Decomposition Model of the Total Store Purchase and Its Application

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The assumption that single purchase payment and inter-purchase time are independent is inconsistent with the real purchase behavior. Actual interdependency between the two aspects is concealed by the seemingly insignificant correlation coefficient. Hereby, the decomposition of the total store purchase based on the independence assumption could not present the real pattern accurately. Based on the observation and analysis of real consumer purchase behavior, the authors develop a decomposition model with the consideration of the interdependency between single purchase payment and inter-purchase time. Furthermore, the impact of marketing efforts is introduced into the model to see how these efforts affect single purchase payment and inter-purchase time, and therefore total store purchase. An empirical analysis shows the effectiveness of the model on analyzing customer store purchase.

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EXTENDED ABSTRACT

To investigate customers’ purchase behavior, researchers usually decompose the total store purchase (TSP) into the product of average single purchase and patronage frequency within a certain period of time. Previous study holds an assumption that single purchase payment (SPP) and inter-purchase time (IPT) are two independent variables (e.g. Colombo & Jiang 1999; Fader, Hardie & Lee 2005; Schmittlein & Peterson 1994). Though it does not mean that previous researchers believe SPP and IPT are actually independent, the independent assumption is widely used in the analyses of purchase data tendency to keep mathematics tractable.

Instead of using the previous assumption, we propose a decomposition model of TSP based on the assumption that SPP and IPT are interdependent. The new assumption is discreetly examined based on the observation and analysis of consumer purchase behavior. We divide consumers’ purchase behavior into three stages: whether to go shopping or not, which store to go, and finally how much to purchase. With the analysis of these three stages, it is quite clear that SPP and IPT are interdependent. Previous purchase quantity (represented by SPP) and how long it has been last will influence the decision of whether to go shopping or not. If the customer decide to do shopping in the target store, current IPT for the certain store is determined. Then previous SPP and IPT will exert their impacts on purchase quantity decision, thus current SPP is obtained.

However, the interdependency of SPP and IPT could probably be concealed by a seemingly insignificant correlation coefficient. For each customer within a target store, we propose that there exists an upper limit of total demand, the changing of which may lead to insignificant correlation coefficient. If the limit of total demand does not change much, the more SPP is, the longer IPT will be, and vice versa. This is constraint effect of the total demand. But if the upper limit changes, which means a customer focus his/her purchase more (or less) on a certain store, the SPP will increase (decrease) while IPT will simultaneously be shorter (longer). This is called changing effect of the total demand.

A model is developed to manifest the interdependency while decomposing TSP. We use simultaneous equations instead of joint-distribution approach to deal with the mathematical problems (Schmittlein & Peterson 1994). Stochastic models with covariates are used for each equation to capture random factors (Gamma-Gamma model with covariates is introduced for SPP and Exponential-Gamma model with covariates for IPT). With those models, the impact of marketing efforts could also be introduced into the model as covariates. By doing so, this model would explain how those marketing variables affect SPP and IPT separately, and therefore affect the total purchase.

We use our model to analyze customers’ purchase behavior in a certain supermarket. A sample set of 70 households and 720 purchase records is chosen from CTR Market Research’s panel. These records are kept from chain stores of the supermarket within 13 weeks. The result shows that the constraint effect and changing effect of total demand do exist. With the constraint effect, SPP and IPT do not simultaneously change towards the managers’ will. Thus the correlation coefficient of SPP and patronage frequency (PF, PF=Time/IPT) should be negative. However, while the upper limit changes (changing effect), it is possible that the correlation coefficient is insignificant, and this may lead to misunderstanding that SPP and IPT are independent.

With the introduction of marketing variables as covariates, we find that the result is much more useful than directly relate these variables to TSP. The result shows different impacts of a marketing variable on SPP and IPT. When we use a marketing strategy, we should carefully investigate both what it does to SPP and what it does to IPT. If we only keep eyes on a general result, it may mislead our decision making or incline us to miss a certain valuable commercial opportunities. Thus, with our model, the effects of these marketing variables on TSP are also decomposed, and more useful information could be used for research and decision making.

In conclusion, our interdependency assumption focuses on customers’ real purchase behavior, rather than on the analysis of data tendency. We prove that SPP and IPT are highly interdependent. Using correlation coefficient is not a reasonable way to tell whether SPP and IPT are independent or not. The model we develop meets the requirement that the interdependency of SPP and IPT should be incorporated in a TSP decomposition model. Furthermore, our model is able to take marketing variables into consideration, and decompose their effects on TSP.

References


