Journal of Business and Organizational Development *Volume 3, December 2011*

ANALYSIS OF CONSUMERS DEPTH OF REPEAT PURCHASING PATTERN: AN EXPLORATORY STUDY OF BEVERAGES BUYING BEHAVIOUR DATA

Akomolafe A.A
Department of Mathematics and Statistics
Joseph Ayo Babalola University, Ilesa, Osun State
E-mail: akomolafea@yahoo.com

ABSTRACT

Existing research on tracking relied on cumulative buying behavior data. In order to provide a significant improvement to the degree of prediction and its acceptability, depth of repeat buying behavior was used as a remarkable improvement thus showcasing the instability of consumer buying behavior. The model was developed and maximum likelihood estimation techniques was used to estimate parameters from the data culled from standard wholesales outlets of beverages. Result from the empirical test about the structure of repeat buying for the new packaged goods. The findings provide a foundation for test-market forecasting and offer much stronger support for the model's validity than a single cohort analysis can provide.
Keywords: Consumer buying behavior, depth of repeat, maximum likelihood estimate, forecasting

INTRODUCTION

Measure of depth of repeat of buying behavior has drawn people's attention from different filed of academic Endeavour. The dramatic changes that took place some years back led to changes in the way that rate of buying measure are viewed and utilized. The high proportion of buyers, a pattern very similar to what has been observed for a variety of offline behavioral patterns are still in a state to transition. However these is also an account view of the actual trends in buying behavior shoppers who have had the opportunity to make more buying in a fixed period of time will by definition have shorter average inter visit times than those shoppers for whom we could only observed a small number of visits in the same time interval. Buying research as an integral part of organizational marketing research can be defined as the system who model building, data gathering analysis and interpretation for the purpose of improvement decision making in the marketing of goods and services. However, repeat purchasing develops gradually with attrition continuing to occur among customers even often they have bought a new brand. Several times Tauber (1977)suggest that "this wear out phenomenon is probably due t the factors such as boredom after continual use eventually resistance to price, or the consumers need to use a product a number of times to be able to tell if It really fits their needs. Knowledge of such adoption phenomenon is the foundation for analytical effects directed toward the assessments of the new brands prior to test marketing (silk and urban 1978:tanber1977) and the subsequent forecasting of sales for early test market results. Building on the ideas put forth in Eskin's depth of repeat model Eskin 1973; Eskin and Kalwani 1980,Eskin and Malek 1976, have reported progress in understanding the process of how repeat buying develops .Models on the evolution of the proportion of repeat buyers where the attrition pattern of previous buyers occurs systematically from the first trial onward and is described by a simple decay function. Eskin and Malec (1976) further postulate that the frequent of purchasing remains unchanged after the first repeat. The key implication of this hypothesis is that the ongoing sales of package goods can be obtained from knowledge of cumulative proportion and then purchase frequency over a period of time.

Analysis and empirical findings on the structure of repeat buying for new packaged goods was critically examined in this paper. The depth of repeat models is used to analyses the structure of repeat buying. The objective is to compare the time paths of the cumulative proportions across various repeat levels. Models parameter estimated by a maximum likelihood method are used to test hypothesis related to these questions we desire the depth of repeat model when time is treated in discrete intervals and also we establish that the continuous analog of the discrete model is a familiar stochastic model based on a Beta Binominal /Beta -Geometric model. Result from the empirical test for beverages products are examined, and the implications of these result for consumer research on new packaged goods are discussed.

METHODOLOGY

Our analysis of repeat buying follows the work of Fourt and wood lock 1960, Massy 1990 and Eskin (1973)Eskin and Kalwani 1980, depth of repeat\te classes are defined as the penetration or cumulative proportion of consumers who repeat a j^{th} time (J=1,2,3,…….) given that they had previously made J-1 repeat purchases. Note that the repeat class (or level) J=1 refers to first repeat the repeat class J=2 refers to second repeaters and so on for higher repeat levels. Two postulates underline the penetration model proposed by Fourt and Woodlock(1975). First, there is a coiling on the proportion of consumer who converts from one repeat class to the next. Second the number of consumers who enter the next repeat level in each time period is a constant fraction of the remaining consumers who will eventually convert into the next class evidence to support both of these postulates.

Considering repeat level J where J=1,2,3 given the preceding two postulates it follows that the proportion of consumers P(c) who convert into the modeled repeat level j during the C^{th} time period is given by $P(c)=F(C) - F(C-1)$

$$=(1-e)(\alpha-F[C-1])\text{--------------(i)}$$

When F(C) is the cumulative proportion of consumers who convert into a particular repeat level, J by the C^{th} time period since their previous purchase the cumulative proportion who will eventually convert into the repeat class J, thus α represent the penetration

Solving equation (1), recursively

[With F(0)= (0)], one obtains

$P(C) =[1-e][\alpha-F(c-1)] = \alpha e^{c-1}[1-e]$----------(2) C=1,2,3,………

$P(C)=\sum_{L=1}^{C} \alpha e^{C-1}[1-e]\alpha(1-e^{c})$--------(3) C=-------1,2,3,……

An examination of the preceding expressions' for P(c) and F(c) reveals that the purchasing behavior of consumers who enter repeat class J is given by a geometric distributions. The average inter-purchase time ϒ of these consumers who will eventually convert into some repeat level J is given by

$$E(C)=\Upsilon \quad = \frac{\sum_{C=1}^{\infty} C\alpha e^{C-1}[1-e]}{\sum_{C=1}^{\infty} \alpha e^{C-1}[1-e]}$$

$$=\left[\frac{1}{1-e}\right] \text{----------(4)}$$

Which can be rearrange as

$$e= \left[\frac{\Sigma-1}{\Sigma}\right] \text{----------(5)}$$

The expression for inter purchase time given in equation 4 is based on the assumptions that data on conversions into the j^{th} repartee level are available over an infinite period of time. In practice however the period over which conversion rates are observed u bound to be limited, if we assume that the conversion for T periods, the expression for average inter purchase time Υ_T becomes

$$\Upsilon_T= \left[\frac{1}{1-e}\right] - \left[\frac{Te^{T}}{1-e^{T}}\right] \text{---------- (6)}$$

hence the average inter purchase time Υ_T for truncated data is smaller than the theoretical average inter purchase time , Υ.

Empirical evidence, however indicates that the first trial into other repeat trials tend to be heavier(Eskin 1973;Fourt and Woodlock 1960;Massy 1969;Partitt and Collins 1968). Fourt and Woodlock note that the estimated penetration level based on equation (3) fit the date well except that the predictions for long time period or repeated trial periods tends to be too low. The poor fit is attributed to heavier buyers.

The addition of a trend factor, Υ, provide for this level of penetration which leads to the adjustment as shown in equation(2)and (3) si shown below

$$P(C) = \alpha e^{c-1}[1-e] + \delta \text{---------(7)}$$

$$c=1,2,3,\text{----}$$

$$F(C) = \alpha(1-e^{c})+\delta c \qquad c=1,2,3,\text{----}$$

This modification allows the ceiling to be a linear function of time instead of a fixed quantity. The expression for a given average inter purchase time given a finite observation time period,T_2 now becomes

$$\tau_T^{\delta} = \left[\frac{\sum_{C=1}^{T} C\alpha e^{C-1}[1-e]+\delta}{\sum_{C=1}^{T} C\alpha e^{C-1}[1-\delta]+\delta}\right] \text{--------- (9)}$$

$$= \frac{\alpha\left\{\frac{1-e^{T}}{1-e} - Te^{T}\right\} + \frac{\delta T(T+1)}{2}}{\alpha(1-e^{T})+\delta T}$$

Empirical evidence presented his Fouth & Woodluck (1960), Akomolafe and Amahia (2010) and Eskin Fisher(1999) suggest that the numerical value of the "stretch out "factor, δ, is very small in compares with the conversion proportion term, α. Therefore the effect of the δ term in equation (a) is likely to be minor especially when the observation period over which the purchase data are available is of limited duration(say12 or 24 weeks). The continuous type of the discrete depth of repeat model is the familiar negative binomial model, the density function time to conversion into the jth repeat class if distributed as a negative exponential which assumes exponential distribution inter purchase time that is equivalent to a poisson distribution of purchase events across successive time periods of equal length as shown below.

$F(t) - \lambda e^{-\lambda t}$-------- (10) $\lambda > 0$

If we assume that the mixing distribution of λ is gamma, with μ as the scale parameter and V as the slope parameter, the expression for $F(t) = \frac{V}{\mu}\left(\frac{\mu}{\mu+t}\right)^{r+1}$----------(11)′ and

$F(t) = 1 - \left(\frac{\mu}{\mu+t}\right)^{r}$------ (12)

A refreshment of this model allows for a "zero group" of consumers who are not in the market for the new product and to be excluded from the relevant population.The expression for f(t) and F(t) with this modification are given by

$F(t) = A\frac{V}{\mu}\left(\frac{\mu}{\mu+t}\right)^{r+1}$-------- (13)

$F(t) = A\left\{1 - \left(\frac{\mu}{\mu+t}\right)^{r}\right\} - - - - - - - (14)$

Penetration estimates from equation (14) are compared hereafter with those from the discrete case as in equation (8) to show whether the latter model performs as well as the continuous model.

Source of data

The results reported are based on an analysis of purchase data for four new products (yogurt, vanilla, bottled Pepsi and Can Pepsi). The source of purchase information is secondary data culled from the sales record of the above products. The observation covers twelve months period after its introduction to the market. Findings are reported only for those repeat levels where the sample sizes are at least 30.

Parameter Estimation

Maximum likelihood methods were used to estimate model parameter for each repeat level. It is well know that under very general regularity conditions, maximum likelihood estimates are best asymptotically normal i.e. they are consisted, asymptotically normal and asymptotically efficient in addition, maximum likelihood is invariant. The difficult with using the maximum likelihood method is that it is not possible to obtain a closed form analytical solutions . Therefore numerical optimization Is required to obtain the maximum likelihood estimate, for the purpose we used a general optimizing procedure developed by kalwaui and silk (1994). The likelihood expression that is maximized is determined by the following procedure. Considering any one of the repeat levels, J. let n_c denote the number of consumer who enter repeat level J during the C^{th} time period since their previous purchase. Furthermore, let n_c denote the number of consumers who had C time period available to convert into the j^{th} repeat level but did not do so. Then

$\sum_{c=1}^{52} \bar{n}_c = (m - n)$

Denotes the total number of consumer s who have not entered the repeat class J given that , altogether, m consumers made (J-1) purchases of the new product.

The likelihood expression given purchase da $n_{\mathbb{C}}$ and $\bar{n}$ for , say $\mathbb{C} = 1, \ldots\ldots\ldots .52$ is given by

$(n_{\mathbb{C}}\ s, \bar{n}_{\ c}, s; \alpha, e, \delta\,)$ ------- (15)

$\prod_{c-1}^{52}(p[c])^{n_{\mathbb{C}}} \prod_{c-1}^{52}[1 - f(c)]^{\bar{n}_c}$

Table 1 (yoghurt drink)

		Parameter estimates		
Repeat level	Sample size	α	e	δ
1	134	0.5410	0.9394	0.0001
2	86	0.6786	0.9474	0.0000
3	66	0.7116	0.9446	0.0018
4	49	0.7560	0.9363	0.0000

Table 2 (Vanilla Ice Lolly)

		Parameter estimates		
Repeat level	Sample size	α	e	δ
1	64	0.3929	0.9264	0.0000
2	39	0.5378	0.8928	0.0014
3	31	0.7991	0.9042	0.0000

Table 3 (Pepsi Drink)

		Parameter estimates		
Repeat level	Sample size	α	e	δ
1	118	03027	0.8264	0.0025
2	75	0.6191	0.8837	0.0014
3	54	0.7605	0.9190	0.0000

Table 4 (Can Pepsi Drink)

		Parameter estimation		
Repeat level	Sample size	α	e	δ
1	150	0.6425	0.9235	0.0000
2	99	0.6694	0.8852	0.0014
3	72	0.8092	0.8755	0.0003

Where

$P(c) = \alpha p^{c} (1\text{-}e) + \delta$

$F(c) = \alpha (1\text{-} e^{c}) + \delta c$

The left side of equation (15) represent the joint probability of funding n_c (c=1,2,3,------- 52) consumers who converted into the jth repeat class written C time period of them previous purchase. Similarly the right side forms the joint probability of observing that $\bar{n}_c(L = 1,2,- - - - - -52)$ consumers failed to enter repeat class J within C time periods of their previous purchase.

RESULT AND FINDINGS

Maximum likelihood estimate of parameter, displayed in the tables 1-4 are the basis for evaluation of the three parameters. The first in the parameter e would be approximately the same across repeat levels for each of the four new products. For yoghurt, which has the largest sample size, table review very little variation across the four repeat levels with the estimated $e^{/S}$ flunctuating around 0.94 the result for vanilla (table 2)and the two Pepsi brand (table 3 and 4) appears less consistent but the variability is still slight. The range of the estimated **e's** for these three product ranges between 0.88 and 0.93. However some variation in **e** is expected for the two Pepsi because **e** is related to the inter purchase time, which is affected by variations in the consumptions of Pepsi. The second parameter **δ** would be approximately the same across repeat levels for each of the four products. Result show that the estimated value of **δ** is small, generally less than 0.2%, which is consistent with the empirical experience of fourth and Woodlock (1960).
The last parameter **α** js concerns the proportion terms. On the basis of the result we postulate that these terms will increase systematically to α_∞ which is expected to be slightly less than unity. The maximum likelihood estimate of the αj terms for the four new products are shown in *table 1* through *table 4*. Though the specific estimate of α_2,α_3 and α_4 for yogurt drink in *table 1* f the **αj's** are not exactly equal to the hypothesized value they do exhibit a non-decreasing pattern . table 5 show the differences between estimated and hypothesized value of the **αj's**. Note that the deviations are all within approximately 10% of the hypothesized value.

Finally, we compare penetration for time intervals (since last purchase) of 12, 24, 36 and 52 weeks. The estimated penetrations based on the discreet and unconstrained version of the continuous models are very close to the actual penetration level. The result shown in table 6 relate to the good news of fit rather than the predictive accuracy of the discrete and continuous models. These results indicate that the discrete models which have parameter that are easier to interpret and it provides a fit as good as that of the unconstrained continuous models. The two key parameter of the discrete model are **e** and **α**. The parameter e is directly related to average inter purchase time, and the parameter **α** simply represents the cumulative proportion of consumers' who convert from a given repeat level to the next one.

Table 5: ***Difference between estimates and hypothesized values of αj's***

		Observation –hypothesized value			
Parameter	Hypothesized value	yoghurt	vanilla	Bottled Pepsi	Can Pepsi
α_2	0.60	0.0786	-0.0622	0.0191	0.0694
α_3	0.74	-0.0284	-0.0409	0.0205	0.0692
α_4	0.84	-0.0840	-	-	-

Table 6: ***Observed and estimated penetration (%) for Yoghurt***

	Estimated (T=12 weeks)			Estimated (T=24 weeks)			Estimated (T=36 weeks)			Estimated (T=52 weeks)		
Repeat level	observed	Dis	Cout.	Observed	Dis	Cont	observed	dis	cout	observed	Dis	Cout.
1	30.3	28.7	28.8	43.3	42.2	42.2	48.8	48.8	48.8	52.8	52.5	52.8
2	32.8	32.4	32.6	50.7	49.3	49.2	56.2	58.2	56.1	64.2	63.8	64.2
3	36.0	37.4	37.4	59.3	57.4	57.4	67.4	68.5	68.4	76.7	76.8	76.7
4	43.3	41.3	41.5	62.7	60.0	60.0	68.7	68.5	68.4	73.1	73.1	73.1

A total of 28.7% of first purchasers entered the first repeat class with 12 weeks of trying the new product.

CONCLUSIONS

Maximum likelihood estimate of the model parameter were developed from four new packaged goods and compared for consistence with the hypothesize patterns. The first hypothesized product that for a new given product a measure of average inter purchase time would be constant across repeat level overall, the parameter estimate contained are found to be consistent with these hypothesis-especially in the case of yogurt as to lesser but still supportive degree for the other three brand. The parameter **δj** displays little variation across repeat levels and further, is magnitude is generally found to be very small. The hypothesis carries important implication for the tasks of making either pre-test market or early test market forecast of the time path and equilibrium level of penetration for new brands. Given that there hypothesis about the repeat buying hold, it follows that penetration level for various repeat classes depend primarily on the factors. The average inter purchase time of existing brand by examining the inter purchase times of existing brand in the product class.

REFERENCES

Ehrenberg, A.S.C (1959)"the pattern of consumer purchases" applied statistic,8,26-41.

Eskin, Gerald J;(1973)" dynamics forecasts of new product demand using a depth of repeat model," journal of maketing research,10(may), 115-29

Fourt Louise A and Joseph w. woodlock (1960)"early prediction of market success for new grocery product "journal of marketing, 24(October 31- 8)

Kalwani, M.u.(1975)"zero-order models: specification data requirement and estimation unpublished ph.d dissertation graduate school of business, columbis university.

Massy, William F (1869)"forecasting the demand for carencence products" journal of marketing research, 6(November 0, 4015-12)

Rear fih, J.H and B.J.K Collins (1968)"use of consumer panels for brand-share prediction, "journal of marketing research, 5(may) 131-45

Slik, aluumi j And Glei.L. urban (1978)"pretect- market evaluation of new packaged goods; a model and measurement methodology" journal of marketing research 15(may), 171 – 91

Tauber, Edward m. (1977),"forecasting sales prior to test market" journal of marketing .41(January), 80 – 4.