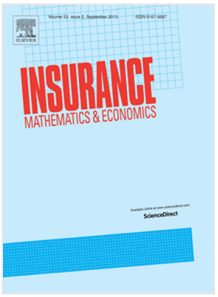

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Incorporating model uncertainty into optimal insurance contract design

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Abstract

In stochastic optimization models, the optimal solution heavily depends on the selected probability model for the scenarios. However, the scenario models are typically chosen on the basis of statistical estimates and are therefore subject to model error. We demonstrate here how the model uncertainty can be incorporated into the decision making process. We use a nonparametric approach for quantifying the model uncertainty and a minimax setup to find model-robust solutions. The method is illustrated by a risk management problem involving the optimal design of an insurance contract.

Keywords: insurance optimization, model error, minimax solution, distributional robustness

1. Introduction

A common approach in risk assessment and risk management is to base the risk estimates on observed data and to use the statistically obtained estimates for finding the optimal risk management strategies. However, the fact that statistical estimates can never give precise values of unknown parameters due to estimation error, is quite often neglected. Moreover, the choice of the probability model, i.e. the class of possible distributions, is typically chosen by the statistician and is not further questioned.

In general, statistical estimation procedures do not allow to single out one specific probability model, but only a whole set of models can be determined, in which the true model lies with a prespecified probability. Such a confidence set can be taken as the set of models for a minimax decision, where the best decision under the worst model in the model set is sought for. We call such sets of models *ambiguity sets*. The minimax solution in this case is called *distributionally robust*.

Modeling uncertainty. Economic decisions are made under some assumptions on the decision-relevant parameters. In deterministic optimization, the parameters are considered to be known and fixed. Already in the early days of optimization, this assumption was considered as a very narrow one. Two possible setups have then been developed: (i) in robust optimization, a set of possible parameters is determined, while (ii) in stochastic optimization the parameters are considered to follow a certain probability distribution. In robust optimization, the values of the parameters are not weighted according to probability and one has to use minimax strategies (i.e. to find the best strategy under the worst case). In contrast, probability models come with a lot more of possible strategies: expected utility maximization or minimization of risk

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