

A Probit Model with Structured Covariance for Similarity Effects and Source of Volume Calculations

Source of volume calculations are used in a variety of marketing and economic calculations to measure the origin of demand due to changes in marketing mix variables. A manufacturer considering the introduction of a new product offering, for example, is interested in the extent to which demand is sourced from existing brands in their product line versus competitive brands. Demand sourced from existing brands is detrimental to the profitability of the new entrant, and is often referred to as "cannibalization." An important aspect of source of volume calculations is the ability to accurately predict patterns of substitution among existing offerings. Doing, so, however, is potentially costly in terms of the parameterization of a system of demand. For J offerings, there exists $J^2 - J$ possible cross-effects for any product attribute or price that can change demand for an offering. Economic models are therefore used to reduce the number of parameters needed to characterize demand patterns, with the logit model being the most parsimonious. A logit model can represent demand for J offerings with as few as J parameters – i.e., $J-1$ intercepts for the offerings and one price coefficient. However, as might be expected, this parsimonious representation of a demand system comes at a potential cost of misrepresenting patterns of substitution.

Our model allows for higher rates of substitution among similar offerings through a structured error covariance matrix that relates the magnitude of off-diagonal elements to pair-wise measures of product similarity. The structured covariance matrix is parameterized as a function of observables about the alternatives, much as the deterministic utility component is a function of the alternative attributes. We propose and test alternative measures of product similarity, and show that our model provides a better fit to the data and more reasonable estimates of substitution. An advantage of a structured covariance matrix is that it readily accommodates the introduction of new product offerings in a counter-factual analysis, and allows analysis of demand for choice sets of varying size. These features are important for calculating cannibalization rates due to new product entry. Our model does not require additional data beyond that already used for estimating choice models, and requires just one additional parameter.

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