Capturing flexible correlations in multiple-discrete choice outcomes using copulas

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Abstract

This paper aims to examine three purchase patterns which frequently occur in multiple-discrete choice situations: joint-purchase, quantity-preference, and quantity-concordance. First, "joint-purchase" refers to the tendency that two products are either purchased together or separately. Second, "quantity-preference" refers to the tendency to purchase a product in preferred amounts. Third, "quantity-concordance" refers to the tendency that purchase quantities of two products are either concordant or discordant. These patterns are mainly attributed to unobserved factors such as economic reasons, habits, time pressure, mood, and/or physical environment. No study has fully incorporated the three purchase patterns simultaneously.

In this study, we develop a unified copula-based approach which can incorporate all the three purchase patterns simultaneously. The proposed approach is so flexible that any copula function or parametric distribution can be used. We use a simulation study to illustrate the trade-off between the Gaussian copula and the FGM copula. We show the Gaussian copula which captures the full range of correlations quickly becomes infeasible as the number of choice alternatives increases. On the contrary, the FGM copula substantially reduces the computational complexity and is scalable to larger dimensions. Furthermore, we extend the range of correlations of the FGM copula at almost no cost by introducing the sine generating function. To show the scalability, we apply this approach to IRI scanner panel data with 13 alternatives. Throughout two empirical studies, we show that the three purchase patterns indeed exist in our data. Moreover, we find that ignoring the three purchase patterns distorts key managerial metrics such as demand predictions and price elasticities. This results in suboptimal managerial decisions regarding peelies promotions, bundling, and package size. Furthermore, we illustrate that managers can improve the profitability of promotions by implementing a joint promotion strategy based on the three purchase patterns.

Keywords: Joint-Purchase, Multiple-Discrete Choice, Cross-category Dependency, Correlation, Copula