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Cyclical patterns in brand switching behavior: An issue of pattern recognition

Moshe Givon and Eitan Muller

The Leon Recanati Graduate School of Business Administration, Tel Aviv University, Tel Aviv 69978, Israel

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Abstract: Cyclical patterns which repeat themselves periodically in consumers' purchasing habits are investigated in this paper. The phenomenon is explained and studied empirically using consumers panel data. It is found that most consumers do have a recognizable pattern. Prediction based on cyclical behavior is found to dominate the zero order process.

1. Introduction

There is abundant empirical evidence in the marketing literature that consumers buy different brands from the same product class (e.g., Wind, 1977; Bass et al., 1984). Many reasons exist for individuals to vary their choices among brands along time, and to buy multiple brands. McAlister and Pessemier (1982) provide an extensive taxonomy of motives for varied consumption behavior. These range from needs for social distinction and affiliation, to psychological needs, market changes and constraints (e.g., changes in the feasible set and stockouts) and marketing mix activity (price changes, deals, advertising).

Yet, consumers switch among familiar alternatives even in the absence of external effects. Curiousity (Berlyne, 1954) and boredom (Givon, 1984) lead to variety seeking. Attribute satiation (Jueland, 1978; McAlister, 1982) and the need to balance among different needs and attributes (Lancaster, 1966; Farquhar and Rao, 1976; Lattin, 1987) lead consumers to alternate among brands in order to achieve a desired combination of attributes that may not exist in any one brand. Every individual has an ideal point in a product attributes space that represents this desired combination. Some consumers may find this combination in one brand and always buy this same brand. These are the so-called brand loyal consumers. Yet, others need to combine brands in certain proportions to arrive at their ideal point. This need to vary brand choices leads consumers to purchase brands in sequences of repeating patterns, that appear like cycles to observers of purchase data. Thus, the theoretical notion of ideal point gives rise to an empirical notion of ideal cycle. The main purpose of this paper is to provide a simple and efficient method to *recognize these cyclical patterns*, and to evaluate empirically how prevalent they are.

Most models of brand switching behavior yield estimates of parameters that represent tendencies of consumers to switch among brands. Yet, for most product line decisions the collection of brands purchased by the consumer, their relationships and the consumer tendency to adhere to a cyclical pattern are of crucial importance. They help determine brands competitiveness and desired positioning, as well as segment consumers by their preferred brands and their vulnerability

Correspondence to: Dr. M. Givon, The Leon Recanati Graduate School of Business Administration, Tel Aviv University, Tel Aviv 69978, Israel.

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to marketing mix activity (Blattberg and Sen, 1976; Blattberg et al., 1978).

For the purpose of this study we distinguish between two types of brand switching: a) *structural switching* which leads to a recognizable cyclical combination of product attributes. This type of switching behavior is expected to persist even without any external effects. However, it may be interrupted by b) *transient switching* that is caused by shocks to the environment, like promotional activity, new brands and stockouts. An observed purchase sequence is a result of these two types of switching behavior. Our purpose is to parcel out the structural pattern from the transient switching and identify different types of cyclical patterns and the tendency of consumers to adhere to them in the face of external marketing activity.

Different stochastic models were offered to describe brand switching behavior. The most popular models are the 1) zero order model, 2) first order Markov model and 3) linear learning model. Givon and Horsky (1979) showed that consumers are heterogeneous in their switching behavior and different ones can be better described by each of these models. The main difference among these models is in the assumption about the length of consumers memory and the effect of past purchases on future ones. The zero order model, which has been demonstrated by Bass et al. (1984) to be a good description of switching behavior of a large proportion of consumers, assumes that previous brand choices are not remembered and have no effect on future choices. The first order Markov model (e.g., Givon, 1984; Lattin and McAlister, 1985; Kahn, Kalwani and Morrison, 1986) assumes that only the last brand choice is remembered and has an effect on the next brand choice. In a recent paper Bawa (1990) suggested a model with variable memory, in which consumers remember only purchases of the last run, that is, consecutive purchases of the same brand. All these models try to predict the next brand choice from past choices and yield estimated tendencies of purchase reinforcement. In contrast, the concept of ideal cycle looks for a *core group* of brands and their proportional relationships. While a precise form of structural switching is offered in the next sections, it is clear that the length of consumers' memory does not have to be larger than twice the length of their cycle. One cycle length is reserved for the ideal cycle and one for the purchases already made in the last cycle.

In the next section we specify two mechanisms by which the consumer can implement the desired cycle. The third seciton presents an empirical procedure to identify cyclical purchase patterns and the results of its application to consumer panel data. In the fourth section we present a simulation to assess the predictive ability of the model and compare it to that of the zero order model. We conclude with implications of our findings and suggestions for further research.

2. Cyclical choice models

The ideal point model is a satisfactory representation of consumers who are brand loyal. They can be either 'high brand loyal' where the proportion of purchases devoted to the favorite brand is very high, say 90%, or 'brand loyal', who occasionally switch, because of any number of transient reasons and then quickly return to the favorite brand (see Blattberg and Sen, 1976). However, purchase diaries reveal that most consumers switch among a few brands regularly. For these consumers this interpretation of the ideal point model seems quite inappropriate. For example, Bass et al. (1984) bring information on ten food categories from diary panel data over a one-year period. They found that in nine categories the number of households that always buy the same brand is less than 5% of the total sample. Only regular coffee had 24% brand loyals. The average number of brands bought per family was from a low of four for regular coffee up to 14 brands for ready-to-eat-cereal.

Consumers can use two competing procedures to achieve their desired cyclical purchase patterns. We denote one as a 'bundle' mechanism and the other as 'sequence' mechanism. The theory, however, tells us little as to which is the one likely to be followed. In Section 4 we check empirically to see the predictive ability of each mechanism.

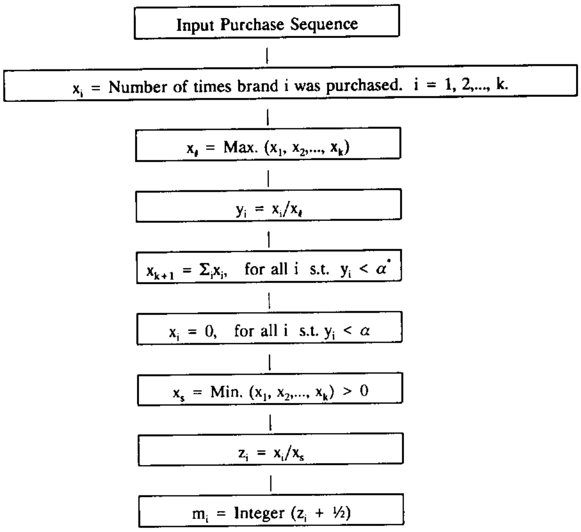
A *sequence* mechanism is one in which at every single purchase the consumer is trying to bring his past purchases to a perfect ideal cycle. For example, if a consumer whose cycle is [1,1,1,2,2,3] bought in his most recent purchases brands 1, 1, 2, 2, 3, then the next purchase is brand 1 (with probability 1.00). Thus, the consumer with a cycle length of k purchases considers his ideal cycle and the last $k-1$ purchases. He will next purchase the unique brand that will complete together with the last $k-1$ purchases the ideal cycle, or as close as possible to it.

A *bundle* mechanism is one at which the consumer is occupied with the current cycle only. When a cycle has been completed and a new one starts, the next purchase is a random event with probabilities proportional to the weights of the brands in the ideal cycle, e.g., $\frac{1}{2}$ for brand 1, $\frac{1}{3}$ for brand 2 and $\frac{1}{6}$ for 3 for the previous consumer with ideal cycle [1,1,1,2,2,3]. If for example the first choice was 1, then the next purchase is a randome event with probabilities $\frac{2}{5}$ for brand 1, $\frac{2}{5}$ for 2 and $\frac{1}{5}$ for 3. Thus, the consumer remembers the ideal cycle of length k and the number of purchases already made in the current cycle (say n). The next purchase is a random event with probabilities specified by the ideal cycle and the previous n purchases (or alternatively by the $n-k$ remaining purchases).

3. Empirical identification of cyclical patterns

The hypothesis of cyclical patterns of brand switching implies that a chronological sequence of purchased brands can be broken into similar (ideally identical) parts that repeat themselves in a cyclical manner. *The information contained in a cyclical time series can be completely conveyed by a detailed description of its shortest unit that repeats itself – a cycle.* Knowledge of the structure of this unit in terms of number of purchases per cycle, brands of which it consists, and the relative frequencies of these brands within a cycle enables prediction of the time series in terms of these units. The shorter these units are, the more detailed the prediction can be. Thus if a cycle is ten purchases long, prediction can be made in batches of ten purchases, without any information on the order of occurrence of these ten purchases. If the primary cycle is of three purchases only, a more condensed amount of information enables more accurate description and prediction – every batch of three purchases rather than ten can be detailed. In the extreme case of cycle length of one purchase, one bit of information – the brand name – is all that is needed to detail the whole purchase sequence. This is the known case of brand loyal consumer. Thus in the interest of parsimony and accuracy a cyclical pattern should be defined by the shortest recognizable cycle.

To identify these cycles a simple algorithm was developed based on the principle that the least bought brand will appear in every cycle just once, thus determining the length of the cycle. All other brands will appear in a cycle in the same proportion as they appear in the whole sequence of purchases relative to the least bought brand. Recognizing the transient component of switching, we modified this principle by first 'cleaning out' all brands that were purchased less than a certain percentage of times relative to the most bought brand. Four percentage levels were tried: 10, 5, 3 and 1. All the 'cleaned out' brands were grouped together in what is called the 'transient brand'. Following this 'clean out' procedure the principle mentioned above was applied to identify an expected cycle based on the whole sequence of purchases. In case a cycle existed in more than one 'clean out' percentage level, the best cycle was chosen by the modified chi-square statistic which is discussed below. In most cases where a cycle exists, it existed in the 10% case. The algorithm for identifying the cycle is described in Fig. 1.



*Values tried for α were 0.1, 0.05, 0.03 and 0.01

Fig. 1. Purchase cycle algorithm.

Despite the 'clean out' procedure, the effect of transient factors is not likely to be completely eliminated, since brands that are part of the permanent pattern may also be affected by transient factors. This fact will present itself in deviations from the expected cycle identified by the algorithm. Thus the conformity of the cycles in a sequence to the expected one based on this sequence was tested statistically. This test is essentially the same as the test of homogeneity of parallel samples suggested by Rao (1965, p.332). Instead of the traditional chi-square, a statistic suggested by Shields and Heeler (1979) which is especially suited for analysis of cells with sparse values was used,

$$\Lambda_s = 2\left[\sum_{ij} \ln(n_{ij}!) - \sum_{ij} \ln(m_{ij}!)\right],$$

where n_{ij} is the observed frequency of the i-th brand in the j-th cycle and m_{ij} is the expected integer under the null hypothesis. For the case at hand a 'cell' corresponds to a brand, and $m_{ij} = m_i$ are the frequencies computed by the algorithm. Λ_s is distributed asymptotically as chi-square with the same number of degrees of freedom as in the case of homogeneity test, (number of brands -1) $\times$(number of cycles -1), except for an adjustment due to sparse cells. One degree of freedom is deducted for every two cells for which the expected frequencies are zero or one. Note that the order of brands purchased within a cycle is not important in this test since the statistic used involves frequencies only. Thus, if the consumer intended to buy one brand but because of some special promotion or deal bought another brand, he will purchase the former in the future in order to maintain the desired balance among all brands belonging to his evoked set. In the cycle specification the brand order is irrelevant.

This procedure was appllied to data from the Chicago Tribune panel, which was maintained by the newspaper during the late fifties and early sixties. As in Blattberg and Sen (1976) only heavy buyers with 30 or more purchases were considered.

The data are broken down to five major categories: Aluminum foils, Facial tissues, Cold remedies, Liquid detergents and Waxed paper. An aggregate description of the data is given in Table 1.

Table 1
Description of the product categories

Product category	Years of panel	Number of panel households	Number of 'heavy purchasers' households
Aluminum foil	1960–1966	384	59
Cold remedies	1959–1961	771	59
Facial tissues	1958–1961	809	170
Liquid detergent	1959–1961	751	186
Waxed paper	1963–1966	873	50

Some typical patterns that have emerged are discussed below. The first example in Table 2 of consumer No. 863, is that of an almost perfect cycle of two brands appearing in equal proportions in the cycle. Even in this simple case two observations can be made: 1) The order of appearance in the cycle does not matter. The cycle is (3, 4) and thus whether the consumer bought the brands in the order of 3, 4 or 4, 3 or simultaneously is irrelevant. 2) Even though no other brand was bought by the consumer this is less than a 'perfect' cycle since there are some deviations from the cycle (3,4), for example cycles 3 and 10 are (3,3) and 9 and 11 are (4,4).

Table 2
Cyclical purchase patterns

Cycle number	Brand code	
	'Almost perfect' cycle [a]	Short cycle [b]
1	4,3	8,1,1
2	4,3	1,1,1
3	3,3	8,1,1
4	4,4	1,8,8
5	3,4	1,1,1
6	3,4	8,1,8
7	3,4	1,1,1
8	4,3	8,1,1
9	4,4	8,2,1
10	3,3	1,1,8
11	4,4	1,1,8
12	3,4	1,1,8
13	3,4	
14	4,3	
15	4,3	
16	4,3	
17	3,4	
18	3,4	

[a] Consumer No. 863; Liquid detergent category; Cycle length = 2; cycle = {3,4}.
[b] Consumer No. 2186; Waxed paper category; Cycle length = 3; cycle = {8,1,1}.

The rest are examples of a short cycle, a long cycle with a large number of brands, a long cycle with a small number of brands, a loyal customer and a vulnerable one. The short cycle example is given in Table 2, consumer No. 2186. The cycle is (8,1,1) and out of the 12 cycles, 6 conform precisely to this pattern. The rest have one brand out of the three being 'out of phase'.

In Table 3, consumer No. 310 has no cycle with a perfect match to the predicted ideal cycle. However, out of the seven cycles, there are five with one or two transient purchases which are enclosed in parentheses.

Consumer No. 505 had 45 purchases of Aluminum Foil. The 29th and 39th purchases were of brand 2 and the rest of the 43 purchases were of brand 1. The difference between this consumer and consumer No. 2047 in Table 3 is in the number of times brand 2 was bought. For consumer No. 505 the number is too small to fall into a pattern, thus the consumer is classified as a brand loyal. Consumer No. 2047 bought brand 2 frequently enough to be considered an integral part of a cycle and thus the consumer is classified as a purchaser with a two brands cycle. The classification was done according to the modified chi-square test as explained earlier.

The 'transient brand' was defined as all the brands which were purchased less than 10 (5, 3 or 1) percent of the times relative to the most frequently bought brand. In all the above examples, the 'transient brand' was infrequent enough to be excluded from the cycle. However, sometimes the transient brand appears frequently enough and regularly enough to be part of a cycle. This is demonstrated for consumer No. 1142 of Waxed papers where brands 5, 6, 8 and 9 are grouped together as the 'transient brand' (X). Out of the four actual cycles, there are two with two purchases being out of cycle and two with one purchase out of cycle, as can be seen in (Table 4).

Table 3
Cyclical purchase patterns

Cycle number	Brand code	
	Long cycle with many brands [a]	Long cycle with few brands [b]
1	6,2,3,1,2,3,1,1,(1) [c]	(3),(3),2,1,1,1
2	1,1,3,6,3,(5),(3),4,1	(3),1,1,1,1,1
3	3,1,6,2,1,4,(4),(8),1	1,1,1,1,1,(1)
4	4,3,1,3,(4),2,2,3,1	1,2,1,1,1,1
5	1,2,1,1,(5),2,4,(1),(2)	1,1,1,2,1,1
6	2,3,6,2,1,(6),1,(2),(6)	1,1,1,1,1,(1)
7	1,1,2,4,2,1,6,(2),3	1,1,2,1,1,1
8		1,1,1,1,1,(1)
9		1,1,1,2,1,1
10		1,1,2,(2),1,1
11		2,1,(2),1,1,1
12	2,(2),1,1,1,(2)	

[a] Consumer No. 310; Wax paper category; Cycle length = 9; Cycle = {1,1,1,2,2,3,3,4,6}.
[b] Consumer No. 2047; Aluminum foil category; Cycle length = 6; cycle = {1,1,1,1,1,2}.
[c] Transient purchases in parentheses.

Table 4

Actual cycles	Predicted ideal cycle								
	1	1	1	1	1	1	4	X [a]	X
1	1	1	1	1	1	(X) [b]	4	X	X
2	1	1	1	1	1	(X)	(X)	X	X
3	1	1	1	1	1	(4)	4	(4)	X
4	1	1	1	1	1	1	4	(1)	X

[a] X designates the transient brand (5, 6, 8 and 9).
[b] Parentheses around a given brand indicate a purchase out of cycle.

In this case the predicted ideal cycle is 6 times brand 1, once brand 4 and twice any brand out of brands 5, 6, 8, 9. Consumer 1142 demonstrates another phenomenon: if, for some reason, the desired pattern is not achieved in one cycle, the following cycle or cycles compensate for it to maintain an overall balance. In cycle 2 one purchase of brand 4 was missed and replaced by X. This was compensated in cycle 3 where the reverse occurred. As previously mentioned, to predict single purchase is much more difficult than predicting a cycle of 10 purchases. Indeed, one of the results of the simulation study reported in the next section is that while the average correct prediction for a single purchase is about 25%, the average correct prediction for a full cycle is about 75%.

The results are summarized in Table 5. As can be seen, cyclical pattern is indeed common. Altogether more than 60% have some kind of cyclical pattern. In some product catergoires this number is as high as 75% of households.

4. Model's prediction

The main thrust of this paper is to develop a model to identify cyclical patterns and report

Table 5
Summary of results

	Percent loyal	Percent with cycle	Percent without cycle	Total number of house-holds [a]
Aluminum foils	23.7	45.8	30.5	59
Cold remedies	1.7	74.6	23.7	59
Facial tissues	11.8	42.3	45.9	170
Liquid detergents	15.6	39.2	45.2	186
Waxed papers	40.0	44.0	16.0	50
Total	16.0	45.4	38.6	524

[a] Households for whom the chi-square was insignificant at 10% or more were classified as having a cyclical purchase pattern.

their ubiquity. Still, one would like to check the predictive ability of the ideal cycle model and compare it to a commonly used model. We chose to compare the ideal cycle model to the zero order model because of its wide acceptance (Bass et al., 1984) and because both models are based on proportions of brands purchased. In addition, one would like to compare the predictive ability of the two mechanisms discussed in Section 2, i.e., bundle vs. sequence. These objectives were achieved by comparing simulated predicted purchase sequences to actual ones.

The simulation was done as follows: in the liquid detergent catergory about 39 percent of the consumers were following a nontrivial cycle, i.e., a recognizable cycle of length greater than 1, see Table 5. A zero order process was simulated for each of these 73 consumers. The probability of a brand being chosen was set as the relative frequency of its appearance in the full diary of purchases of the consumer. In the ideal cycle model two mechanisms were chosen: In the bundle mechanism, weights of the brands in the ideal cycle determine the probabilities of the first purchase in the cycle. The probability of a brand being chosen in subsequent purchases within the cycle is the number of times the brand appears in the ideal cycle minus the number of times it was already bought in the cycle, divided by the number of purchases left to complete the cycle. The sequence mechanism is almost deterministic. In each purchase brand is chosen so that together with the last $k-1$ purchases it completes the ideal cycle of length k. Thus, the brand chosen is one such that the difference between its appearance in the last $k-1$ purchases and predicted appearance in the ideal cycle is maximal. If there are two such brands, one of them is chosen randomly.

As an example, consider the second cycle of consumer 2186 in Table 2, i.e., the fourth, fifth and sixth purchases. The ideal cycle of this consumer is (1,1,8). The zero order model would predict that in each of these purchases, brand 1 will be chosen with probability of $\frac{24}{36}$, brand 8 with probability of $\frac{11}{36}$ and brand 2 with probability of $\frac{1}{36}$, since these are their respective relative frequencies in the sequence of 36 purchases.

In the ideal cycle model, the bundle mechanism would predict in the fourth purchase that brand 1 will be chosen with probability $\frac{2}{3}$ and 8 with probability $\frac{1}{3}$, since the ideal cycle is (1,1,8). If 1 is chosen then the fifth purchase prediction will be 1 or 8 with probability of $\frac{1}{2}$ each,and the last purchase prediction is deterministic being 8 if 1 was chosen in the fifth purchase and 1 if 8 was chosen.

If the sequence mechansim operates, since the second and third purchases are 1 and 1, the fourth purchase is predicted to be of brand 8, to complete the ideal cycle (1,1,8). Subsequently, the fifth purchase is predicted to be of brand 1 and so is the sixth. In each purchase, therefore, the purchase plus its two predecessors are predicted to complete the ideal cycle.

The criterion for comparison between the different models was the percent of correct predictions within a cycle. We compare the simulation results to the actual diary and within each cycle count the number of correct predictions where the order of purchases within the cycle is irrelevant. Thus for example, if the zero order, bundle mechanism, and sequence mechanism would simulate the *fourth* cycle for consumer No. 2186 in Table 2 (1,8,8) to be (1,1,2), (1,8,1) and (8,1,1) respectively, their percent of correct prediction is accordingly $\frac{1}{3}$, $\frac{2}{3}$ and $\frac{2}{3}$. The overall measure for each consumer is the average over all cycles of these percentages.

The results are as follows:
Percentage of consumers for whom prediction of cycle by:

Bundle mechanism outperformed zero order model 82.2%
Bundle mechanism performed exactly as zero order model 9.6%
Total: 91.8%
Sequence mechanism outperformed zero order model 71.2%
Sequence mechanism performed exactly as zero order model 8.2%
Total: 79.4%
Bundle mechanism outperformed or did equally as well as sequence mechanism 75.3%

The average correct prediction over all consumers with recognizable cyclical pattern is 67.1% for the zero order model, 74.9% for the ideal cycle model with bundle mechanism and 73.0% for the sequence mechanism. The latter two therefore clearly dominate in terms of their predictive ability as is reflected in this simulation study.

One should be aware that we could not have compared the models for all consumers since, in order to operate the ideal cycle model as a predictive mechanism, an ideal cycle should first be found. We are not claiming here an overall domination.

What we present is an opportunity for segmentation. For that segment of the market for which a recognizable pattern of cyclical behavior can be found, the ideal cycle model in one of its mechanisms dominates the zero order process. Since, in the previous section, it was found that for all prodct categories checked in this study this segment is respectable in size (mostly slightly over 40%) we do think that this represents a nontrivial opportunity.

5. Implications

The results that are summarized in Table 5 show that the consumer, in order to satisfy a need, does not, in general, buy a single brand and switches away from the brand because of dissatisfaction with it. Instead, the consumer chooses a bundle or assortment of brands among which he alternates regularly in a given cyclical pattern.

The percentage of the population which behaves according to the above rule in a recognizable pattern is indeed sizable. Excluding brand loyals, over 54% of the remaining consumers had a cycle of some length (being not less than two in length). In addition, for this segment of the population, the ideal cycle model predicts better than the zero order model.

Determination of the cycle length and its permanent components can help in developing the product line and a competitive strategy. The concept of cyclical switching implies that a 'full line' should not necessarily mean all possible brands, but-rather all the *structural* brands of the consumer's cycle. A company may wish to develop a full cycle line or specialize in one brand, which is one part of a cycle to be complemented by other companies' brands. This one brand may be a large part of the cycle of a few or many consumers, or a small component of the majority of the consumers.

Retailers can use this concept to plan their shelf space in full cycle offerings, combining brands of several companies if necessary. Furthermore, producers and retailers with full cycle line can design their packaging to combine brands that will satisfy different types of cycles. For example, assorted packages of toothpastes 'For the Family' for different kinds of households can be used to tie-in different toothpastes and thus gain the advantage of common brand name and advertising.

The method that was described to determine a cycle also helps to identify the transient brands. These are the competitive brands that were bought because of promotional activities on their behalf or lack thereof on the structural brands' behalf (stockouts, etc.). The transient brands are substitutes of the structural ones rather than complements. Identifying these brands helps to identify the competition and how effective it is in breaking up the cyclical pattern. A time series study of changing patterns may reveal how successful are the attempts to *establish a new brand as a permanent member of the cycle*. Achieving this goal should be a signal to reduce promotional activity since a brand is usually a substitute to one component of the cycle but a complement to others. One should not waste effort to take over a full cycle with one brand. A more effective way is to introduce different brands that will substitute different components of the cycle. The results of pursuing this goal is a policy of so-called brand proliferation (Schmalensee, 1978). The reasoning behind such a policy, however, is most likely the brand cycle phenomenon and not necessarily the FTC's claim of entry deterrence.

The cycle concept can also be used to classify consumers into segments according to their type of cycle. For example, a household for whom a grouped 'transient brand' is an integral part of its cycle will be classified as 'promotion prone'. Households with different size, age, income, etc. may very well have different distinct cycles that should be kept in mind by package designers and advertisers. This seems to be a promising area for further research into the cyclical purchase phenomenon, as is the effect of the number of salient attributes on ideal cycle length and the number of brands it includes.

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