Modeling Multivariate Claim Counts Using Copulas

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Actuarial practice often involves modeling of claims counts from multiple types of coverage, such as the rate-making process for a bundled insurance contract. Since different type of claims are usually correlated with each other, the multivariate count regression models that emphasize the dependency among claim types are more helpful for inference and prediction purposes. However, traditional methods typically assume an identical count process for all types of claims and specify a fairly restrictive dependence structure among claim types. To address these issues, we propose two alternative approaches to modeling multivariate claim counts using copulas. The first one works with the discrete count data directly with the mixture of max-id copulas that allows for flexible pair-wise association as well as tail dependence. The second one employs elliptical copulas to join continuitized data while preserving the dependency among original counts. In the empirical analysis, both methods are applied to an insurance portfolio from a Singapore auto insurer where claim frequency of three types of claims (third party property damage, own damage, and third party bodily injury) are considered. The results demonstrate the advantage of the copula-based approaches over traditional multivariate count regression models.