the simulation path to allow the insurance company to cover all losses incurred over the entire period simulated (n years) without external capital supply in this simulation path.

- The selected risk measure, ρ, can now be applied to the *MaxLoss*: $\Omega \rightarrow$ IR in order to determine the risk-capital requirement.

Multi-year risk capital

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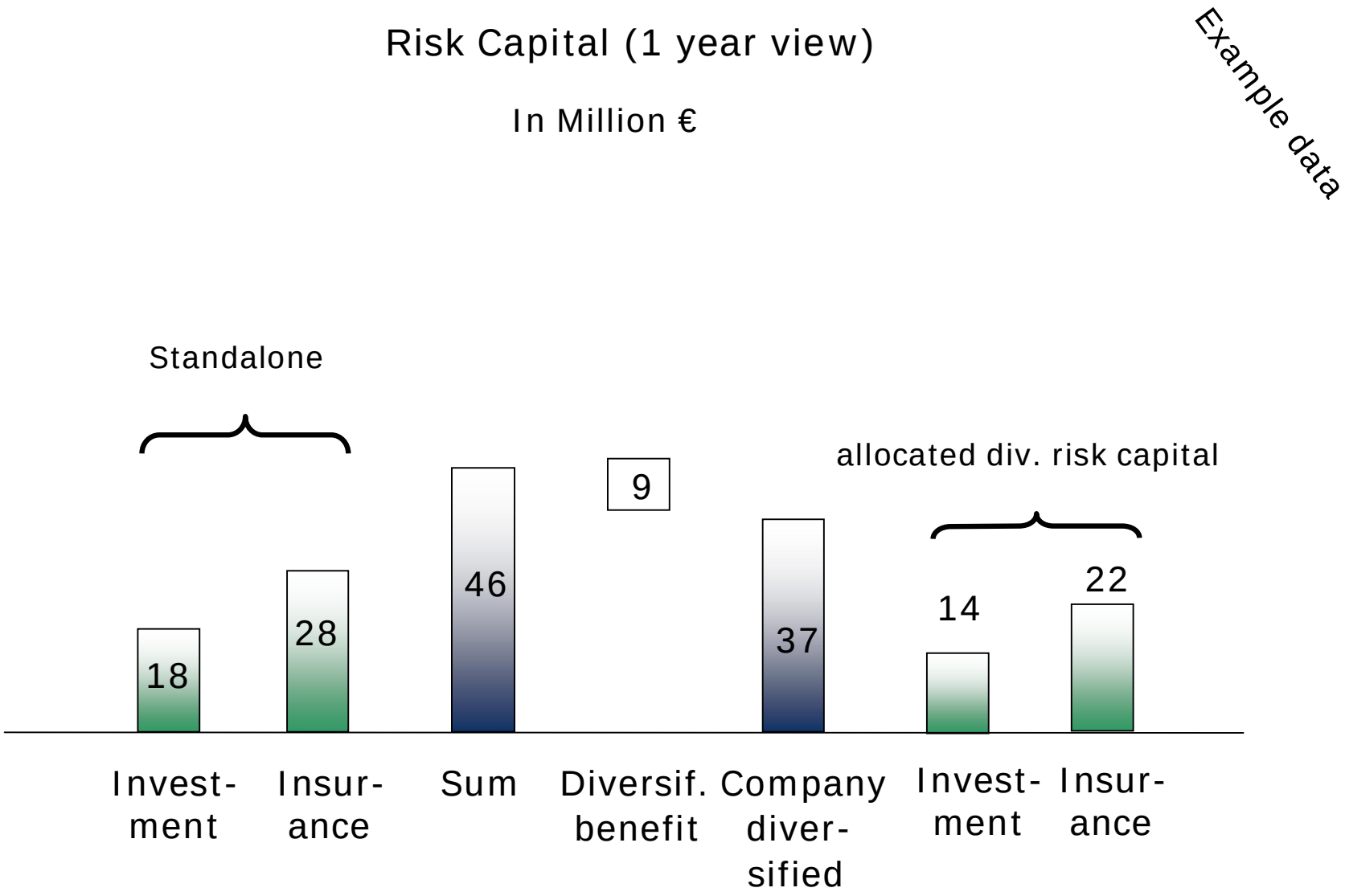

correlation (investment, insurance): 25%

Multi-year risk capital

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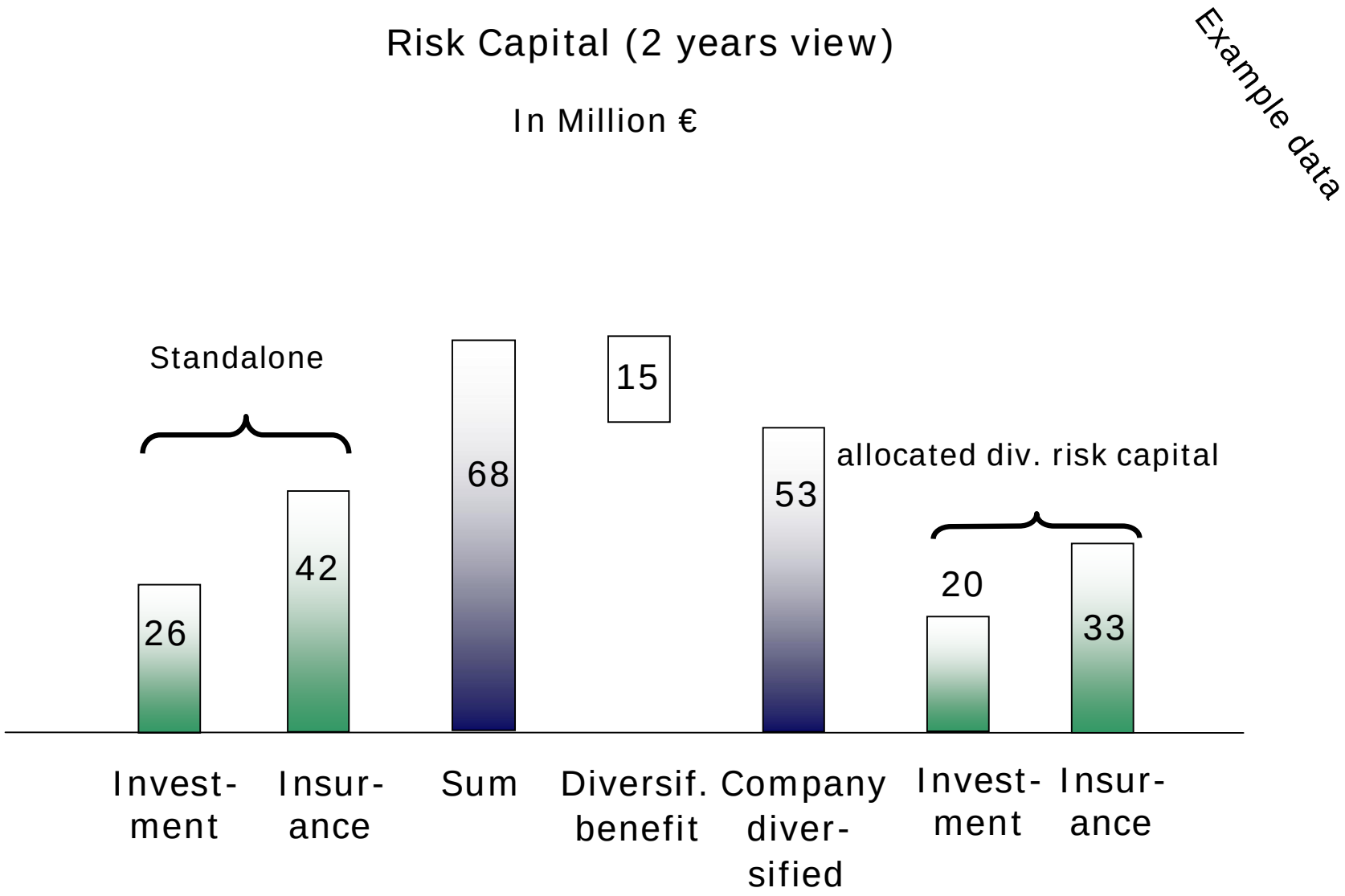

Multi-year risk capital

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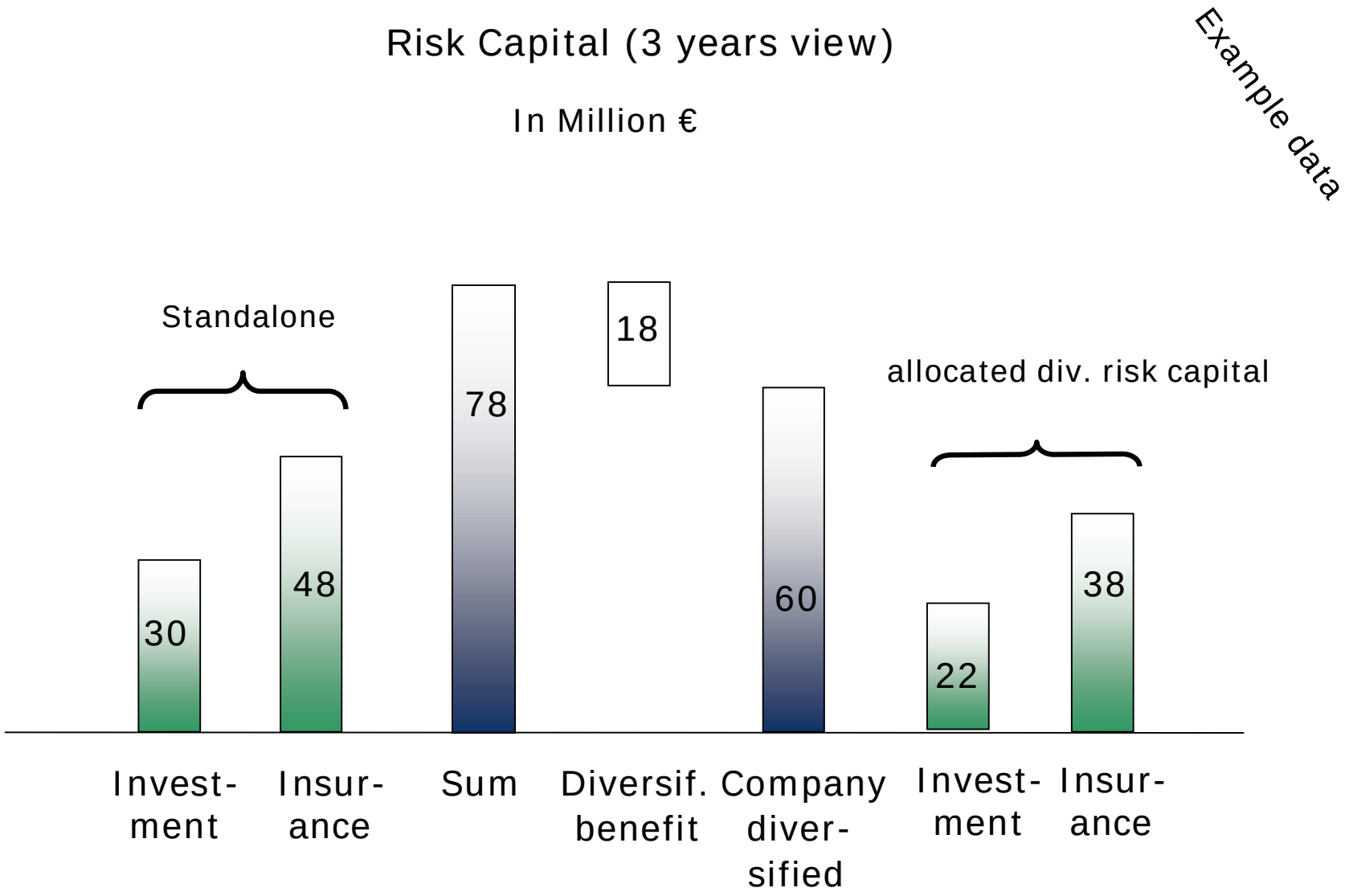

Multi-year risk capital

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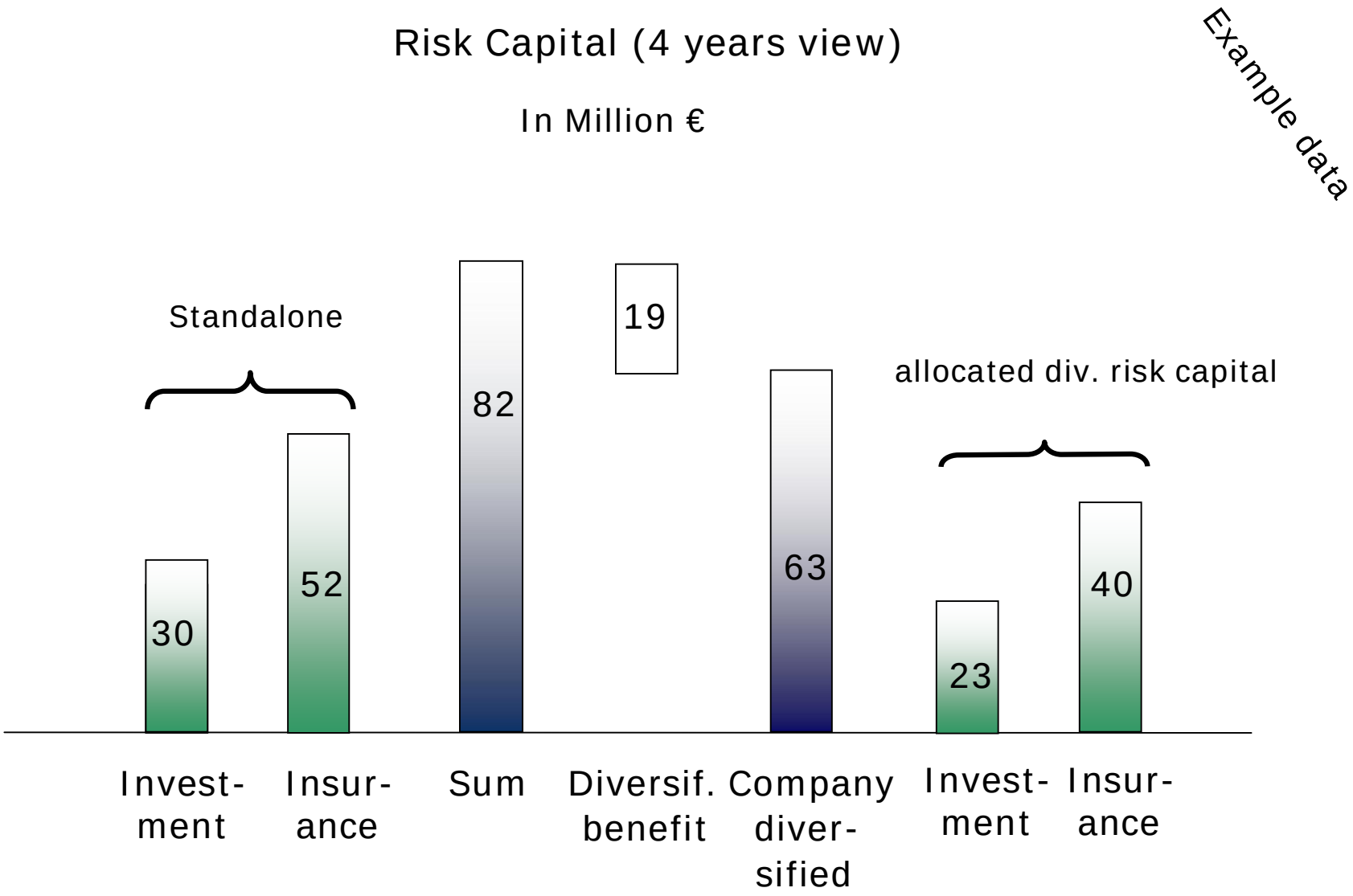

Multi-year risk capital

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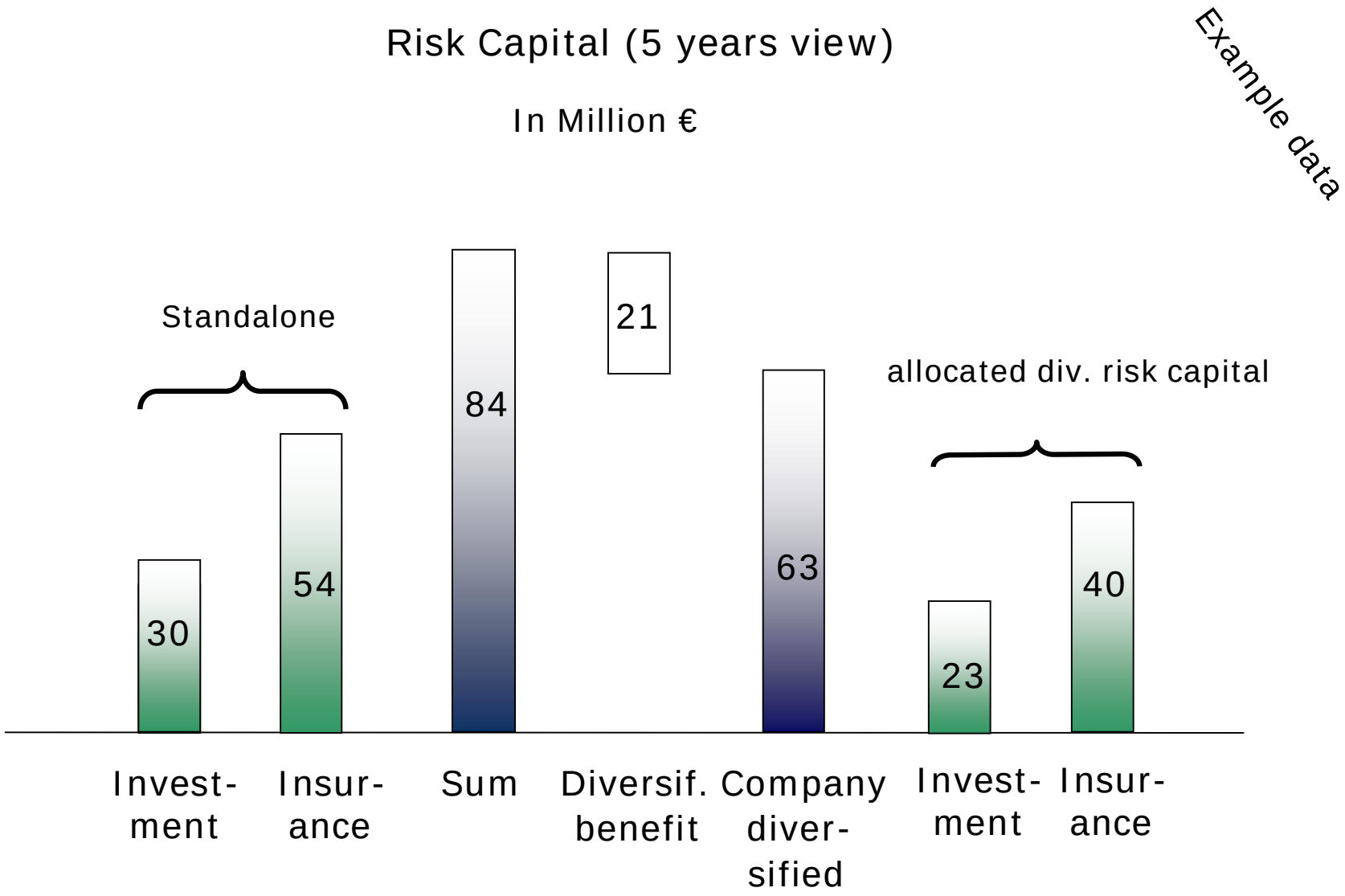

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Strategies (1/2)

Ø Expansion in lines of business

- where return exceeds cost of capital (with a high EVA or RoRAC),
- which show a high diversification (to other lines of business of the portfolio).

Ø Withdrawal from various agreements which do not fulfil the above conditions.

Ø Introduction of arrangements which reduce the risk situation

- deductibles,
- limits,
- insurance agreements (e.g. exclusion of special risks; demand on risk reducing measures, such as walls against expansion of fire, etc.)

Strategies (2/2)

Ø Finding adequate reinsurance strategies

- To which level should the company have reinsurance contracts? Which level is necessary with regard to the available solvency margin?
- Finding adequate reinsurance contracts to achieve an „optimal“ return and risk situation
- Groups: Reinsurance contracts on group level

Ø Adequate asset allocation

- Optimised asset allocation with regard to the return and risk situation of the company

All strategies are discussed with regard to the realisation of an „optimal“ return and risk situation of the company and in the background of value and risk based management. So management has to decide, if for example the return situation of the company should be improved by expansion in special lines of business, reduction of reinsurance, changing the asset allocation, etc. The effects of the different strategies should be evaluated in a multi-year context. In the paper we analysed the influences of different strategies.

Example of management strategies

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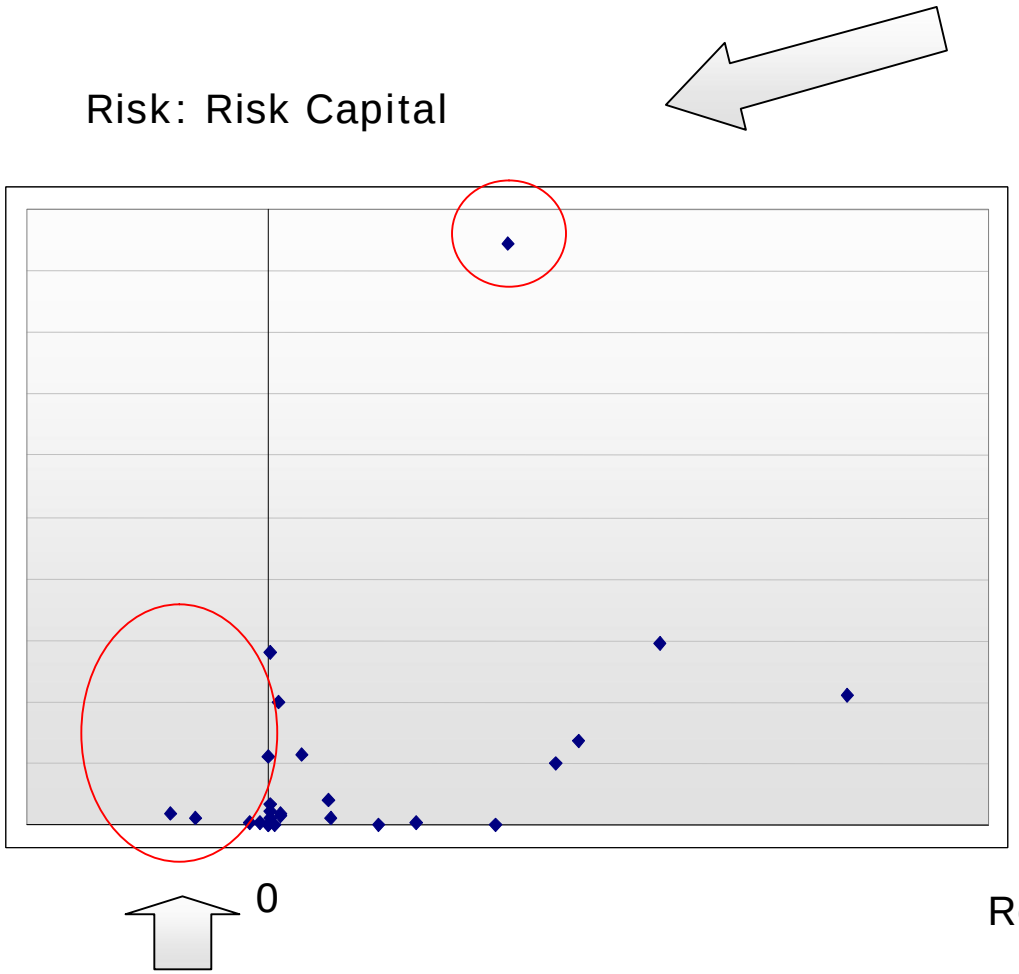
Return and risk situation as a base for value- and risk-based management



Management has to think about strategies so that risk capital requirement decreases (e.g. deductibles, reinsurance). If the insurance has enough economic capital to cover risk capital requirement, no change in strategy is necessary if the return position is adequate.

These lob create a negative return. Here management should think about strategies to improve the return situation.

Source: D. Diers, Interne Unternehmensmodelle, ifa-Verlag, 2007

Example of reduction of risk: Introduction of deductibles

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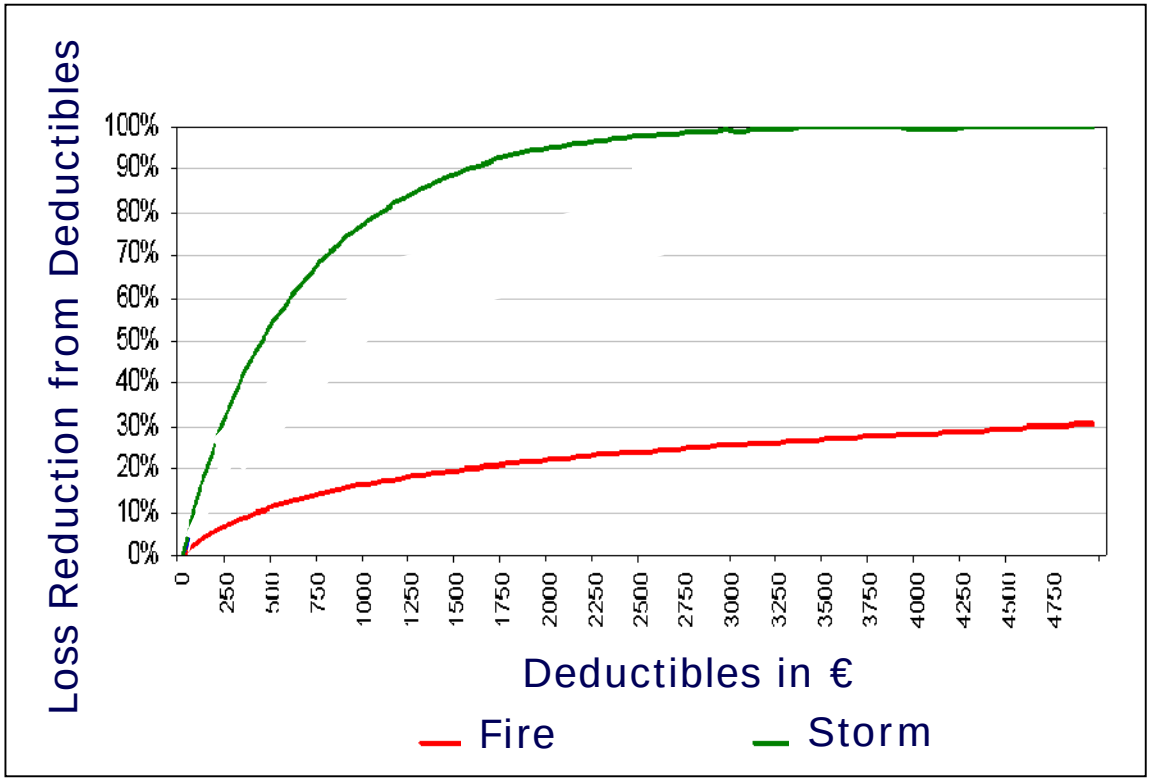

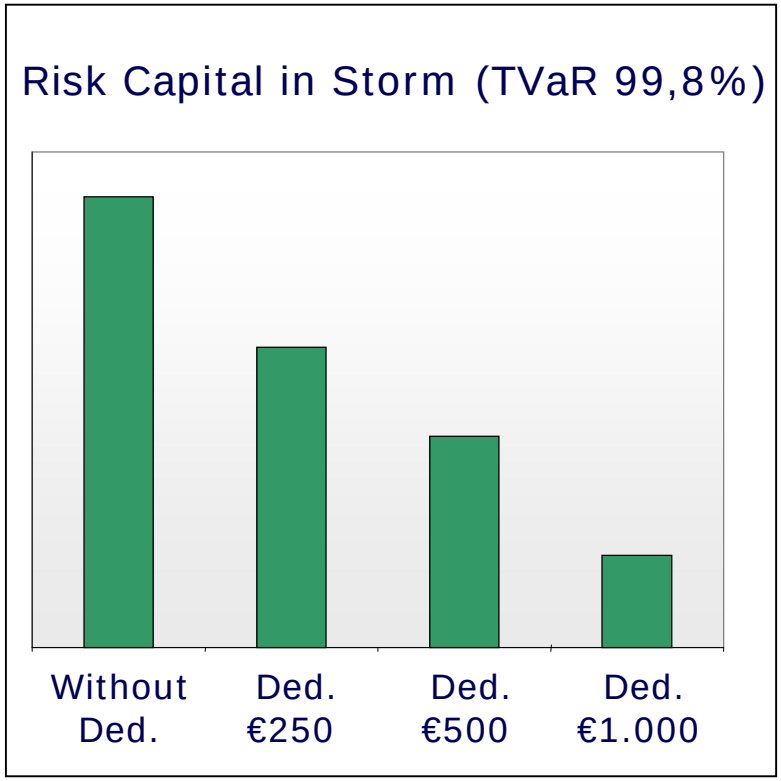

Introduction of deductibles in storm leads to a significant reduction in risk capital.

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Iterative management process

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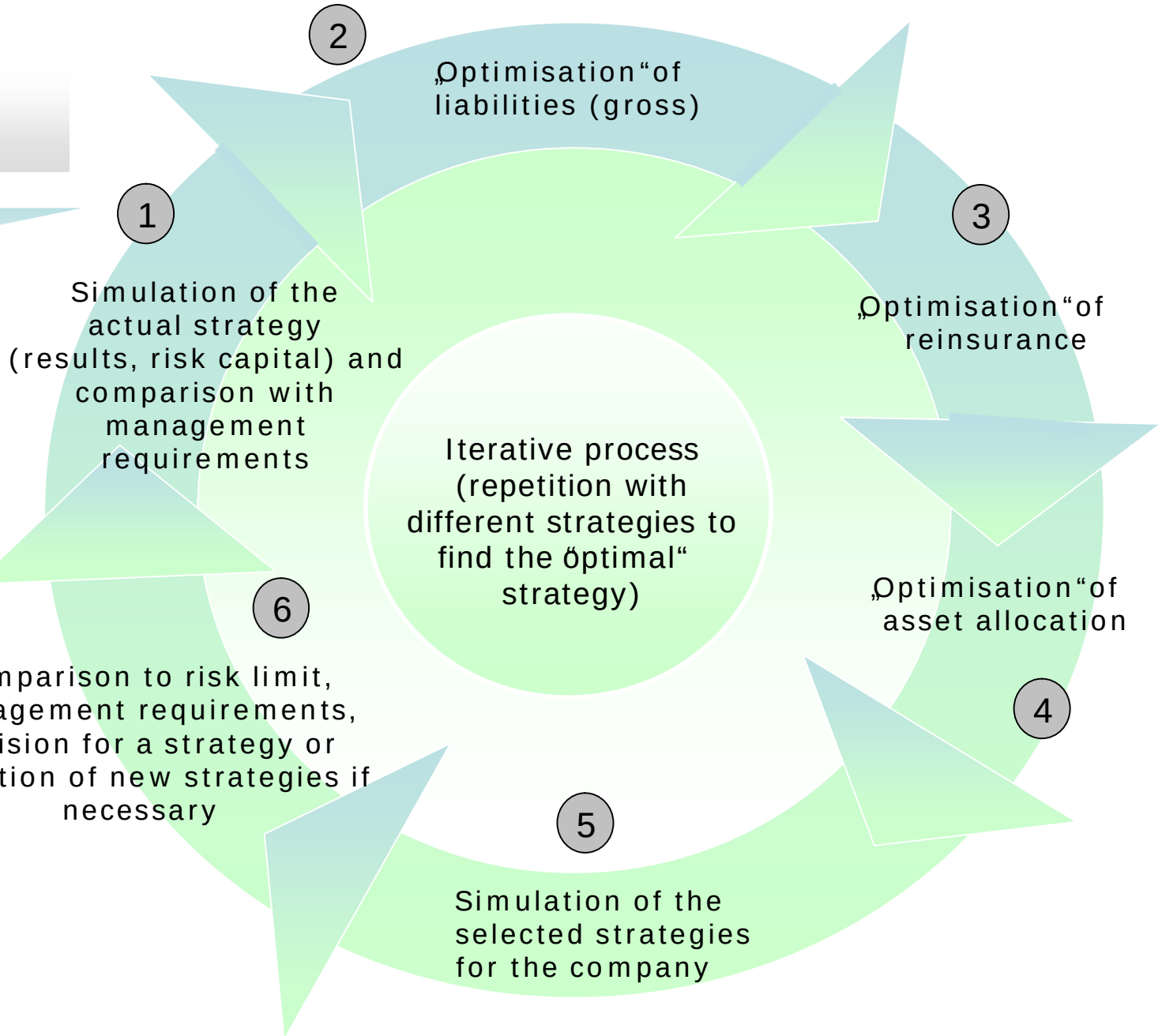
Management has to define:

I. Methods
II. Time horizon
III. Risk Tolerance
IV. Required return



Source: D. Diers, Interne Modelle in der Mehrjährigkeit, Deutscher Verein f. Versicherungswissenschaft, 2008

Iterative management process with conditions

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The iterative management process should consider the following restrictions:

- Management requirements concerning the results in the balance sheets (intended investment or technical results, net interest, annual surplus)

- Regulatory restrictions (actually for European countries: Solvency I and analyses of worse scenarios; in the future: Solvency II)

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Central role of internal models in the company

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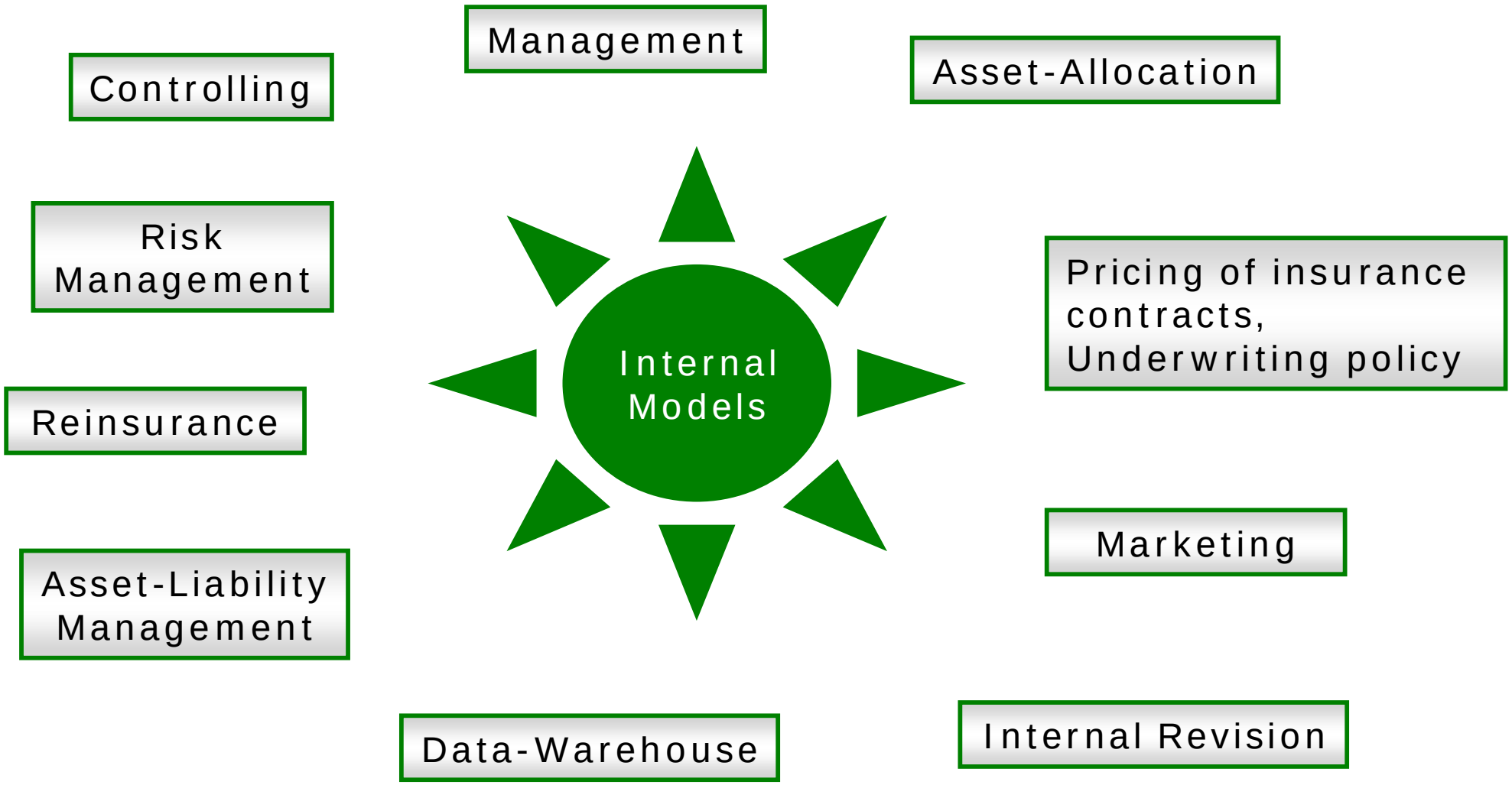
Internal models play a central role in management processes of almost all company divisions.



Source: D. Diers, Interne Unternehmensmodelle, ifa-Verlag, 2007

Summary and Outlook

- This management process will influence various divisions such as development of insurance products, pricing, reinsurance, marketing, asset management.

- So development of insurance products and pricing will be oriented at the cost of capital the products will cause and the diversification potential they have. In this context adequate capital allocation methods are needed.

- Methods for risk reduction will become more important, e.g. the introduction of deductibles.

- Internal models cannot replace the management decision, but they can represent an important base for deciding for the adequate strategy.

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