Assessing the Impact of Climate Risks in Non-Life Insurance within a Collective Risk Model with Upper Tail Dependence

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Abstract

It is both intuitive and empirically shown that catastrophic events point to nonlinear upper tail dependencies between the severity of losses and the number of losses, see e.g. [3], [9] and [5]. At the same time, climate risks with potentially catastrophic losses and related stress tests become increasingly important from a regulatory perspective. With this in mind, this paper presents a more intuitive method for modeling these dependencies within the discrete time collective risk model. Nonlinear dependencies within the collective risk model according to Sparre Andersen have already been well researched (e.g. [1] and [2]). The difference to previously explored methods for incorporating dependencies between severity and frequency of claims is that the individual claim severities are not identically distributed, but only originate from the same distribution family. The expected value of each single damage depends in each case on the expected value of the number of damages and the considered time interval. This makes it possible to explicitly include certain time-dependent distribution properties in the overall damage distribution.

In addition, model parameters and distribution assumptions will be estimated from a comprehensive empirical analysis and the model will be evaluated according to its quality and explanatory power. For this purpose, empirical data on individual losses in catastrophes are examined, time- and location-dependent factors are determined, and optimization is performed via model parameters according to various optimality criteria e.g. maximum-likelihood method.

Finally, an optimization over reinsurance structures will be performed, considering classical reinsurance structures such as quota share or excess-of-loss reinsurance as well as modern reinsurance principles based on weighted loss functions [4]. Particular attention is paid to those reinsurance structures that maintain solvency levels even in the face of catastrophic loss events, and to those that maximize overall solvency levels according to model specifications. The present work is therefore also related to the literature on risk- and value-oriented management under Solvency II (e.g. [7] and [8]).

Keywords: Sparre-Andersen risk model, catastrophe modeling, tail dependence.

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