Back to the future: Dynamic Financial Analysis (DFA) for decision making

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July 9, 2004

We give a short non-technical overview of the current state of financial modelling. Dynamic financial modelling allows better decision-making and strategic planning.

We illustrate typical DFA use-cases with three short examples:

- life insurances
- banks giving credits to SMEs
- a merger of two travel-industry players

The market is ready for DFA

The rise of more transparent real-time enterprise resource planing software, big surprising disasters like Enron, missed chances and ever more computing power are the basis of the break-through of dynamic financial analysis.

Dynamic Financial Analysis (DFA) is used mainly in the insurance domain. DFA is a ”systematic approach to financial modeling which projects financial results under a variety of possible scenarios, showing how outcomes might be affected by changing business, competitive and economic conditions” (cf. Cripe, Hayne et al., 1996).

Cash Flow at Risk (CFaR) is a similar approach focusing on Cash Flow. Cash Flow at risk is an integrated Corporate Risk Management solution. The Cash Flow at Risk approach answers the question of how large the deviation between actual Cash Flow and the planned value (or that used in the budget) is due to changes in the underlying risk factors. The Earnings at Risk approach is a similar view of the problem, based on book depreciation. Here the focus is not placed on financial accounting in-flows and out-flows (Cash Flow), but instead on profits and losses relevant to the many clauses of trade law. It was developed by Peter Hager in his thesis and published in (Peter Hager, 2004).

One of the best known DFA/CFaR examples outside of the insurance industry is Shell, which is no surprise, as like the insurance industry, petrol companies must make big investments where for many years the payoff is unknown. Early risk measurement and awareness is a great management tool. Shell used it to research scenarios in which

the price of natural gas might fall (cf. Schwartz, 1996) and was well equipped for the liberalization of the policy of the Soviet Union with its vast gas reserves.

DFA/ALM in life and pension insurance

What is called DFA in non-life insurance is often known as *Asset Liability Management (ALM)* in life insurance. However, where Dynamic Financial Analysis is usually defined by the application of *stochastic simulation* to financial Cash Flow modelling in (non-life) insurance companies (cf. Kaufmann, Gadmer and Klett, 2001), classical ALM uses deterministic models (or few deterministic scenarios) for capital markets. Nonetheless, we will talk of ALM in this section as the importance of stochastic simulation also increases in the life insurance sector.

The economic meaning of proper risk management techniques in life insurance becomes perhaps clearer by the following numbers: In 2003, the total capital hold by German life insurance companies (including pension insurances) was 615,000,000,000 Euros (book value). The aggregate sum of benefits paid to the insured was 75,400,000,000 Euros, where 11 billion Euros were used for reserve purposes (Source: Gesamtverband der Deutschen Versicherungswirtschaft e.V.).

So, a tremendous amount of private capital in Germany, and also in most of the G-7 nations, is invested into life insurance contracts in its widest meaning (risk insurances, pensions etc.). Most of the contractual payments (Germany: 75.4 billion Euros yearly) are guaranteed years before they actually take place. It must be of foremost interest for life insurance companies to be able to securitize these payments at the earliest stage possible.

For classical life insurance contracts such a *matching* of financial risks could always be done by classical debt securities like AAA-rated bonds or government bonds. However, things have become more complicated since life insurance contracts nowadays feature properties which were years ago only known from financial trading.

Today, a life or pension insurance can be *unit-linked*. For instance, payoffs are not guaranteed amounts of currency units (e.g. Euros), but guaranteed numbers of shares from a certain financial funds or a market index - often equipped with a guaranty which ensures that a certain minimum amount is paid even when markets crash. Such an insurance is rather a financial option with some mortality risk included, than a classical life insurance contract.

These differences to former insurance contracts must also emerge when it comes to the hedging of such contracts. Where formerly debt securities (bonds) where enough to deal with, modern insurance mathematics has drawn the right conclusions from modern financial mathematics and the actuarial community is aware of the fact that option-like contracts must be hedged by financial options (European Puts etc.).

By now, many scientific publications on that topic exist and it is very well known, for instance, how to hedge an insurance contract such that variances of contractual payments together with hedges become minimal, or such that the balance per insured individual gets close to zero.

The problems that can arise with such methods are twofold. A major problem is liquidity of markets. The demand for respective financial hedging strategies by insurance companies might be higher than the ability of banks to offer such strategies. Another

problem are legal aspects. For example in Germany, laws relevant to the insurance business are so strict that life insurers are not allowed to use the respective numbers of financial options they would actually need. It is even not allowed to outsource the business to banks. Other countries may have an advantage, here.

Modern Asset Liability Management in life insurance companies has not only had effects on hedging, but also on valuation of contracts - and finally on valuation of whole insurance companies. This is also stressed by the ongoing discussion about the definition of a reasonable *Embedded Value* of a life insurance company - a number which should take into account the present business and contracts of the company, but not the (expected) future business.

The valuation methods commonly used in the literature set the value of any cash flow in an insurance company to the value of its respective hedge. The role of financial hedging methods in life insurance is further stressed by this valuation approach. There is no doubt that readers of current research papers on topics like *stochastic reserves* or *stochastic embedded values* need a strong background in stochastic financial mathematics.

Also on classical contract forms a new light is shed when modern valuation methods are applied. Where in a classical mathematical framework classical fairly priced contracts have value zero (this is the effect of the *Expectation Principle* and the *Principle of Equivalence* when we neglect all safety loads and operational fees), such a contract has a value depending on the recent term structure of interest rates when evaluated by the new models. We demonstrate this by a numeric example (cf. Fischer, 2003).

Example. We consider an endowment contract which pays a benefit c at the end of the calendar year when the insured dies during a certain time interval (e.g. 10 years), but also pays c when the insured is still alive after that time interval. Figure 1 shows the historical development of the present value per benefit ratio (PV/c) for a 10-years endowment contract for a 30 year old German man. Consider the present value as a measure for the profit of the contract from the viewpoint of the insurer, or simply as the *expected discounted profit* neglecting all additional costs.

For instance, the present value PV of a 10-years endowment with a benefit of c=100,000 Euros under a technical interest rate of 3.5% was 20,398.70 Euros at July 31, 1974. At the 31st January 1999, it was worth 2,578.55 Euros, only. The situation gets even worse in the case of a technical (or promised) rate of interest 5% (dashed line) - which is quite little in contrast to formerly promised returns of e.g. German life insurers. At the 31st January 1999, such a contract was worth -3,141.95 Euros, i.e. the contract actually produced a loss in the mean.

For comparison, Figure 2 shows the historical yield structure of the German debt securities market from September 1972 to April 2003. These values were used to compute the present values of the endowment contract (Source: German Federal Reserve). The dynamics of the computed present values are directly induced by the dynamics of the debt securities market.

Interest rate models like the well-established Cox-Ingersoll-Ross model (with multiple factors) can be used for stochastic simulation of debt securities markets. Applying such a model, as e.g. explained in Fischer, May and Walter (2004), one has the ability to simulate or forecast present values of contracts, but also the impact of

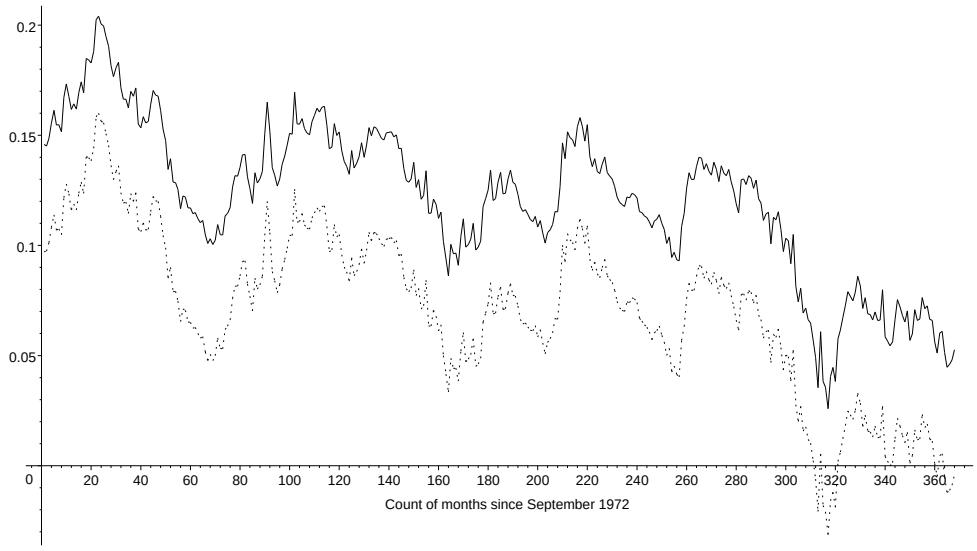

Figure 1: PV/c (present value/benefit) for the 10-years endowment under a technical interest rate of 3.5% (solid) and 5% (dashed)

different financial hedging strategies. This would be a major step forward to modern, i.e. stochastic, DFA/ALM in life insurance. Stochastic business models or randomly developing mortalities would be further comprehensive steps in that direction.

We conclude that DFA or ALM methods in modern life and pension insurance are crucial for hedging, but they are also important for realistic insights into values of liabilities. Astonishingly enough, these methods are still not yet as well established as e.g. methods of financial mathematics in investment banks.

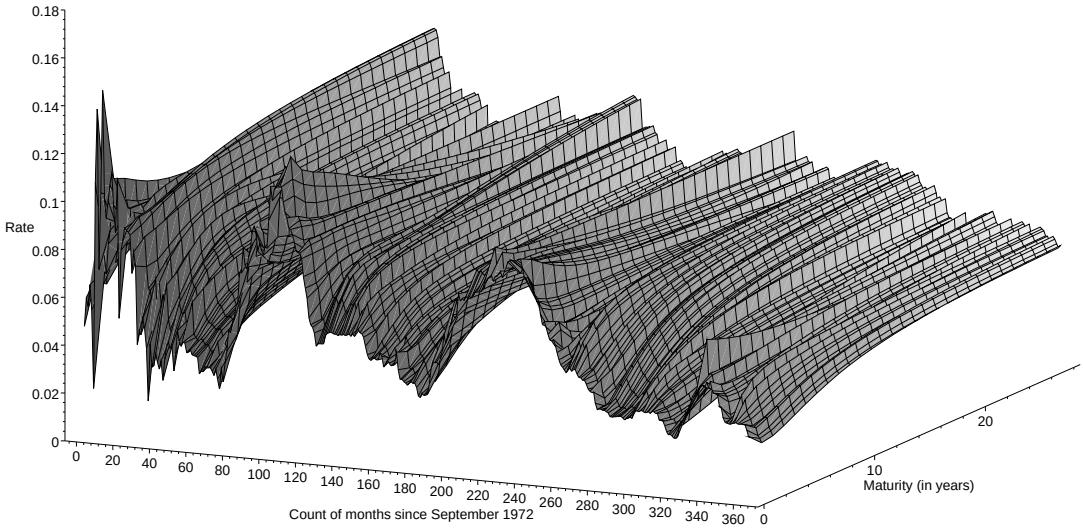

Figure 2: Historical yields of the German debt securities market

DFA for banks giving credits

The slow economic recovery in Germany combined with the cautious attitude of banks - a result of Basel II - shows how important DFA is, especially for SMEs.

The quality, quantity and in-depth of information needed for investment and credit decisions rose enormously in the last years. Important business data and statistics must be available in near real time. There is only a small number of enterprises with sufficient own capital funds, therefore the exact controlling and monitoring of the liquidity becomes a main task. Risks and bottlenecks must be swiftly recognized to enable the enterprise to react accordingly. Next to current business data, also future developments must be considered in the analysis process. In future resource planning optimizations more attention has to be dedicated to the factor capital. Modern IT systems with DFA/CFaR software are the necessary instruments to make liquidity risks measurable and controlable.

Enterprises must adjust themselves to the partners.

A fundamental change in the relationship between banks and entrepreneurs is in progress. It is not a common practice to give customers and suppliers a complete insight into your books. From this point of view it is understandable that entrepreneurs will not immediately change their attitude towards banks, who now want to be treated like partners with almost full insight in all company divisions. In these times of hard competition it is difficult to rely just in the entrepreneur's word of honor. Now it is important to back that honor with verifiable and analyzable numbers and facts and by minimizing risks using exact planning and reporting. However an entrepreneur must concentrate on his most characteristic executive functions, therefore he needs efficient DFA systems for automatic data collection, preparation and analysis. The financial section for most external information receivers - as shown in illustration 3 - is usually the decisive factor for the condition and scope of action of the enterprise. The main interest particularly for the partners from the money and capital market range is the future financial development of the enterprise.

Dynamic Financial Analysis systems automatically generate characteristic numbers and statistics out of current data. Prognosis and monitoring mechanisms guarantee that the enterprise stays on the proper financial path. Even at SMEs, banks and other investors with insight to these systems, become partners and take over a more powerful monitoring function, equal to a supervisory board at large-scale enterprises. Initial integration problems on both sides will typically occur. On the bank side, interfaces and standards about which enterprise data and in which form are needed and therefore must be defined and evaluated. These standards have to be implemented in ERP and DFA systems as soon as possible to get the enterprises ready to provide the data fast and with justifiable costs. Unfortunately each consulting company and bank institute is still trying to establish its own system on the rating-market. It will be only after some best practice solutions succeed and get enough market share, that these new analysis methods will be seen as a good and trustable way to evaluate suppliers and business partners and Dynamic Financial Analysis will play a fundamental part in these. The financial scope of action determines each business decision; in particular for enterprises in crisis situations it is essential to get hold of financial figures as fast as possible to escape the vicious circle. Risk management, simulation- and prognosis functions will

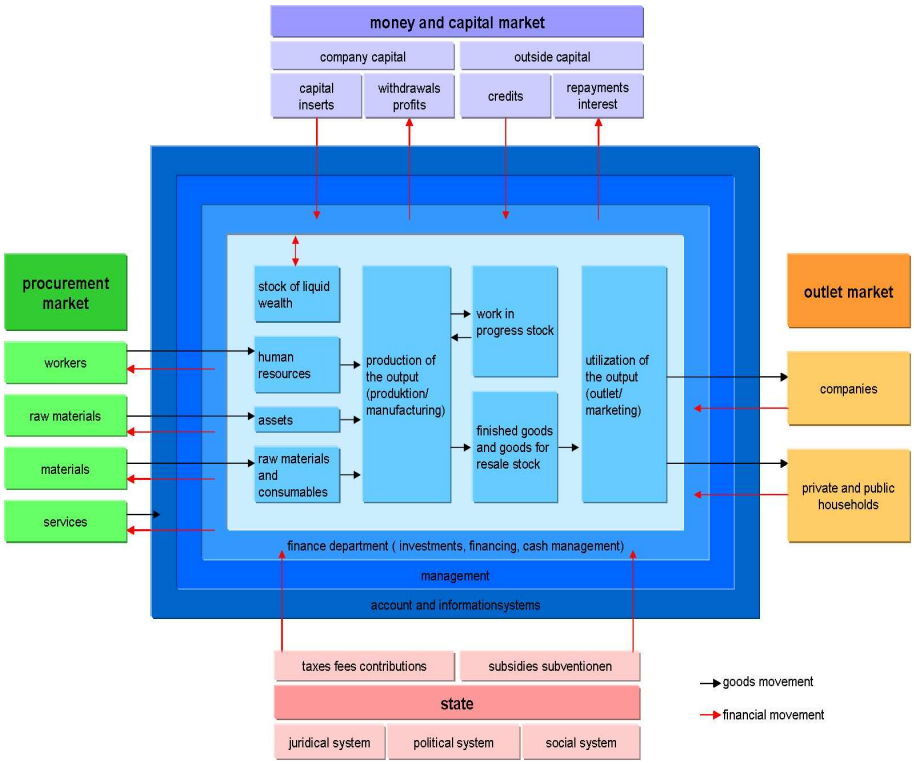

Figure 3: For a typical KMU relevant factors (cf. Döring and Günter, 2002)

become important extensions of DFA systems.

For a good relation between the enterprise and its bank agreements (e.g. maximum overcharge of the account) have to be made and kept exactly. The push and pull sides have completely changed, it is now up to the entrepreneur to inform his bank early enough if problems accrue. Banks' internal revisions do not permit thoughtless passing over irregularities anymore. Only enterprises which are able to handle their finances and deal with these new kinds of irregularities will have the best interest and credit conditions in the future.

Requirements of efficient DFA systems:

- The functions for modern DFA systems specified in the following support the optimal planning and management of all financial streams within the enterprise.
- Simulation of the account balances: Effects of financial decisions can be checked in advance
- Determination of optimal dates of payment for suppliers under utilization of discount-cash offers
- Simulation and optimization of own conditions of payment for customers (payment deadline, discount payment)
- Risk evaluation of all financial streams, discover interdependences
- Automatic compilation of the monthly data for banks and other credit givers (with ad hoc messages)
- Supply bundling: Improved utilization of discount by collective orders consideration of all deliveries and costs in advance (fixed costs, wages, insurance, credit payments, taxes, etc.)
- Determination of optimal investment times? Reduction of foreign exchange risks
- Customer valuation, Customer rating
- Documentation of the business transactions, revision-safe archiving
- Simple integration into existing IT landscape, compatibly with ERP systems, simple data import/export
- Integration of international accounting standards
- Discover of enterprise dependences (of customer, suppliers, products, etc)
- Consideration of fiscal effects
- ..

The use of DFA systems makes the complex structures and interdependences of financial figures in the whole enterprise controllable. Important factors of influence become more visible and therefore high topicality changes (e.g. in the purchase behavior) can be recognized and analyzed faster, making it easier to get Credit institutes and creditors on board. Also the effects of planned investments can be approximated from the current genuine data and simulated first.

The latest developments of the German stock exchange New Market (Neuer Markt) are evidence that focusing on the shareholder value is not an optimal and lasting strategy of the management. Also banks must learn again that business thinking and acting may not be limited on the next financial year if one wants to have success on a long-term basis. Some investments are only worthwhile on the second often more long-term view. This can be better forecasted with the DFA systems simulation and prognosis functions in different risk levels. The complexity of investment decisions again becomes more controllable and transparent.

Only the question about the efficiency of such systems remains. Of course new miracles cannot be achieved using Dynamic Financial Analysis. These systems will not replace business feeling and farsightedness of managers fore sure. Nevertheless they will allow the user to get a better overview of the financial processes in the enterprise. They will confirm a good entrepreneur and help him to become even better. Also they will flag a bad entrepreneur quickly showing him his errors and giving everyone a chance to avoid further damage.

DFA/CFA-Travel-industry example

While going up the ski-lift the CEO of company A had the idea of buying a large travel-industry player B. After some initial due diligence, a rough strategy of how to restructure and focus the new joint-company arose. Nevertheless many unknowns made it difficult to get a realistic image of whether it would make economic sense to take over B.

As the heydays of the .com-boom are gone, instead of simply executing the deal the next week, the board decided it would be best to first better understand the future payoff.

In the next 6 months, a team of computer scientists, domain experts, finance- and accounting gurus, created a simulation of the new company, including its competitors like low-cost airlines. This allowed to get a realistic grip on the routes to serve, the load-factor of transportation units, human resource costs, petrol-costs, pricing of tickets, etc. Looking at the distribution of the range of future cash-flows, company A understood that to create value it had to alter its strategy of products provided and that ultimately company C at a decent price would be a better option.

At the moment, the negotiations for a very different deal are still going on. The insights obtained using DFA together with other information have lead to a different pricing model in the future, as well as better understanding of company's A's strength and weaknesses. This is a primal example of DFA/CFaR-analysis as the travel-industry has the following characteristics:

- Currency-exchange rates fluctuation
- Exact payment dates unsure
- Many different countries involved
- Huge impact of petrol-price heding (one mistake and you suffer for the next quarter as the competition can change the prices)
- Disruptive competitors: low-cost airlines
- Seasonality and other huge peaks, require advanced statistical analysis (Extreme Value Theory amongst others) and careful dynamic ressouce-allocation.
- Huge potential for new products.

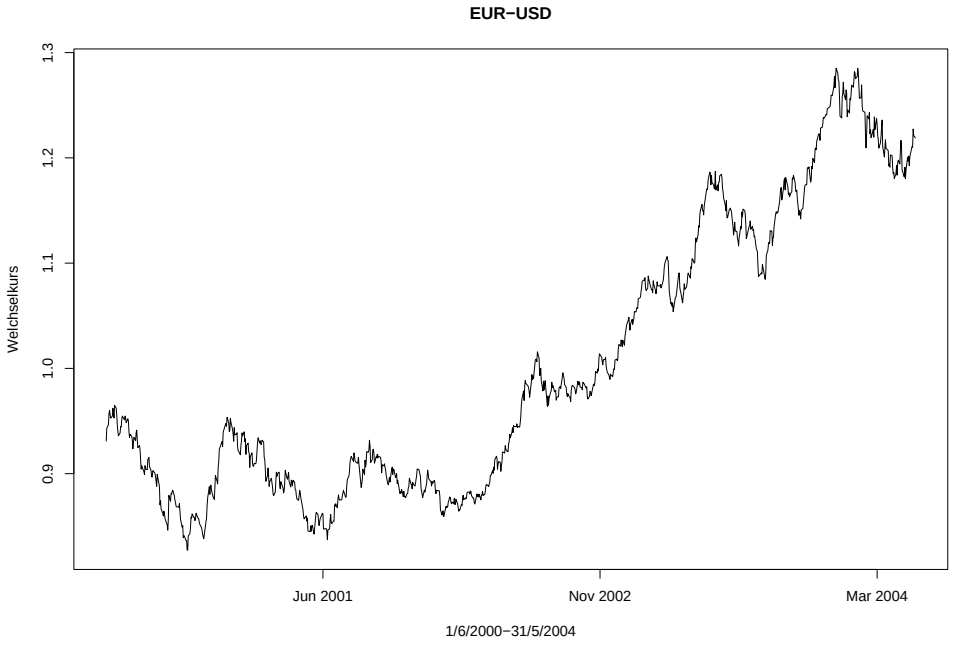

Figure 4: Euro-strength requires a good hedging and currency-exchange policy.

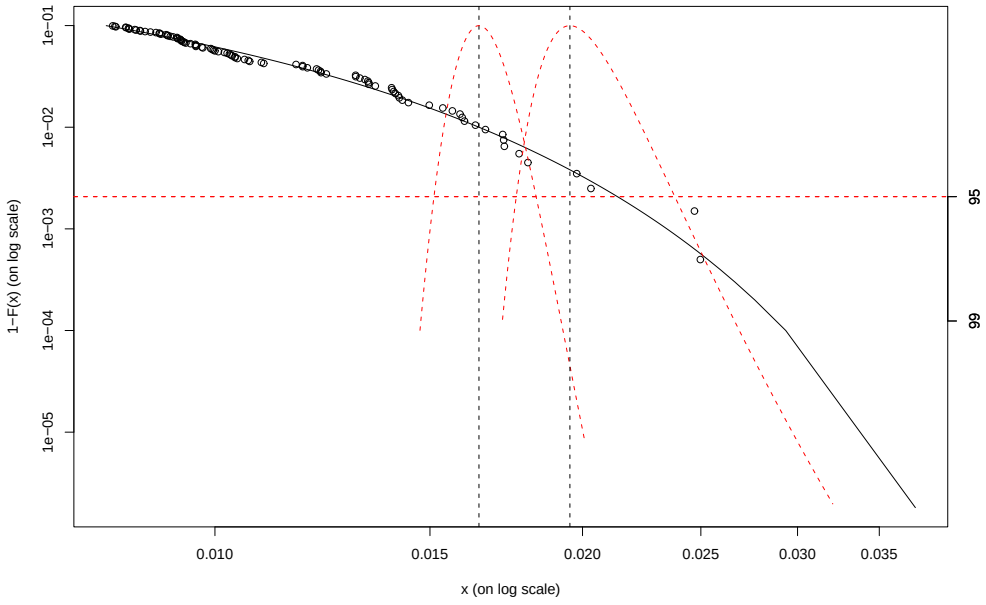

Figure 5: Value-at-Risk (VaR, left) und Expected Shoftfall (ES, right) to estimate the influence of currency flucations. The ES is a more conservative and more realistic estimate. Assuming it goes wrong, it tells you how wrong it will go. The VaR gives an estimate on the the border of where it will be in 99% or 95% of the cases. Portfolios consisting of several currencies, in addition to unsure payment dates create interesting challenges.

DFA/CFaR is the way to go

Whichever buzzword one wants to use, the use of real-time information, compared with probabilistic models based on the current and future cash-flow is a competitive advantage, and in the near future a business necessity. The further one examines positive and negative scenarios in the future, the better one can prepare one's enterprise to become a successful marketleader.

Building such a model can be a huge venture, but during the process one discovers a lot about one's own enterprise and the potential pay-off can be enormous, could even be the difference between going broke and staying in business. Depending what questions one wants to answer, one can often start focusing on the few risk-factors that have most impact. Models by definition are always an abstraction of reality, but better to have a vague idea of the future than no vision at all. One chief risk officer of a global high-tech company told us: the worst for my company is to see an opportunity and not having the necessary resources to take advantage of it.

We recommend DFA/CFaR as a daily tool to base decisions on all levels of the enterprise and to avoid crises before they happen.

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  The author is funded by the German Federal Ministry of Education and Research (BMBF, 03LEM6DA).
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