Swiss Re

Risk and capital
Some thoughts on risk modeling in insurance companies

Technical publishing

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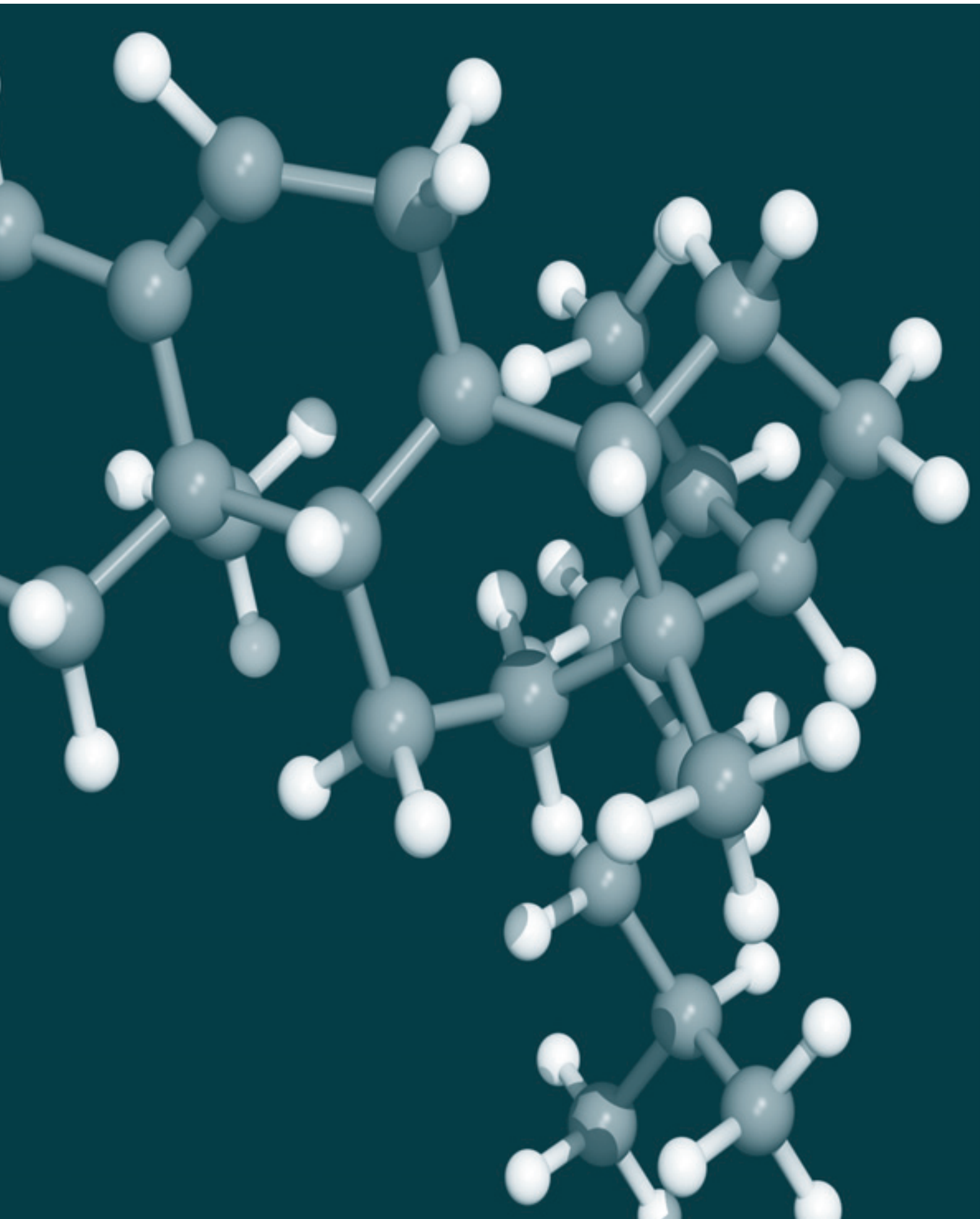


1 Outline of this booklet

This booklet is part of the "risk and capital" series. It reflects on some issues regarding risk models and risk model types; it is presented in a "non-technical" style and is aimed at interested readers who would like to learn more about these fields without going into detail, eg on how risk and risk models can be defined. In many cases simplified examples are used together with a set of questions to alert the reader to the *basic ideas and key elements when it comes to risk modeling*.

This booklet first gives a rough motivation for using risk models. Basically, this is done with the help of empirical surveys. The key idea is derived from a simple example: *there is no such thing as the perfect model, there are many models that may serve a specific task or purpose more or less well*; and these models can differ significantly.

Secondly, a number of criteria for identifying a risk modeling purpose are discussed. These criteria can also be used to classify certain risk models. This part highlights typical questions which are intended to enhance sensitivity for some of the key elements in the context of risk modeling.

Last but not least, some areas of Swiss Re's services for insurance[1] companies in the field of risk modeling are described. However, this booklet is not the proper format for drawing up a complete list of all the services Swiss Re provides in the field of risk and capital management. Therefore, please do not hesitate to get in touch with your contact person at Swiss Re to discuss services on a more individual and tailor-made basis.

1 In the following sections, the term "insurance" is used to refer to both insurance and reinsurance.

2 Why do you need risk models?

2.1 Some key motives

Recently, terms such as "risk management", "holistic risk management", "corporate risk management", "risk management models", and "risk models" can be read and heard more and more often throughout theory and practice, in the literature and at meetings.

New challenging questions

Is this because of some new trend in the (insurance) industry or regarding the behavior of market participants? As a consequence, more questions arise: Could the impact of deteriorating capital markets in the early 2000s have been avoided? Could the impact of some catastrophic events – whether man-made or driven by natural perils – have been averted? Would risk models, ie models capturing the relevant fields of the corporate risk landscape, have helped to identify such potentials in advance or at least to mitigate their impact? To what extent are risk models being used in risk management processes today? What are the main reasons for using risk models?

Empirical KPMG survey – from capital adequacy to capital management

To identify some motives and some fields of application of risk models as well, reference is made to KPMG's study with its empirical survey of *purposes for which risk models are used.*[2] Figure 1 provides an aggregated overview of the outcomes.

Figure 1: Relative importance and degree of application of risk models

Function/Purpose	Importance	Usage of risk models
capital adequacy	1.00	95%
asset allocation	1.00	90%
provisioning	0.89	89%
pricing	0.89	94%
overall risk profile	0.89	89%
diversification strategy	0.83	94%
capital allocation	0.83	94%
capital management	0.77	94%
product development	0.77	82%
evaluating financ. hedges	0.72	81%
pricing strategy	0.67	86%
performance measurement	0.6	85%
evaluating insurance	0.55	72%
matching	0.50	75%

2 See KPMG: Study into the methodologies for prudential supervision of reinsurance with a view to the possible establishment of an EU framework, Brussels 2002. See also European Commission: MARKT/2515/02–EN, appendix p 18.

The fields from "capital adequacy" to "capital management" appear to be the more important areas of application for risk models (the middle column gives an idea of the importance, where 1.00 means relatively important). These fields also show quite a high level of use of risk models as opposed to non-risk-based models (the right-hand column shows the application of risk models in relation to the application of all types of models).

The outcomes of this empirical survey *cannot be generalized* as the application fields may vary for each and every company as well as over time. However, this survey does demonstrate the variety of motives for using risk models.

Findings of European Commission – external und internal drivers

The *European Commission* has performed an empirical study in which it asked insurance companies about their *reasons for using, and the benefits to be gained* from, risk models in the context of risk management.[3] These findings help to categorize the various motives shown in Figure 1; essentially, internal and external drivers can be distinguished:

Internal perspective
From an *internal perspective, ie from the viewpoint of management*, risk models provide an opportunity to identify and measure risks. It is possible to quantify the minimum level of capital corresponding to a given risk appetite. Additionally, risk models may provide a reference framework for measurement of risk-adjusted returns on business activities. As a consequence, they may facilitate efficient capital allocation and risk-oriented business steering.

External perspective
The motives or benefits driven by an *external perspective* can be summarized under the heading of disclosure to external stakeholders. Risk models may be helpful in dialogue with rating agencies. These (internal) risk models cope better with the individual diversification and pooling of risks. Also, in a few cases the converse is true: the concepts and terminology used by the rating agencies appear to have influenced the insurance company's risk models to some extent. In some other cases, risk models have been developed in anticipation of a change in the regulatory environment or in response to requirements of financial analysts.

The evolving status in some countries and on an international level leads to a growing importance regarding the knowledge of a company's internal risk landscape. Thus risk models – especially internal risk models – will become more valuable as possible tools in gathering that knowledge.

3 See European Commission: MARKT/2515/02–EN, pp. 4–6 and appendix pp. 13–14.

Holistic view regarding risk landscape and financial stress events

In addition to the findings of the European Commission, reference is again made to the *KPMG study*. The study also emphasizes the integrated view of a company, which allows for exploring interdependencies:

- Risk models offer the advantage of combining all relevant operations of an insurance company (eg underwriting, investment, pricing, taxes, assets, liabilities, etc) into an integrated model which provides an insight into future operations and capital requirements.
- Risk models can be beneficial in evaluating decisions and in analysing alternative business strategies. These evaluations or analyses should focus on major risk scenarios, including what might happen if more than one thing goes wrong at the same time.
- Risk models also provide information on options or strategies, identifying those with the least significant risks and those with the greatest rewards. Thus they can help companies prepare strategies to deal with financial threats.

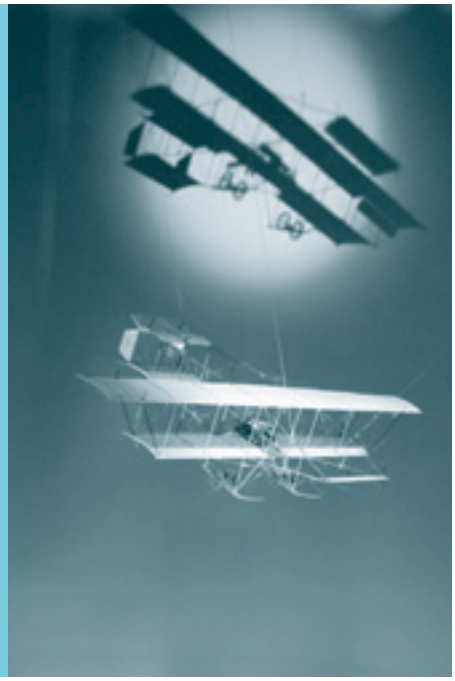
If risk models are properly developed, the increased awareness of "financial stress events" is likely to lead management to strengthen its monitoring of areas where the company is most exposed. No model is perfect for all purposes at the same time, but risk models can be a first step towards understanding the impact of adverse events or developments, and how to manage them.

2.2 Purpose and granularity

In general a (risk) *model can be defined as a purposeful and adequate reduction of reality*. As the empirical studies showed, risk models are used for a variety of purposes. Therefore, the purpose to be served by a model is one of the key questions; the following example serves to illustrate this basic idea.

A model is a purposeful and adequate reduction of reality

Which features or properties a model should take into account and which aspects of reality can be ignored thus depends strongly on the purpose of the model.



Modeling purpose in context of an aircraft model

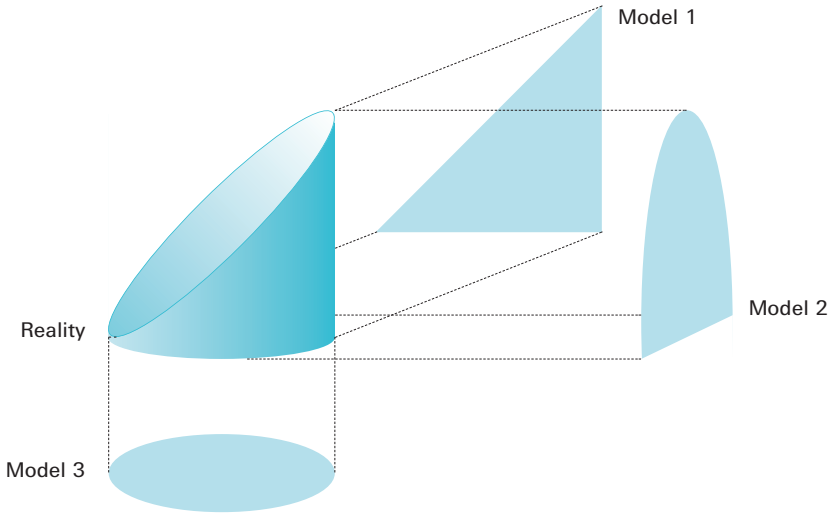
Imagine that an aircraft is to be "modeled". Models already exist for almost any type of aircraft, eg on a scale of 1 : 1 000, ie 1 meter in reality equals 1 millimeter in the model scale. The purpose of this model is to have the same "look and feel" as a real aircraft – apart from the scale, and apart from the fact that it does not fly. So the purpose is obvious, and the reduction of reality is obvious as well.

Another well-known model is the paper plane. A paper plane usually does not look in any way similar to a real aircraft – but it is able to glide through the air. The purpose of this model is totally different from that of the first model, and properties such as scale or color are ignored as not material to the purpose.

Different purposes lead to different risk models

Which features or properties a model should take into account and which aspects of reality can be ignored thus depends strongly on the purpose of the model. And evidently, models differ significantly, depending on what and how something real is to be modeled.
Figure 2 provides a visualization: depending on the purpose (shown here as a perspective), the appropriate model (shown here as a projection) is different; furthermore it might be helpful to use more than one model at the same time to cover different aspects of reality.

Figure 2: Different models as reductions of reality



To underline the importance of the purpose of modeling in the context of risk models: one basic question is what fields of risk are to be modeled. Is it enough just to model the insurance side, eg in order to optimize the business mix or reinsurance structures? Or has the investment side to be taken into account as well, to get a feeling for the risk landscape of the entire operation? *The question of scope or the risk fields modeled* is dealt with in section 3.2.2. In any case, Figure 2 shows that more than one model can be applied to cover more aspects of reality.

Three paths of granularity

The modeling purpose is relevant not only in determining the scope, but also in the question of *how detailed a risk model should be*: the three following "granularity paths" illustrate that the complexity of reality has to be (purposefully) cut off at some point.

- Firstly, to concentrate on a "*drill down path*" in the insurance field: should the model be capable of covering life and non-life business; should it cover long-tail and short-tail business in non-life insurance; should it then model certain product types; should it be capable of simulating specific policy conditions per product type?
- Secondly, a "*generalizing path*" could be set up for the investment side: which asset classes should be modeled; given fixed-income bonds, which elements determine one or more interest structures; is inflation to be taken into account when modeling interest; do the gross domestic product or other variables influence inflation; and is there an even more general driver for these variables?
- Thirdly, if the model also accounts for major risk management options, *to what granularity level, ie level of detail, should these options or strategies be modeled*? Take the example of reinsurance as part of risk management: are facultative and obligatory ("treaty") reinsurance structures modeled; are non-proportional and proportional arrangements covered; is it possible to set up a surplus treaty over several lines of business; can event limits or annual aggregate conditions be applied? Take another example regarding investments: are derivative financial instruments modeled; to which underlyings – eg stocks, interests, or currencies – can they refer; are "exotic options" to be modeled, too?

The modeling purpose is relevant also in the question of how detailed a risk model should be:

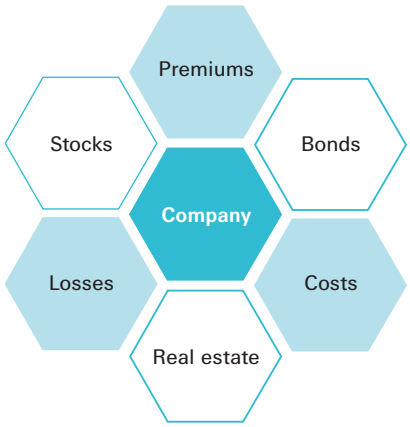
Granularity is interrelated with the question of whether the model is to be used strategically at a high level or for operative evaluation of the modeled business segments or of specific possible actions.

Some real life examples in the insurance industry

To give at least a few answers regarding the granularity of risk models: some models are capable of modeling the insurance side, others model the investment side, a few both.

- Most risk models stop within the insurance side at the level of perils or lines of business for a specific insurance business segment. These elements, usually called "nodes", "bases", or "risk factors", require relevant input items such as premiums, payments and reserves for insured losses or claims, and expenses.
- On the investment side, most models make it possible to specify the asset allocation to usual asset classes. The level of granularity for the investment model is basically driven by the complexity of the insurance liabilities. A simple example would be to determine the probabilistic behavior of stocks and of yield curves for bonds; the value of financial instruments and their cash flows can then be derived. A few models go beyond that level and start with an economic environment generator to describe an economy and then to derive capital market variables.

Some models are capable of modeling the insurance side, others model the investment side, a few both. Most risk models stop at the level of business segment



Granularity and model purpose

Usually, granularity is interrelated with the question of whether the model is to be used

- *strategically* at a high level or
- for *operative evaluation* of the modeled business segments or
- for *operative evaluation* of specific possible actions.

But basically the question of granularity corresponds to the question of appropriate reduction of reality for a given purpose. If the model is used eg for risk-capital-driven optimization of reinsurance structures, then a high degree of (reinsurance) treaty detail could be necessary, whereas exotic options implemented for hedging special price or market risks are not relevant.

3 What types of risk models exist?

3.1 Overview of model types

What aspects are relevant when choosing a risk model? In theory it would be possible to cluster all purposes when it comes to risk modeling; then it would be possible to formulate risk model types that best match the given purpose. In practice, however, reality is too heterogeneous, too individual and too specific in each situation or insurance company. For this reason it does not appear reasonable to formulate fixed rules for deciding which model best serves which purpose or situation.

Classification and characteristics of risk models

However, it is possible to classify risk models by certain characteristics. The decision variables are then reduced to the question of which characteristics a model should offer or possess to serve best in a specific situation. Thus it is basically a *matter of individual objectives, preferences and restrictions which risk model and which characteristics of risk models are considered crucial*.

Figure 3: Some polarized characteristics of risk models

Scope		
Perspective	internal	external
Risk fields	insurance side	investment side
Features		
Uncertainty	deterministic	probabilistic
Time	single-period	multi-period
Dynamics	static	dynamic

In terms of scope, there are one or more perspectives and one or more risk fields to be modeled. The model features themselves cover characteristics such as handling of uncertainty, time and dynamics. Figure 3 summarizes some characteristics of risk models and gives a few examples of these characteristics. These examples are neither clearly separated nor complete; there are many more possibilities and permutations. The following sections give some guidance on these characteristics of risk models.

3.2 Some model characteristics

3.2.1 Internal and external perspectives

One of the key questions in the context of risk modeling is: from which point of view should the company be modeled? Is the perspective driven internally or externally?

Internal perspectives usually lead to economic evaluations of the company's substance and activities.

- Relevant variables usually are measured on a *market value basis* (marking to market or marking to model). The company is interested eg in cash flows and market prices of investments in financial instruments. This approach leads to a *cash-flow orientation* on the insurance side, too; market-oriented measurement can then be performed by replicating or discounting future insurance-related (loss) payments, as appropriate.[4]
- The internal point of view primarily looks at the insurance business from a *treaty-year* (as opposed to a financial-year) perspective; that is to say the future run-off of today's activities is evaluated – not necessarily today's run-off of business written in the past.

External perspectives can materialize in further sub-perspectives which are not necessarily harmonized, in an extreme case being completely different from any internal perspective:

- *Financial reporting perspective*: which set of generally accepted accounting principles (GAAP) should be applied: local GAAP, US GAAP, or international GAAP (IAS/IFRS)? Model variables are then measured according to one or more accounting frameworks.
- *Statutory or supervisory perspective*: how are variables or how is risk measured from a prudential supervision point of view? In some countries this perspective is based on financial reporting, in others it is not.
- *Tax perspective*: again, in some countries the framework for determining taxable corporate income or substance differs from the standards and rules to be applied in financial reporting. Should this perspective also be modeled?
- *Rating agencies' perspective*: what methods and requirements do rating agencies apply when measuring an insurance company's risk? Should the risk model take this approach as guidance, should it provide relevant outcomes according to this perspective?

4 See also Hancock/Huber/Koch: The economics of insurance: How insurers create value for shareholders, in: Swiss Re (editor): Technical publishing series, Zürich 2001, p 10.

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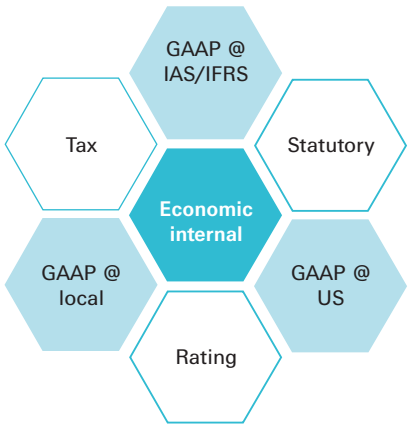


Perspectives as measurement framework

These are only some examples of the different perspectives from which a company can be looked at. Which of these perspectives should be covered by a risk model and which should not? If a risk model is used to support risk-adjusted business steering, an internal perspective is appropriate or even required; relevant variables are then measured economically and on a consolidated basis. If it is used to obtain a deterministic, scenario-based, or probabilistic view of business plans in terms of projected future financial reports, an external perspective based on the applicable GAAP should serve as the measurement framework for target variables.

3.2.2 Modeled risk fields

Insurance and investment

When analyzing a corporate risk landscape, one of the first questions to be answered is what corporate functions or so-called risk fields should be modeled. Common classifications focus on more relevant and quantifiable areas; roughly speaking one can identify the following – not necessarily independent – risk fields:

- on the insurance side influencing the technical result;
- on the investment side influencing the investment result.

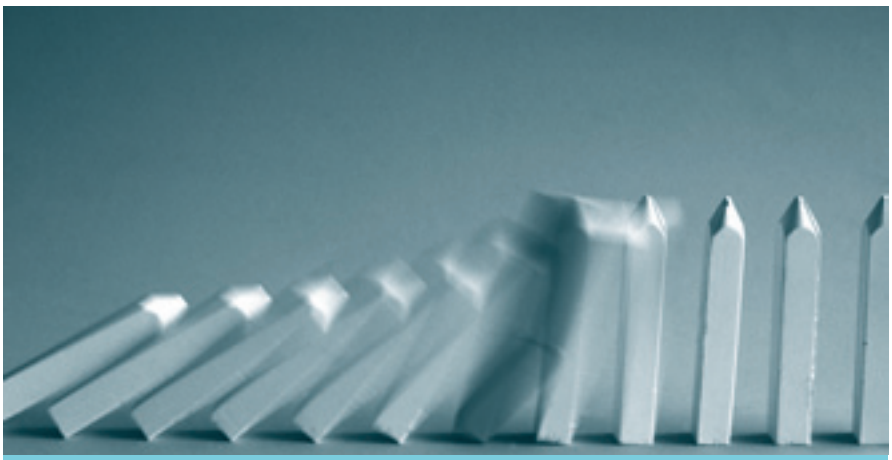
Another risk field of interest could be the operational side. A more detailed discussion of these risk areas would be beyond the scope of the present work.[5] The question is, essentially, should a risk model cover one, several or "all" of these risk fields.

5 See, for example, International Actuarial Association: A Global Framework for Insurer Solvency Assessment, Research Report of the Insurer Solvency Assessment Working Party, 2004.

Relationships and interdependencies of risk fields

Given that the risk fields and associated risk factors, ie deeper drivers, are specified as entities, the question of *relationships* between these entities becomes apparent.

- The granularity paths basically determine *cause/effect relationships*. For example, the technical results of all lines of business lead to the overall technical result; thus the lines of business could be viewed as deeper risk factors having an impact on or even determining another risk factor (overall technical result) at a higher aggregation level.
- Are there any *interdependencies* between the risk fields? Reality shows that, in extreme events, insurance results and capital markets, and therefore investment results, do not respond independently. Furthermore, inflation affects not only capital markets but also future loss payments; natural catastrophes may hit several lines of business.



Risk fields and risk factors can have different dependencies:

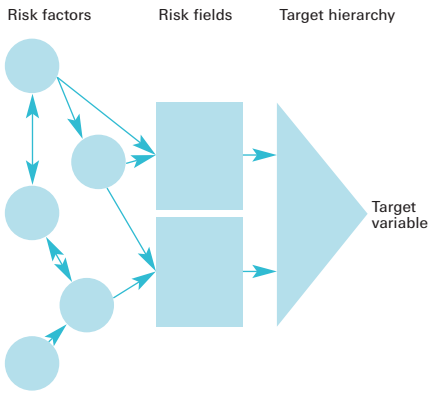
- cause/effect relationships or chains
- interdependencies such as mutual influences
- dependencies and functional relations in the time dimension.

Risk fields and risk map

The visualization of risk factors and their interdependencies, the effect on exposed transformation areas and/or risk fields, and the cause/effect relationships within the hierarchy of the company's goals are known as the "risk map". Four examples will be discussed briefly:

- The risk field on the insurance side can be split into the fields of life insurance and non-life insurance. Typical cause/effect relationships in non-life are risk factors such as natural catastrophes or changes in jurisprudence influencing insurance losses – even across several lines of business. This triggers the technical result and thus the result of the company as a whole as the assumed target variable.
- In life insurance, risk factors such as epidemics, changes in longevity and/or mortality rates can be taken into account; they lead basically to the same chain of cause and effects as stated above.
- Examples of risk factors on the investment side are shifting interest-rate environments or stock market trends. The interdependencies between risk fields can now be analyzed at the granularity level of risk factors. A change eg in interest rates might show effects on the investment side as well as on the insurance side via higher (nominal) future insurance loss payments.

A "risk map" is the combination of risk factors, their interdependencies and cause/effect relationships vis-à-vis exposed risk fields, plus the hierarchy of the company's goals. Effects and leverages of risk factors and risk fields regarding the target variables can then be analyzed.



Dependencies in the time dimension

If several periods or time points are modeled, *dependencies in the time dimension* can become relevant. For example, extreme loss events usually have repercussions on insurance prices, after a longer or shorter time lag. National economies and therefore capital markets also go through upswings and downswings. Modeling multiple periods may therefore require consideration of these dependencies.

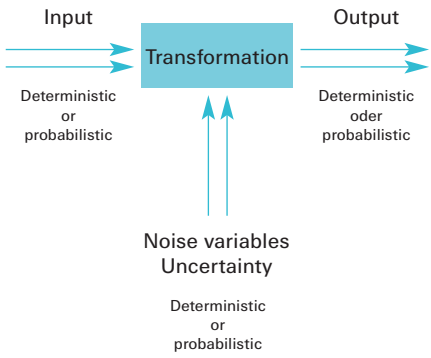
3.2.3 Deterministic and probabilistic models

Combination of deterministic and probabilistic models

Risk can be defined as a concept of achieving goals in uncertain environments. In the context of uncertainties, it is evident that *deterministic modeling* is helpful, but may not be enough. Basically, this one-input-one-output approach helps to analyze specific scenarios, whether they occurred in the past or are assumed for the future. More useful is a *combination of deterministic and probabilistic modeling*. Variables with less impact on the degree of uncertainty are then modeled as certain; the others are modeled taking probabilities into account.

A one-input-one-output approach helps to analyze specific scenarios, whether they occurred in the past or are assumed for the future.

In the context of uncertainties, it is evident that deterministic modeling is helpful, but may not be enough.



Examples of scenarios and probability distributions

A purely *deterministic model* is typically used to analyze a set of given or defined *scenarios*. Two examples from different areas are looked at:

- In life insurance, demographic stress scenarios such as a locally concentrated or even a globally widening epidemic can be of further interest.
- Certain scenarios affecting investments, eg time histories of interest rates, have to be analyzed. How much would the market value of bonds and other investments vary if an interest rate is "shocked"?

The question in the context of risk modeling is whether and how typical scenarios are generated automatically and how the management of scenarios is implemented. Remember that only the associated occurrence probabilities need to be specified in order to derive probabilistic views from these originally deterministic scenario-based models.

One question for *probabilistic models* is to which variables probability distributions – whether predefined or stemming from a specialized tool (eg for natural catastrophes) – can be applied. To give a few examples from a wide spectrum, insurance losses in non-life insurance are discussed here:

- Are loss frequency and loss severity modeled separately for a single insured entity or for a portfolio of insureds? The former alternative would make it possible eg to model facultative or proportional surplus reinsurance in (too much?) detail.
- Are any loss classes to be defined and modeled separately? The majority of risk models permit at least separate modeling of large single losses, event losses – eg for applying catastrophe reinsurance covers – and the remainder as basic or core losses.

Similar questions have to be answered for the investment side; only two brief examples are stated here:

- What model should be used to determine the prices in stock markets? Are Brownian motions assumed? Are these process models applied to each and every stock or to aggregated stock indices?
- How is the interest rate environment modeled with its effects on bonds? How many term structures of interest rates are taken into account and are eg spot rates and long-term rates modeled as probabilistic processes?

Number of simulation runs

Within a probabilistic model there is also the question of how the *algorithms* work. If the model follows a purely *analytical approach*, the possible types of probability distributions and dependency structures and the types of risk management options are rather limited.

The alternative to an analytical model is a *simulation model*. Simulation models use a large number of random realizations. In the end, a sufficient number of realizations of the associated target variables determine the probability distribution which is of interest. The more random realizations are generated, the more stable the outcomes become.

This aspect leads directly to performance issues. Especially if the modeled risk landscape is rather complex and the risk measure focuses on the "tail", ie rare but possible extreme events, many simulation runs (several hundreds of thousands) are necessary to produce stable results and to permit reliable derivations.

3.2.4 Single-period and multi-period models

Another modeling aspect is how to handle the time dimension. This can be broken down into two questions: time horizon and time steps.

The *time horizon* denotes the latest future point in time at which outcomes should be looked at. To mention a few examples:

- One year, eg the current or coming year. This could be enough if the perspective is driven by financial reporting issues.
- A few years, eg the next three to five years. This could be of interest if eg mid-term effects of business strategies are to be analyzed.
- A more abstract example is the time horizon "infinity". This means all relevant variables are taken as ultimate values (whether discounted or not).

How many *time intervals* should be modeled or should be shown within this time horizon?

- On the insurance side, the business mix usually does not change significantly within one year. Here it could be enough to model just one time step from the beginning to the end of the one-year time horizon.
- On the investment side, however, capital markets tend to change rather quickly. It could be necessary to model eg quarterly time steps when analyzing for one-year outcomes.

If more than one time step is modeled, another set of questions arises. How should the dependencies in the time dimension be taken into account? Are there insurance trends or cycles, whether for premiums or for losses? Are there trends or cycles within capital markets?

3.2.5 Static and dynamic models

There is a clear distinction between models with one or more periods and between static and dynamic models. Whereas the time dimension describes only the environment, the static/dynamic dimension has something to do with actions. A model is *dynamic* if, and only if, contingent actions can be formulated. That is to say, what should be done if a specific state materializes. If no contingent actions are modeled the model is static.

Simple example of a dynamic model

For a simple static multi-period model situation, imagine someone wanting to order a drink in a defined time frame. A contingent action is needed, ie a strategy such as "if the waiter comes close, place the order". There may also be further strategies such as "if the waiter does not appear within a certain time, look out for him and call him over".

A model is dynamic if, and only if, contingent actions can be formulated. That is to say, what should be done if a specific state materializes.

Multi-period models lead to questions as to how market rules (ie the behavior of reality in the time dimension) are to be modeled. Dynamic models lead to questions of how management rules are to be defined.

Dynamics in insurance

In a risk model of *an insurance company, some typical examples* of actions to be covered by a dynamic model would be:

- If investments are modeled and stock prices or bond prices move significantly before the time horizon is reached: would a real-life portfolio manager then take action, eg reallocate investments?
- If insurance is modeled over several years and loss events – however parameterized – have an impact on reinsurance premiums in subsequent periods: would an outward reinsurance manager restructure the reinsurance cover, eg buy more reinsurance (if prices fall) or raise retentions (if prices rise)?

Multi-period models lead to questions as to how market rules, ie the behavior of reality in the time dimension, are to be modeled. Dynamic models lead to questions of how management rules are to be defined. Rules such as "if this and that occurs, then this and that must be done" have to be identified and modeled.

3.3 Conclusion

Risk model decision variables

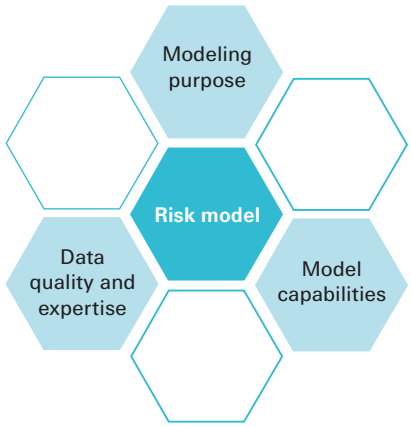
To summarize in a few bullet points, models can be classified by the discussed criteria:

- Purpose and granularity.
- Internal and external perspectives.
- Modeled risk fields.
- Deterministic and probabilistic models.
- Single-period and multi-period models.
- Static and dynamic models.

There are also some further aspects that could be relevant for risk models, such as:

- Available data and data quality.
- Available expertise for parameterizing.
- Make or buy decisions, ie build a model on your own or have it done by someone else.
- Periodicity of risk analyses and performance issues for simulation models.
- IT requirements (eg standardization) and integration into existing business application architecture.
- Interpretation and communication of results stemming from a complex model.

Aspects such as modeling purpose, capabilities of a model, and given data quality and expertise almost form a "Bermuda triangle" of decision variables for risk models.



One size fits all?

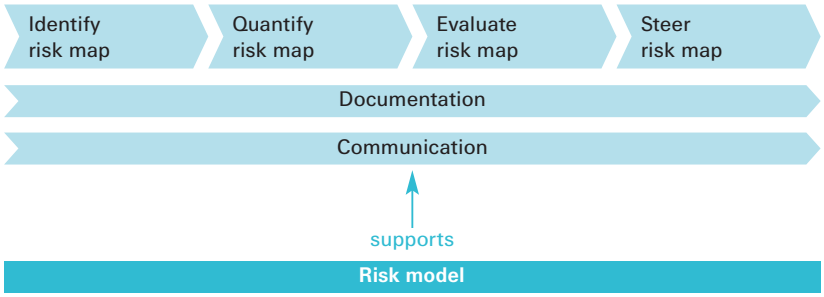
Is there an all-in-one device suitable for every purpose? Should a risk model cover all possible features and, if so, should it be easy to handle, cost-efficient to implement, etc? These questions sound rather contradictory and rhetorical.

Thus the crucial questions are: *what is the purpose of the risk modeling approach, what is the intended benefit and what should it cost*?

Steps of risk modeling

If these questions are answered, experience points to the next steps, which can be summed up, maybe with just a little exaggeration, as follows:

- *Develop a "risky" mindset and a "risk awareness"*:
  Insurance business needs two production factors, monetary capital and human capital – so start with people first, as it takes a while to develop a mindset for risk and risk measurement.
- *Start with a simple model*:
  Reduce the requirements to an absolute minimum – the models, their parameterizing and implementation into business processes will increase in complexity anyway.
- *Make it relevant*:
  Integrate the models into specific decision support – but do not start with a risk-based due diligence in an unfriendly takeover.
- *Learn from experience*:
  The more you learn with the risk model in place, the clearer the relevant requirements – and the irrelevant ones – will become.
- *Be efficient*:
  Ask for support and know-how transfer – there is no need to reinvent the wheel.
- *Continuously enhance the models*:
  But never forget to use common sense to capture aspects not (yet) modeled and to check the model-based results for plausibility.



Risk models as part of risk management

Bearing these steps in risk modeling in mind, what goes beyond risk modeling – and thus beyond the scope of this booklet? A brief glance needs to be taken, because a risk model is still far short of risk management as such.

- However, risk models do support the risk management core process which iteratively and continuously identifies, quantifies, evaluates, and finally steers the company's risk map/situation.
- In addition to the risk management core process, some supportive activities need to be performed which do not necessarily require risk models. These activities basically cover corporate risk governance, ie clear responsibilities and accountabilities, transparent and "auditable" documentation as well as risk communication. Risk communication also increases risk awareness and supports risk-based business steering.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4 Do you want a discussion partner?

Spectrum of risk models

The previous sections have indicated some aspects of risk modeling. The key premise made in this booklet is that there is no *such thing as "the" perfect risk model*; what an appropriate risk model should look like depends on the purpose of modeling. Thus, applied risk models vary significantly in line with the different objectives. To give just a few basic examples from a broad spectrum of possible models:

- To obtain a rough and basic idea of sensitivities, eg for the next financial report, it may be sufficient just to take a spreadsheet and model some scenarios. This approach may be extended by integrating some probabilistic simulation methods.
- For optimizing reinsurance structures of a non-life insurance company in short-tail business, it may be appropriate to ignore the investment side.
- For exploring the effects of certain asset allocations, it could be adequate to model roughly the net technical result distribution and not to go into further detail on the insurance side.
- For more advanced purposes, eg to gain a more holistic view, it is necessary to integrate both the insurance operations and investment activities.

Depending on the time or budget constraints and on the modeling purpose, it could be worthwhile to set up a generic risk model or to rely on third-party risk modeling frameworks and customize these. It could also be sufficient to outsource specific or recurring analyses to someone else and to utilize the delivered results.

Key issues and quality

The majority of current risk models have a history and a focus within which they claim to be more adequate. Therefore it is useful to specify clearly the capabilities and limitations of a risk model or a risk model framework. Our idea then is to *concentrate on those areas at which the key purpose of risk modeling* is aimed.

Swiss Re can assist at many stages of risk management processes and support various purposes in risk management. When it comes down to using one of Swiss Re's risk models designed for insurance clients, Swiss Re concentrates more on specific key issues in risk modeling. Concentrating on key issues enables Swiss Re to provide high-quality solutions. To put it another way: to focus on key elements and then be sufficiently profound – that is our aspiration in servicing risk modeling.

- Has this booklet made you curious about Swiss Re's services in risk modeling?
- Would you like to learn more about Swiss Re's support in quantitative risk management?
- Are you interested in seeing any of Swiss Re's tools designed for risk modeling of insurance companies?
- Do you need additional expertise in parameterizing or analyzing your data?

Do not hesitate to approach your designated contact at Swiss Re, or get in touch with Swiss Re directly via the website *http://www.swissre.com*

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