Modeling Consumer Demand for Variety

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Abstract

Consumers are often observed to purchase more than one variety of a product on a given shopping trip. The simultaneous demand for varieties is observed not only for packaged goods such as yogurt or soft drinks, but in many other product categories such as movies, music compact disks, and apparel. Multinomial (MN) choice models cannot be applied to data exhibiting the simultaneous choice of more than one variety. The random utility interpretation of either the MN logit or probit model uses a linear utility specification that cannot accommodate interior solutions with more than one variety (alternative) chosen.

To analyze data with multiple varieties chosen requires a nonstandard utility specification. Standard demand models in the economics literature exhibit only interior solutions. We propose a demand model based on a translated additive utility structure. The model nests the linear utility structure, while allowing for the possibility of a mixture of corner and interior solutions where more than one but not all varieties are selected. We use a random utility specification in which the unobservable portion of marginal utility follows a log-normal distribution. The distribution of quantity demanded (the basis of the likelihood function) is derived from these log-normal random utility errors. The likelihood function for this class of models with mixtures of corner and interior solutions is a mixed distribution with both a continuous density portion and probability mass points for the corners. The probability mass points must be calculated by integrals of the log-normal errors over rectangular regions. We evaluate these high-dimensional integrals using the GHK approximation. We employ a Bayesian hierarchical model, allowing household-specific utility parameters.

Our utility specification related to the approach of Wales and Woodland (1983) who employ a translated quadratic utility function. Wales and Woodland were only able to study, at the most, three varieties because there was no practical way to evaluate the utility function at that time. In addition, the quadratic utility specification is not a globally valid utility function, making welfare computations and policy experiments questionable. Hendel (1999) and Dube (1999) present an alternative approach in the utility function which is constructed by summing up over unobservable consumption occasions. While only one variety is consumed on each occasion, the marginal utilities of varieties change over the consumption occasions, giving rise to a simultaneous purchase of multiple varieties.

Our Bayesian inference approach allows us to obtain individual household estimates of utility parameters. Household utility estimates are used to compute the value of each variety. We compute a compensating value for the removal of each flavor; that is, we compute the monetary equivalent of the household's loss in utility from removal of a flavor. These calculations show that households highly value popular flavors and would incur substantial utility losses from removal of these flavors from the yogurt assortment.

Next we consider the implications of our model for retailer assortment and pricing policies. Given limited shelf space, only a subset of the possible varieties can be displayed for purchase at any one time. If consumers value variety, then a retailer with lower variety must compensate the consumers in some way, such as a lower price level. We see this trade-off between price and variety across different retailing formats. Discount or warehouse format retailers often have both lower variety and lower prices. To measure this trade-off, we explore the utility loss from reduction in variety and find the reductions in price that will compensate for this utility loss. These price reduction calculations must be based on a valid utility structure.

Heterogeneity in tastes is critical in these utility computations and policy experiments. We find that a relatively small fraction of households with extreme preferences dominate the compensating value computations. That is, some households are observed to purchase mostly or exclusively one variety. These households must be heavily compensated for the removal of this variety from the assortment. In some retailing contexts, customization of the assortment is possible at the customer level. We show that such customization virtually eliminates any utility loss from reduction in variety.

(*Variety; Corner Solutions; Assortment; Translated Utility*)

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