FINANCIAL MATHEMATICS

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EXPERTISE IN CONVENTIONAL FINANCIAL MATHEMATICS, DATA SCIENCE, AND THE ENERGY INDUSTRY

Our application-oriented research provides the basis for the development, analysis and implementation of mathematical models for business enterprises. We rely on the latest findings of financial and statistical research. At the same time, we draw on a portfolio of successful projects with banks, insurance companies, energy suppliers, and manufacturing companies.

We cover all practice-relevant areas of financial mathematics – from modeling to the development of evaluation algorithms and their implementation – and maintain our own software libraries. Frequently, our projects result in software programs for use in company operations.

We assist companies to validate their data through mathematical modeling and to discover insights from the data using classical and modern statistical methods. The applications apply to the most diverse areas of controlling – from company-specific asset valuation such as leasing vehicles, to the detection of anomalies in accounting data. Our work involves a combination of classic statistical methods such as regression models and cluster analysis and modern machine learning methods.

The use of financial mathematical methods is increasingly important in the energy economy. We are familiar with the specific problems and characteristics of the energy markets and have experience with various models. We use current research results in developing algorithms that efficiently solve valuation problems and we also provide ready-to-use software packages that manage portfolio risk.

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MAIN TOPICS

- Financial economy

- Data science for controlling

- Energy industry

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INTERACTIVE ANALYSIS FOR USED CAR WARRANTIES

Several insurers offer used car warranties: these are insurance policies against premature wear and tear or defects in vehicle components. These policies are important to owners wanting to reduce the risk of high cost maintenance after the expiration of a new car warranty. Of course, the suppliers of such insurance products have to worry about their own profitability.

Our client is a European auto manufacturer that offers a variety of warranties that cover used car repair costs. An evaluation of these products reveals great differences in profitability over time and across different geographic regions. The first step is to analyze the background and cost drivers and predict the future development of costs. Fraunhofer ITWM was chosen as a partner because of its many years of actuarial experience and successful projects in the automotive sector.

Interactive data management
Over the course of the project, it became clear that customers had numerous other questions that could be answered with the available data. Based on R-Shiny technology, a web application was created that enables customers to work interactively with the data. We also developed new methods and models for further refining that data. Our client can exploit the hidden potential of the data significantly better now than ever before.

Fast anomaly detection thanks to machine learning
Our software helps customers merge data from various sources and automatically aggregate it to useful data sets. It also offers new opportunities for exploratory data analysis. Another innovative development is specific anomaly detection. This feature uses statistics and machine learning techniques to automatically search the data for conspicuous patterns. These patterns reveal aspects that, in turn, allow better workshop control, more efficient application review, more efficient contract design, and the optimization of internal processes.

Major aspects of the project are understanding the available data and predicting future costs. To this end, the decision maker has various actuarial methods available that can be adapted to fit the context. Comprehensive back-testing of historical data enables a reliable assessment of the forecasting quality.

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MARKET TRANSPARENCY FOR OCCUPATIONAL PENSION SCHEMES

In 2018, the German legislator passed the Occupational Pension Strengthening Act a major reform package affecting occupational pensions. The main innovation is the introduction of the "social partner model" for bargaining parties. From now on employers only commit themselves to contribute premiums to the retirement provision institutions. Nowadays the guarantee of future pension entitlements is optional and employers no longer assume any liabilities beyond that. To support the members of the "Rentenwerk" in their striving for more transparency in the market of occupational pensions we apply our expertise in developing and establishing an accepted market model.

The reform in the area of occupational pensions opens new pathways and allows more flexibility in the development of products and services. The members of the "Rentenwerk," a consortium of five insurance companies under the lead management of Debeka, have created a new fund-based pension product. A fair assessment of competing plans requires a capital market model that is recognized industry wide as the basis for calculation.

PIA standard model is the benchmark for the industry
Debeka acknowledged our expertise in working with the "Produktinformationsstelle Altersvorsorge" (PIA) and commissioned us to develop a capital market model. One requirement for the model was to be in agreement with current industry standards. Fraunhofer ITWM already created an industry benchmark for stochastic capital market simulations with the PIA standard model for private pension plans. Using this established framework as the starting point, we have further developed the model and included aspects of particular relevance to fund products. For example, the new model can now show the effect of diversification on stock investments and differentiate between government and corporate bond funds.

More fairness thanks to improved information
The commission also included the implementation of the developed model in a software tool to simulate occupational pension schemes. Doing so we created a useful and versatile framework for the analysis and management of occupational pensions. It allows for better profit and loss assessments and an improved description of developments in the retirement period. The more detailed and standardized information supports the consortium in designing a fair company-specific pension plan to the benefit of all the bargaining parties.

ASSET ALLOCATION AND PORTFOLIO OPTIMIZATION – BALANCE BETWEEN RISK AND RETURN

Asset allocation refers to the allocation of funds to various asset classes such as bonds, equities, real estate, currencies and precious metals. The EU's "Solvency II" Directive provides the framework for the necessary capital adequacy. On this basis, we have implemented a new approach to strategic asset allocation with R+V Lebensversicherung AG.

Many companies and individual investors are faced at least once a year with the question of how their existing capital could best be invested in the coming year. Here, the term »best« covers several areas where the respective objectives need to be aligned. Insurance companies, in particular, often strive to achieve the highest possible long-term return at a defined risk level. On the other hand, however, a given liquidity (i.e. availability of funds) should also be guaranteed within different time periods.

Strategic asset allocation mathematically and theoretically determines the long-term composition of a portfolio on a sound basis. Possible asset classes in the asset pool are

- shares
- bonds
- real estate
- financings

possibly broken down by region or risk profile.

In classic Markowitz portfolio optimization, only yield (mean value) and risk (variance) are taken into account. According to this, a so-called efficient portfolio exists if its return can no longer be improved without increasing the risk. The choice of asset allocation is based on a number of efficient portfolios. This gives the investor an overview and allows him to select a portfolio that matches his risk profile.

Under the name "Solvency II", the EU issued a directive in 2009 that has been binding for all insurance companies since 2016. Solvency II places particular demands on the company's capital resources and is therefore another important target function in asset allocation.

Multi-stage solution

Together with R+V Lebensversicherung AG, we have implemented a new approach to strategic asset allocation. On the one hand, this takes into account the solvency ratio under the Solvency II regime. On the other hand, our approach allows other relevant portfolio features to be taken into account.

Our solution is multi-tiered. First, we determine all possible achievable risk-return profiles in the calculation kernel for given weight limits of the individual asset classes. We then optimize the solvency ratio for each of these profiles. This optimization also takes place offline in the calculation kernel. The calculated optimal portfolios are stored in a database.

The programming concept completely separates the visualization from the calculation kernel. This makes it possible to separate the time-consuming optimisation from the other work steps. In addition, the individual project parts are independent and reusable.

User-friendly visualization

The users interact completely via a graphical interface, which is implemented customer-friendly with the help of a web server and is completely separated from the calculation kernel. This allows users to quickly and easily analyse the results of the calculations in their daily work. The visualization shows all solvency ratio-optimal portfolios, incorporates additional constraints and shows variants. In this way, users can dynamically select a portfolio that meets their requirements and appears most suitable to them from the range of optimal portfolios. The program shows the composition of the portfolio and a number of other key figures, such as reallocation, diversification, value at risk and behaviour under stress scenarios. Users can also store their own portfolios in the database and compare them with each other or with the optimized portfolios.

Increased automation planned

Via the web interface, the user can also import further data sets with asset classes and weight limits and start optimizing the portfolios. The results can be exported to Excel for additional analysis. In the next project phase, the focus will be on optimizing further portfolio features. In addition, the entire process will be more automated so that a larger number of different data sets can be processed in parallel.

NEWS

WORKSHOPS WELL RECEIVED

Our joint workshop with the Product Information Center for Pension Plans (PIA) centered on the ALMSim® Path Generator. Our ALMSim Path Generator software enables the simulation of capital market scenarios and pension product contracts. The software supports insurance companies in the implementation of legal requirements. The models we have established have become the market standard and ALMSim is now used by more than 50 life insurance companies.

Our fraud assessment model is gaining wider acceptance in the pursuit of billing fraud in the healthcare sector. This also led to broad interest in our "Billing fraud in outpatient care – Claims calculation in R" workshop last November in Berlin.

COMMODITY RISK MANAGER AT E-WORLD

We have a strong profile in researching applications for the energy economy. In the ENets project, sponsored by BMBF, we develop assessment models for wind and photovoltaic systems. At e-World Energy & Water in Essen we presented our range of services in the energy sector, in particular the Commodity Risk Manager; this tool enables municipal electricity suppliers in particular to plan their electricity purchases on a long-term basis.

But we were not the only ones at the ITWM stand; our colleagues from the Green by IT Group and the department System Analysis, Prognosis and Control were also represented with current research projects.

OUTLOOK 2019

Our good reputation as a competent project partner serves us well, not only in the financial mathematics area, but also in data science. For example, we prepare business forecasts and identify unusual relationships. Our goal is to partner with a consortium of health insurance and associations to implement data-based anomaly detection. Working with industry and research, we successfully develop and market methods to promote flexibility in the power consumption requirements of industrial enterprises.

Front, left to right: Dr. Kerstin Dächert, Franziska Diez, Florian Schirra, Ria Grindel, Dr. Elisabeth Leoff, Renate Wegner, Dr. Andreas Wagner, Dr. Stefanie Schwaar, Wieger Hinderks, Dr. Jörg Wenzel, Dr. Robert Knobloch, Dr. Johannes Leitner, Robert Sicks, Simon Schürch, Philipp Mahler, Dr. Roman Horsky, Christian Laudagé