

Optimization of transition rules of bonus-malus system with respect to global elasticity

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Abstract

Bonus-malus systems are used as a tools of a'posteriori premiums differentiation in risk assessment process in automobile insurance. While the tools of systems analysis and premium calculation criteria are well-described in the literature, relatively little space is devoted to the optimization of transition rules between classes of a bonus-malus system. The problem appears to be particularly interesting from the viewpoint of system design. The possibility of building a system that meets the specified optimality criterion in advance seems to be desirable.

We optimize the transition rules of bonus-malus systems to achieve possibly the best premium elasticity as defined by Loimaranta (1972) and later generalized as global elasticity by De Prill (1978). We use premium scale given by the minimization of mean square error proposed by Norberg (1976). This issue constitutes a nonlinear nonconvex discrete optimization problem. To solve this problem improved greedy optimization algorithm is engaged, similar to the one proposed by Marlock (1984). We also propose alternative measures of global premium elasticity, which allow for better monitoring of characteristics of a bonus-malus system. We analyse systems of different size applied for risk portfolios characterized by the inverse Gaussian risk structure function of various parameters.

We find that for relatively small systems it is impossible to achieve satisfactory level of global elasticity with this particular premium calculation principle even for the toughest transition rules due to not sufficient premium span. Also for larger systems their global elasticity is limited both for original and alternative measures. We also show that in some cases the original measure of global elasticity fails to reflect adequate system properties, thus making alternative measures more favourable.

The proposed approach is a continuation of the authors' former research about optimizing transition rules of bonus-malus systems (to be published). We try to determine if optimization of the transition rules can improve and objectify the process of building a bonus-malus system, and if the aim to obtain a bonus-malus system of good statistical properties goes hand in hand with the desired market utility performance of the system. Therefore for each solution, measures of other system characteristics are calculated and analysed to assess possibility of system market application.

Keywords

Bonus-malus system, transition rules, optimization, premium elasticity, automobile insurance.