Multivariate Longitudinal Modeling Using Copulas with its Application to Insurance Company Expenses

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Abstract

The operating expenses of an insurance company consist of three components: underwriting, investment and loss adjustment. A joint study of expenses by type is critical in understanding their relationships and measuring the insurer’s cost efficiency. However, the heavy-tailed nature and the strong individual effects of expenses make the current technique inappropriate for such joint analysis.

We introduce a new approach for modeling multivariate longitudinal data, where multiple responses are repeatedly observed for each subject, over time. Our method use elliptical copulas to accommodate the between-subject contemporaneous and lag dependence, as well as within-subject serial correlation. Flexible distributions are allowed for marginals with covariates incorporated in distribution parameters. A model validation procedure based on a $t$-plot method is proposed to for in-sample and out-of-sample validation purposes.

The multivariate longitudinal model is applied to the property-casualty insurance company expenses data from the National Association of Insurance Commissioners of years 2001-2006. A unique set of covariates is determined for each type of expenses. We found that underwriting expenses and loss adjustment expenses are complements rather than substitutes. The model is shown to be successful in efficiency classification. Also, a joint predictive density is derived to quantify the future values of each type of expenses.

Keywords: Long-tail regression, Copulas