

Modelling dependence between frequency and severity for liability and housing insurance and its implications in premium calculation

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Abstract

A common assumption in classical risk theory is the independence between claim frequency and severity. However, this often fails in practice, especially when subtle or nonlinear dependencies are present. This study analyses a real-world dataset comprising 15,665 claim records from liability and housing insurance contracts, that were recorded between 01/01/2015 and 31/12/2019, provided by an anonymous insurer. Unlike most literature, often focused on automobile insurance, our data allow us to explore dependence in less-studied lines of business, which pose unique challenges.

We investigate the presence and nature of dependence between frequency and severity, how this relationship evolves over time and across insurance types. Our approach combines parametric and nonparametric methods: we fit Poisson-Inverse Gaussian, Negative Binomial, Weibull, and Log-Normal distributions to the marginals, and apply copula-based techniques to assess joint behaviour. Using pseudo-observations, we estimate empirical copulas, visualize joint densities, and perform statistical tests of independence and equality (KcopTest), which reveal a structural break in housing insurance in 2016.

Results indicate strong positive dependence in liability insurance. In housing insurance, we find a light negative dependence becoming stronger in the tails for all years but 2016, where is strong overall. Using GAMLSS models we confirm diverging patterns: in liability insurance, severity increases with frequency; in housing insurance, it decreases, in contrast to findings by [1].

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We study premium calculation, and show that under dependence premia can be either under or over estimated if we use the classical premium calculation with the independence hypothesis.

Keywords: Dependent risks; insurance risk model; Liability Insurance; Housing Insurance; real data application; premium estimation.

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