

# Managing complex risks successfully

Emerging risk discussion paper

## Contact

Dr. Rainer Sachs  
Dr. Markus Wadé

March 2013

Scenario analyses and stochastic simulations are used in many areas of (re)insurance to identify and evaluate risks, and to examine the relationships between them. For example, in the area of natural hazards the strength of earthquakes and the possible paths of hurricanes are simulated, scenarios defined and potential losses analysed. The findings are used for a number of purposes, such as pricing, internal guidelines and management of the portfolio. The ability to assess risks quantitatively has a direct effect on the insurability of the hazards concerned.

On the basis of Frank Knight's work, a distinction is often made between "risk" and "uncertainty". Both terms reflect a deviation from the expected event and hence refer to the unexpected. The difference between them is that, in the case of risk, we assume that the unexpected can be expressed quantitatively; we have enough information, for example, to be able to calculate probabilities. In the case of uncertainty on the other hand, we do not have that information, or do not have it in sufficient detail, so that we tend to be dependent on expert estimates. Risk is generally more insurable than uncertainty. If the probability and consequences of occurrence cannot reasonably be estimated, related insurance products can only be provided on a restricted basis or at a higher price.

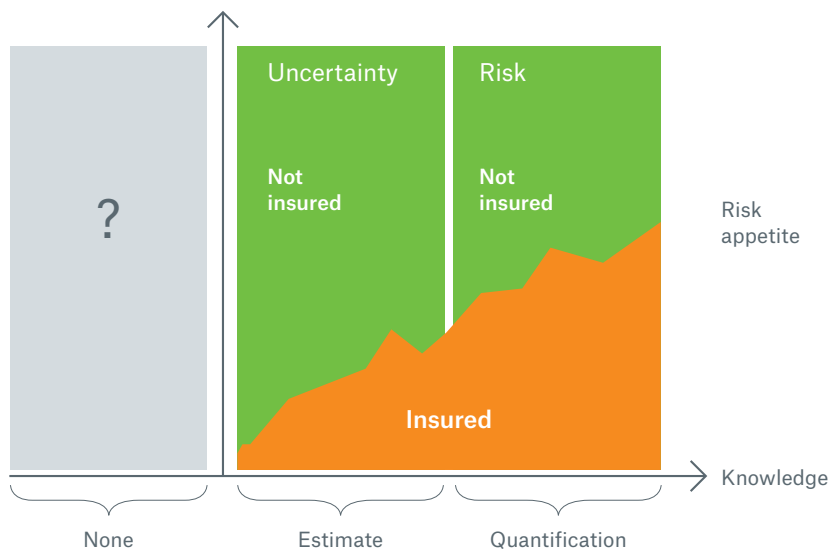
In addition to risk and uncertainty, the unexpected includes another category, often referred to as "unknown unknowns", which are facts that would be relevant to the assessment of a hazard, but are not known at the time of the analysis. Since by definition not even the critical features are visible, it is virtually impossible to apply targeted quantitative or qualitative methodology.

Figure 1 illustrates the various categories.

A series of factors have contributed to "uncertainty" taking on new significance for large parts of society and hence for the insurance industry. The continuing trend towards globalisation of production and trade, and the widespread use of new information and communications technologies offer tremendous opportunities for economic growth and innovation, but at the same time give rise to increasingly complex interdependencies and exposures. Be it in the safeguarding of supply chains, the protection of a company's own data or the search for an appropriate investment strategy, the ability to manage complexity has long been a key success factor.

For insurance companies, complex interdependencies mean that the course of losses is more difficult to forecast, and that the events that trigger them can often not be clearly identified. Competitive pressure ensures that new technologies and substances spread around the world

**Fig. 1: Uncertainty and risk**



in a short space of time, but it is sometimes only later that harmful sideeffects and their consequences can be identified and demonstrated. Domino effects and loss cascades can turn local events into losses of international significance.

In all of these examples, only limited data and experience from the past is available for complex and highly dynamic scenarios, so that in many cases it is not possible to produce a reliable quantitative description. However, not only analysis, but also management based on complex scenarios poses a major challenge. The ability of companies to depict the large number of possible triggers and factors in a traditional control framework is limited.

Where data and models are subject to limitations, the views of experts and decision-makers carry more weight, and it would appear that more account needs to be taken of the "human factor" in risk management. With this in mind, we will take a look at some aspects of the identification and management of complex risks.<sup>1</sup>

### Challenge of complex accumulation risks

To evaluate a portfolio of risks, it is very important to have an understanding of existing interdependencies. Diversification is one of the principles on which the business model of every (re)insurance company is founded. If the increasing globalisation and complexity results in everything being connected with everything else, it will become more difficult to achieve the required diversification. The management of accumulation risks plays a particularly important role in this context.

Accumulation risks are hazards in which a single event can trigger a multiplicity of losses. Classic examples of accumulation risks are the natural hazards we have already mentioned. A severe earthquake affects a large number of people and buildings. If a company has written many risks in a region prone to earthquakes, the purpose of managing accumulation risks is to ensure that it remains solvent even after a particularly severe event. Accumulation risks can be managed by imposing limits on contracts written, or by passing on high risks to reinsurers or the capital markets. Due to the global spread of their business, reinsurers are in a position to carry risks that

would exceed the capacity of an insurance company with regional operations. Thus, to be successful in the long term, reinsurers in particular must have effective accumulation control, be able to manage complex interdependencies and ensure that their portfolios are sufficiently diversified.

Looking back, 11 September 2001 was a watershed event for the re-evaluation of risks: the horrific terrorist attacks changed the world and many lost their lives. In addition, the attacks brought the new complexity home to the insurance world. Not only was the scale of the losses surprising, but the aftermath of the attacks also led to insured losses in almost all classes of business. And the distribution of the claims burden was also remarkable: of the approximately US\$ 32bn in claims payments, around 33% were for business interruption losses (including such claimants as airport duty-free shops affected by the grounding of aircraft). The attacks also caused turbulence in the stock markets, placing further strain on insurers' financial strength.

A second defining event for the perception of complex interdependencies was the subprime financial crisis. A combination of factors, each of which would have been critical in itself but not disastrous, interacted to result in the collapse of whole markets and a global recession. The restructuring of the regulatory framework has been strongly influenced by this experience.

<sup>1</sup> For the sake of simplicity, we will use the term "risk" with its general meaning, i.e. "the unexpected".

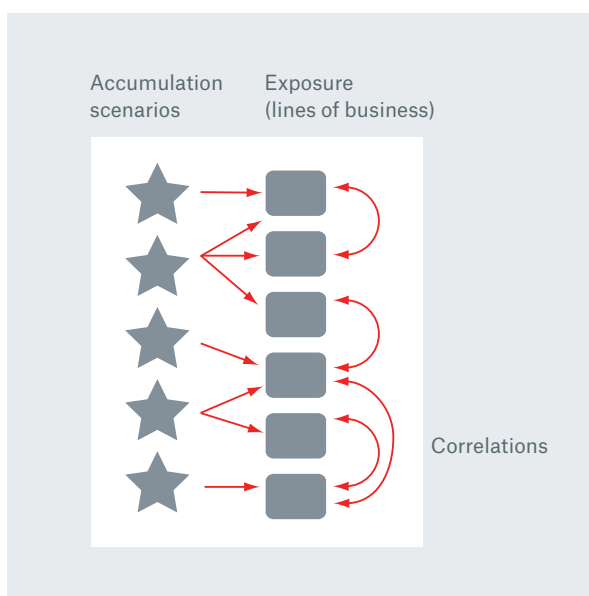
Other examples have been hurricane Katrina, the eruption of the Icelandic volcano Eyjafjallajökull and the Tohoku earthquake. Common to these events is that due to various interdependencies they all triggered a chain of dramatic consequences that surprised many risk managers. In particular, they showed how quickly generally accepted model assumptions and business practices can be overtaken by the complexity of reality.

At Munich Re, we discuss in great depth the implications of increasing interdependencies for risk management. One thing is clear: alongside the known major risks, numerous "HILF" (high impact, low frequency) events and combinations of events are gaining in importance. In his now famous book, Nassim Taleb coined the phrase "black swans" to describe this type of rare but significant event. Diagrams 2a and 2b illustrate what the different situations mean in terms of handling accumulation risks.

In Diagram 2a, each large star represents a regularly recurring accumulation scenario classified as relevant. Windstorms, earthquakes or floods are the classic trigger events here. The historical evidence available makes it easier to define scenarios, estimate the consequences and take risk management action. The accumulation control process for such scenarios comprises the estimation of occurrence probabilities and potential losses, the setting of budgets, and the monitoring of exposures in the individual classes of business. 2011 again showed how important it is to have appropriate models, up-to-date analyses and efficient processes in order to weather difficult years in which many losses are incurred. Even in a changing risk landscape, natural catastrophes and their direct consequences will remain the central drivers of large losses. If companies do not attach sufficient importance to these factors, there may well be little point in their worrying about new and complex threats.

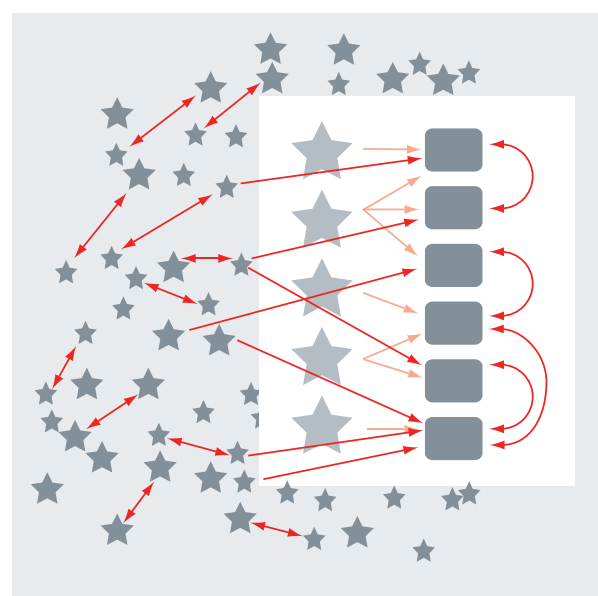
Diagram 2b also shows the world outside the accumulation control process: each small star signifies an event with an occurrence probability estimated as low, but with high accumulation potential. Applying the principle of proportionality, each individual event could be classified as "too improbable" to justify the dedication of significant resources to analysis and control. Before their actual occurrence, many experts would have presumably placed the subprime financial crisis and 11 September 2001 in this category. Things become problematic, however, if the large number of "black swans" makes it relatively likely that at least one of them will eventually occur. Nassim Taleb argues that people are unable to cope with this type of rare and complex risk. To give themselves the feeling of "having everything under control", they simply blank out the existence of these events in their daily work.

Fig. 2a: Known accumulation scenarios



The diagram on the left shows the "traditional world" of accumulation control, in which each star represents a known large risk, the causes and effects of which are (relatively) straightforward.

Fig. 2b: The world of "black swans"



On the right is the world of "black swans": many interdependent events that, though very unlikely to occur, can produce large losses.

## Transparency a necessity

The advice coming out of the current discussions is often rather abstract – “simplify”, “prepare for the next surprise” or “think the unthinkable”. As fitting as this advice may be, actually putting it into practice is very difficult to impossible. The problem with the unthinkable is that by definition it cannot be thought about or anticipated.

A KPMG study advises companies to take a strategic decision to deal with complexity: either “embrace it as a spur to innovation and change” or “avoid it by keeping business processes simple”. For insurance companies, however, the scope they have with regard to this decision is limited. In an economic environment in which even the definition of “risk-free” assets is difficult, havens of simplicity are scarce.

Moreover, a general approach of “keeping one’s distance” from complex reality would involve becoming increasingly removed from clients’ needs. It is inevitably the extent to which risks can be understood and calculated that determines their insurability. This means that for many critical areas, such as cover for supply chains, greater transparency is the first step necessary in the process of developing new insurance solutions. To achieve this, considerable efforts are required both from companies and from the insurance industry.

In order to extract usable input for risk management from the mass of complex risks and make it easier to identify them at an early stage, it is necessary to improve understanding of individual risk drivers, their interconnections and the potential consequences. An essential, though ultimately unsatisfactory, way of gaining greater understanding is to analyse the surprises that have actually

occurred. Since 2001, the whole insurance industry has seen the risk of devastating terrorist attacks in a completely different light in risk management terms. However, such reactions frequently come only after the first major loss and then at a time when many parties are working on ways to defuse the danger, for example through better safety precautions.

If we wish to understand the complex risk environment prospectively and beyond the confines of historical evidence, we are highly dependent on expert knowledge – from a range of different business segments and disciplines. What has proved effective at Munich Re for new and changing risks is an interdisciplinary “emerging risk” structure that provides a forum for this topic up to Board level by way of defined processes, committees and reports. Our think tanks and workshops also include members of our international organisation and external partners. To be successful, it is essential for the professional and cultural backgrounds of those involved to be broadly based and diversified.

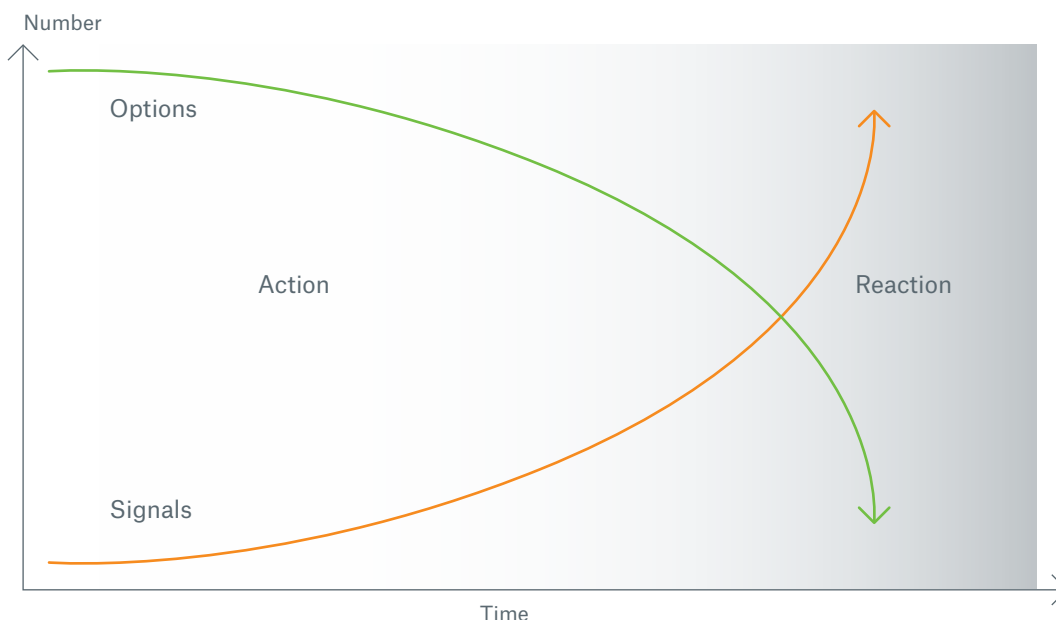
Emerging-risk management is based on the idea that risks develop over a long period. The occurrence probability and loss potential of emerging risks are highly uncertain. Though only weak signals are perceptible in the early stages of their development, there are many possibilities for managing the risks, and the longer you wait for the signals indicating a new risk to become clearer, the more limited is the action you can take.

Early identification of weak signals, combined with active management, is therefore a good way of addressing the problem of uncertainty.

In order to analyse complex interdependencies, we have for several years now been investigating new methods to improve identification, selection and modelling of the resulting accumulation risks. One of the areas this work has focused on is developing a platform that links expert knowledge from a variety of disciplines directly to chains of events and enables us to analyse the results from an insurance perspective. The analyses are based on a database in which significant trigger-consequence combinations are collected and labelled with a series of attributes. The results can help bridge the gap between expert knowledge and the quantitative models.

In view of the large number of potentially relevant risks and the limited resources available, cooperation and exchange of information with others outside the company is invaluable if progress is to be made.

**Fig. 3: Typical course of signals and options for action with emerging risks**



### The human factor in risk management

As already mentioned, complex risks, which are gaining in importance due to the multiplication of interdependencies, and emerging risks resulting from technological or social developments, tend to fall into the “uncertainty” rather than the “risk” category, and expert knowledge is playing an increasing role in their evaluation. Ultimately however, even the results of scenario analyses based only on the opinions of experts will flow into the risk management process, either directly as accumulations with individual limits, or indirectly through the calibration of the internal risk model to arrive at an appropriate capital buffer for unexpected events.

It is thus all the more important for the experts’ subjective risk estimates to be as objective as possible. We all know that subjective estimates are subject to a whole range of influences we are unaware of and may therefore present a distorted picture. If expert estimates are to be used as a support for quantitative management, it is necessary to be aware of the distortions and take account of them in the analysis. Typical effects are:

- overestimation of low probabilities and underestimation of high probabilities,
- overestimation of real risks and underestimation of abstract risks,
- overconfidence in own performance,
- giving undue weight to certain heuristic factors, such as information just received,
- framing - being influenced by the way a question is formulated,
- a tendency to attach greater importance to certain events because information on them is more available.

Munich Re is working on this topic with the Psychology Department of the Ludwig Maximilian University in Munich with the aim of gaining a better understanding of, and if possible correcting, factors that influence subjective risk estimates.

## Complex scenarios in management

Even if greater transparency is achieved for complex risks, we need to consider how to use the knowledge gained in a company's management and organisation. In view of the swarm of HILF events shown in Figure 2b, it is unlikely to be of any great benefit to select some of the risks and attempt to bring them under control using established accumulation-risk management methods and processes. The panoply of possible triggers and loss experiences means that traditional controls are of limited use. Apart from the huge resources required, it is highly likely that the risk chosen will not materialise.

It is in any event advisable to be prepared for surprises when dealing with complexity. The ability to deal well with unexpected developments is closely linked to a company's own risk culture and organisational structure. The key word is "resilience". It is fundamentally not about wanting to avoid surprises and mistakes, but about a company achieving a state of dynamic stability and hence being in a position to deal with the unexpected more effectively. In particular, the company's survival should be assured even if a crisis occurs.

Modern enterprise risk management includes many important elements of this: clear processes and responsibilities, an informed strategic decision on risk appetite for core risks, and transparency regarding the company's own portfolio and capital strength. All of these are fundamental qualities that a company needs if

it is to react to surprises swiftly and effectively. The threat of extreme crisis situations is already reflected in the practice of not going right up to the critical precipice in setting limits, and refining portfolio models so that they pay greater attention to tail dependencies.

In recent years, new chairs have been established at universities and research projects launched to explore the issue of complexity. These focus not only on quantitative models but also on important work on the "human factor" in risk management and possible options for action beyond established control frameworks.

Notwithstanding the current exacting demands of day-to-day business, the handling of complex risks will be a key issue for the insurance industry in the future. It took decades for the present framework of risk management to be developed and become established. Expanding it to meet the challenges of growing complexity will also demand a great deal of time and energy. Another insight from the current crisis is that the reassuring idea of comprehensive "control" of all relevant risks is probably outdated. Nevertheless, we see new approaches emerging – and not only at our company – that may result in significant progress. At this juncture, sufficient scope for new ideas and cooperation both inside and outside the insurance industry are vital.

### References:

- Gigerenzer, Gerd: *Bauchentscheidungen*, Bertelsmann, 2007  
Kahnemann, Daniel: *Thinking Fast and Slow*, Penguin, 2011  
Dörner, Dietrich: *Die Logik des Misslingens, rororo*, 2003  
Knight, Frank: *Risk, Uncertainty and Profit*, 1921  
Taleb, Nassim: *The Black Swan*, 2007  
KPMG: *Confronting Complexity: Research Findings and Insights*, 2011