# Modelling of Premium and Reserve Risk in Solvency II
## *Popular science summary of the project*

The topic of this project is quantitative modelling of premium and reserve risk in Solvency II. The Solvency II Directive came into effect in European Union on 01.01.2016 with the aim of unifying the insurance market and increasing the safety of consumers. As one of its effects, it obliges the insurance companies to hold the amount of capital which ensures that the company will be able to meet its obligations during the next 12 months with a 99,5% probability. For non-life insurance companies, premium risk and reserve risk are the crucial part of the required solvency capital. Premium risk is related to the claims that will be incurred in the future, while reserve risk is related to the claims that have already been incurred. If approved by the supervisory authority, the solvency capital can be calculated with an internal model developed by the company.

Solvency II has provided motivation for improvement and further studies concerning stochastic models of the insurer's activity. In particular, the concept of the one-year risk, which is the cornerstone of Solvency II capital requirement, has opened a whole new research field in claims reserving and measuring the adequacy of the reserves. In our research we tackle five problems related to premium and reserve risk. The first problem concerns the transition from the ultimate to one-year perspective for premium risk. The one-year risk perspective requires to quantify the volatility of the best estimate of the ultimate loss after one year, in contrast to the ultimate perspective which focuses on the ultimate losses paid in an infinite time horizon. We follow the emergence pattern methodology that is described in the literature. We check its underlying assumptions and evaluate its properties for common loss reserving models. We will enhance it, by deriving the true emergence pattern formulas based on the conditional distributions of the one-year loss given the ultimate loss, for considered models. The second problem is related to the simulation of the one-year premium risk. We analyse the base and enhanced formulas for models with explicit emergence patterns and evaluate numerical methods for cases where the emergence factors are impossible to obtain in closed form. We develop efficient numerical techniques for allocating the simulated ultimate loss to the one-year loss. The third problem focuses on the value of the emergence factors in practice and we carry out a benchmark study based on publicly available data from European insurance companies for different lines of business. The fourth problem concerns dependence in reserve risk. We analyse the impact of the assumed dependence between the one-year losses in different lines of business on the dependence between the ultimate losses, both through analytical calculations and simulation studies. In common risk reserve models, we derive relations which show how the correlation between the ultimate losses depends on the correlation between the one-year losses. Finally, we investigate how the claims develop over time from the first value reported to the ultimate loss. We postulate a new reserve risk model for claims development which takes into account correlation between incurred and paid losses and the claims history of paid and incurred losses. We propose efficient estimation methods with neural networks and generalized additive models.

We believe that our results contribute to the actuarial science by expanding the class of probabilistic and statistical models. The audience which should be interested in our research includes actuaries, economists, financial analysts, risk managers, statisticians and mathematicians. The result should help to better understand the characteristics of losses of the insurance company and quantify them in a more advanced way.