The impact of bonus malus systems in finite and continuous time ruin probabilities in motor insurance considering an open versus a closed portfolio

Afonso, L. B.[1], Cardoso, R.[2], Egídio dos Reis,A.D.[3], Guerreiro, G.R.[4]

[1] *FCT-UNL e CMA*
lbafonso@fct.unl.pt
[2] *FCT-UNL e CMA*
rrc@fct.unl.pt
[3] *ISEG-UTL e CEMAPRE*
alfredo@iseg.ulisboa.pt
[4] *FCT-UNL e CMA*
grg@fct.unl.pt

Abstract

In motor insurance, we consider usually two types of ratemaking, a priori and a posteriori. Here, premium calculation is based on past experience and volatility is higher when compared to classical procedures where premium are paid continuously at a constant rate. Typically, the ruin probabilities are computed according to the classical Cramér-Lundberg model. Afonso et al.(2009) consider a model applicable to large portfolios where a varying premium is used by means of a mix of calculation and simulation. That procedure differs from the usual literature and allow us to obtain fast and reliable results in a finite and continuous time horizon. Those ideas can be brought for application in motor insurance ratemaking (experience rating), for two main reasons: First because premium calculation is applied for large portfolios, common in motor insurance, second because premium calculation is based on the past claim record. However, the model needs to be changed to fit in the features common in motor insurance.

Common experience rating models produce variations in annual premiums as function of the past claim number record, and not as a function of the past aggregate claims. This is approached by a Markov chain procedure. Only the number of claims is essential to determine the next rating class and calculate the applicable premium. However, aggregate claims are necessary to compute ruin probabilities for the portfolio.

We will measure the impact of a bonus malus system (BMS) in the ruin probabilities, considering different known optimal scales (e.g. Norberg, Borgan et al., Gilde and Sundt and Andrade e Silva and Centeno), as well as real commercial scales. We will consider both closed and open portfolios and compare the results. In these scenarios we will use real data from automobile third-party liability portfolios of an insurer operating in Portugal.

The methodologies and tools to be used are Markov chains, compound Poisson process, translated gamma distributions approximations, optimal premium scales and simulation.

Key words Ruin probabilities; bonus malus system; motor insurance; open portfolio; closed portfolio

Referências

[Afonso *et al.*, 2009] Afonso, L. B., Egídio dos Reis, A. D., and Waters, H. R. (2009). Calculating continuous time ruin probabilities for a large portfolio with varying premiums. *ASTIN Bulletin*, 39(1):117–136.

[Afonso *et al.*, 2010] Afonso, L. B., Egídio dos Reis, A. D., and Waters, H. R. (2009). Numerical evaluation of continuous time ruin probabilities for a portfolio with credibility updated premiums. *ASTIN Bulletin*, 40(1):399–414.

[Andrade e Silva and Centeno, 2005] Andrade e Silva, J. and Centeno, M. L. (2005). A note on bonus scales. *Journal of Risk and Insurance*, 72(4):601–607.

[Borgan *et al.*, 1981] Borgan, Ø., Hoem, J., and Norberg, R. (1981). A non asymptotic criterion for the evaluation of automobile bonus system. *Scandinavian Actuarial Journal*, pages 165–178.

[Gilde and Sundt, 1989] Gilde, V. and Sundt, B. (1989). On bonus systems with credibility scales. *Scandinavian Actuarial Journal*, pages 13–22.

[Lemaire, 1995] Lemaire, J. (1995). *Bonus-malus systems in automobile insurance.* Springer.

[Norberg, 1976] Norberg, R. (1976). A credibility theory for automobile bonus system. *Scandianvian Actuarial Journal*, pages 92–107.