

Modeling dependence in run-off triangles

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In order to determine appropriate reserves and risk capital for incurred but unpaid losses, property and casualty insurance companies must account for the fact that their lines of business may be dependent. For each line of business, payments relating to past claims are usually structured in a run-off triangle arranged to rows according to the accident years, and to columns according to the development periods. Generalized linear models (GLMs) provide a convenient way to capture the influence of these two factors on the distribution of the loss ratios in each triangle. Following Shi & Frees (2011), copulas can then be used to combine these GLMs across lines of business.

To guard against the undesirable effects of an inadequate choice of dependence model on reserve estimation, a two-stage, rank-based inference procedure will be proposed to assist with copula selection and validation in this context. A hierarchical approach will also be advocated for the construction of flexible copulas. As emphasized by Arbenz et al. (2012), this modeling strategy relies on a conditional independence assumption whose implications will be highlighted. Under this assumption, the hierarchical structure can be constructed iteratively using rank-based clustering techniques, as detailed in Côté & Genest (2015). The entire approach will be illustrated with data for six lines of business from a large Canadian insurance company.

- [1] Arbenz, P., Hummel, C., Mainik, G., Copula based hierarchical risk aggregation through sample reordering, *Insurance: Mathematics and Economics* 51, 122-133, 2012.
- [2] Côté, M.-P., Genest, C., A copula-based risk aggregation model, *The Canadian Journal of Statistics* 43, 60-81, 2015.
- [3] Shi, P., Frees E.W., Dependent loss reserving using copulas. *ASTIN Bulletin* 41, 449-486, 2011.