

## Incorporating Choice Dynamics in Models of Consumer Behavior\*

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### *Abstract*

This paper presents a framework for organizing and discussing factors influencing consumer choice dynamics, how these factors may be incorporated into models of buyer behavior and problems that may arise in estimating such models. The paper identifies research issues and delineates possible approaches.

The growth of interest in models of consumer behavior has led to behaviorally rich models in which choice dynamics play an important role. That is, researchers now try to capture situations where consumer choice is dependent on a variety of factors which vary over time. Some factors are internal to the individual reflecting changes in his/her preferences, while others are external, reflecting changes in the buying environment or the buyers' expectations of the environment. Our purpose is to: (1) review factors which explain choice dynamics, (2) identify methodological and theoretical issues in need of resolution, and (3) present possible approaches that may prove helpful in resolving those issues.

Estimation problems with choice dynamic models can be attributed to three main sources: "state dependence," "unobserved heterogeneity" among buyers and "environmental non-stationarity". We provide examples of each in order to illustrate our understanding of them and to set the stage for further discussion.

"State dependence" occurs when the choice on one occasion affects probabilities of choice on future choice occasions. State dependence in which the choice of alternative A *increases* the probability of choosing alternative A on the next occasion is labeled "learning." Examples include instances in which a consumer likes a brand more as he/she consumes more of it, and instances in which consumers use experience with purchased software in making subsequent software purchase timing decisions. State dependence in which the choice of alternative A *decreases* the probability of choosing alternative A on the next occasion is labeled "variety seeking." Examples include the increased attractiveness of 7-Up after consuming a Coke or the increased attractiveness of a vacation in Spain, having recently visited France.

"Heterogeneity" simply refers to differences across consumers. Consumers can differ in tastes, (e.g. some consumers like Folgers Coffee, some like Maxwell House, some consumers like Macintosh personal computers, some like IBM.) Heterogeneity can also arise if consumers respond differently to marketing stimuli (e.g., some consumers may be very price sensitive, while others may find price far less important.)

"Environmental nonstationarity" refers to changes in the environment that influence the choice process. An example might be the increase in promotion activity in the orange juice category from 1982 to 1988 and the resulting increase in consumer promotion sensitivity. Another example might occur when Food Lion (an Every-Day-Low-Price grocery retailer) enters a market, driving prices at all grocery retailers down, and, ultimately leading to a change in consumer price expectations.

These three main sources of choice dynamics (state dependence, heterogeneity, and environmental non-stationarity) are closely linked. True state dependence can only be unbiasedly estimated when the effects of heterogeneity and environmental non-stationarity have been discounted. For example, the fact that competitors schedule their promotions in some structured fashion and that consumers change their purchase behavior in reaction to them, may lead to non-zero-order behavioral patterns that reflect consumers' reactions to the market environment, rather than any intrinsic loyalty or variety seeking. Furthermore, the aggregate choice behavior of individual consumers with distinct brand preferences will show clear departures from zero-order brand switching behavior, even though each individual consumer follows a strict zero-order brand switching pattern (Frank 1962, Heckman 1981).

In the next sections we consider each of these factors in more depth and consider the special estimation problems that arise when we have both state dependence and unobserved heterogeneity. We close the paper with an overview of our insights.

## 1. State dependence

State dependence refers to the effect of past consumer choices on current behavior. As pointed out above, these effects can be categorized by the direction of influence of one purchase on future ones. The first such effect discussed above was labeled "learning". This effect is also sometimes labeled "loyalty". Since the publication of Guadagni and Little's (1983) landmark paper, there has been a great deal of discussion about the meaning of that term. Before moving on to a discussion of "learning" and "variety seeking" as defined above, we will briefly discuss the topic of "loyalty."

### 1.1. Loyalty

"To paraphrase Kahn, Kalwani, and Morrison (1986), we all have a relatively clear, but not very precise, idea of what 'brand loyalty' is. Like 'attitude' in psychology, a review of articles finds literally scores of definitions suggested or in use (Jacoby and Chestnut 1978).

"Nevertheless, in recent years an operational definition of brand loyalty as the exponentially smoothed sum of past brand purchases has become well accepted. This acceptance follows Guadagni and Little's (1983) pioneering articles which used scanner panel data to estimate the Luce (1959) choice model in the multinomial logit framework. In particular, GL define loyalty for a brand,  $L(n)$ , at purchase occasion  $n$  as follows:

$$L(n) = \alpha L(n-1) + (1-\alpha)\delta$$

The Kronecker delta is one if the brand under consideration was purchased last period and zero otherwise." [Kanetkar, Weinberg and Weiss, p.2]

Kanetkar, Weinberg and Weiss (1990) show that  $L(n)$  does not behave in a manner consistent with our common sense understanding of brand loyalty . . . even though it plays an important predictive role in multinomial logit brand choice models.

"It would appear that  $L(n)$  is not measuring brand loyalty but is instead accounting for heterogeneity among households. This heterogeneity stem[s] from unobserved variables and manifest[s] itself as first order and higher order effects in the purchasing process." [Kanetkar, Weinberg and Weiss, pp. 2, 11]

### *1.2. Learning*

Though brand loyalty might be considered an outcome of learning (perhaps through some mechanism such as positive reinforcement), we will focus on the transient effects of learning. In choice models these effects can be related to changes in both buyer perceptions and preferences (attribute weights), and may depend on the degree of familiarity with the product category. When buyers are less familiar with the product category, increasing experience may result in changes in attribute weights as buyers learn more about what is important in using the product. For example, the importance of "graphics ability" in the choice of a personal computer may increase with experience and may be more important to those who are upgrading relative to those making a first time purchase. Similarly, product perceptions may change over time. For example, consumers learned over time that the "IBM Clones" were quite reliable. This reduced IBM's ability to charge premium prices. Obviously, perceptual changes are more important and more likely when products have salient "experiential" attributes (e.g. reliability, quality). These types of learning effects are more likely to occur in modeling choice of durables or hi-tech products (Sultan and Winer 1990).

For established product categories (especially for frequently purchased packaged goods), we are likely to observe learning effects through changes in perceptions of existing brands brought about by the introduction of new brands. Generally speaking, it will be hard to separate effects of changing perceptions and those of changing attribute importances. Additionally, it becomes important to model the affect of expectations, which are in turn dependent on product-market trends. For example, consumers of electronic products may have expectations regarding declining prices and enhanced product performance. These expectations may influence the timing of product category purchase as well as brand choice.

Bhargava and Srivastava (1990) show that context (or attraction) effects can be explained by a model of relative valuation of attributes where the relative performance of a brand on an attribute is judged not in an absolute sense, but relative to other brands under consideration. Thus, the incorporation of a "new" brand

which is superior on an attribute will have a greater impact on those brands that were previously viewed as better than average on that attribute. For example, a buyer may learn that a store brand is lower on price and adequate on other attributes. This store brand can then be expected to have a larger negative impact on lower priced brands than on higher priced brands.

Consumer learning influences which could be incorporated in choice models for durables include:

1. Learning in order to reduce uncertainty regarding attribute importances and range of possible attribute values. For example Hagerty and Aaker (1984) and Meyer (1981) model choice as a function of both attribute levels and uncertainty.
2. The effects of learning on timing decisions (when to buy something in a category) as well as brand choice decisions. The former is the emphasis in most models for durables; the latter, for frequently purchased packaged goods. For durables, choice models may be developed which simultaneously capture the buy/not buy and brand choice decisions by incorporating "not buy" as an option where the utility of "not buy" is a function of expectations regarding future prices and product performance.

### *1.3. Variety seeking*

McAlister and Pessemier (1982), in their review of the consumer variety seeking literature, point to several causes for such behavior. Most consumer choice models have focused on one of those causes: the intrinsic desire for change. Jeuland (1978), McAlister (1979, 1982), Givon (1984), Lattin (1987) and Bawa (1990) have developed models that consider the impact of many past purchases on current choice. Other models restrict consideration to only the most recent past purchase in order to deal with a more tractable, first-order Markov process.

Some of the earliest of the first-order models (Morrison 1966, Jones 1973), specify different parameterizations of the Markov brand switching matrix without directly tying the parameters to managerial control variables. Givon (1984) proposed a more general model in which variety-seeking intensity is explicitly considered. Extending Givon, Lattin and McAlister (1985), include not only variety-seeking intensity, but also brand preference and interbrand similarity as well. Still, however, these models merely describe consumer variety-seeking behavior.

In more recent research, these models have been re-examined in order to provide direct managerial guidance. Kahn, Kalwani and Morrison (1986) develop statistics to identify variety seeking product classes and (1988) to identify variety seeking brands within a product class. Lattin and McAlister (1985) go on to identify complementary and substitute relationships among brands in a variety seeking product class. Finally, Kahn and Raju (1989) and Feinberg, Kahn and McAlister

(1990) have begun to specify directly the impact of managerial actions in those product classes in which consumers seek variety.

Research in this area has begun to consider the possibility that consumers might seek variety at one point in time and avoid variety at another (Bawa 1990). The managerial implications of such changing behavior and even more realistic and elaborate models of consumer variety seeking behavior promise to be fruitful directions for future research.

A final direction in which consumer variety seeking research is headed is to consider the interaction of variety seeking with marketing control variables and consumer state variables. Kahn and Raju (1989) consider the effects of price promotions on variety seeking behavior. Isen and Kahn (1990) consider the effect of affect (or "mood") on consumer variety seeking behavior. Future research into the interaction of consumer variety seeking behavior with other marketing control variables or consumer state (or trait) variables may yield interesting insights.

## 2. Heterogeneity

The biasing effects of preference heterogeneity in the assessment of state dependence was documented in early research on Markovian brand-switching models. Frank (1962) demonstrated that the aggregate behavior of zero-order individual consumers with heterogeneous brand preferences can show clear departures from zero-order brand switching. Heckman (1981) demonstrated that the aggregate estimation of random-utility choice models based on the observed choices from a heterogeneous sample may lead to a model with strong state dependence even when the choices by each individual choice maker are independent from previous decisions. Given this, we include a discussion of the treatment of heterogeneity in our discussion of choice dynamics.

As pointed out by Gary Russell, there is a major difference between the philosophies of marketers and economists in dealing with the issue of unobserved heterogeneity. Economists see unobserved heterogeneity as a problem to be overcome; marketers see it as a profit opportunity (e.g., as the basis for product differentiation or market segmentation). One way to deal with unobserved heterogeneity is to estimate models at the individual level (Fader and McAlister 1990). At the other extreme, one might estimate a single, aggregate model. It would be valuable to be able to relate the individual level parameters to the aggregate parameters (Jones 1990).

Approaches between these two extremes build disaggregate models which group individuals into segments based on similarity of behavior (Kamakura and Agarwal 1990). Such models can be estimated via mixtures of logit and probit models. A similar approach follows the opposite route (Morichi and Yai 1990). First, an aggregate model is formulated and then segments are formed based on departure from the aggregate. The two approaches should yield equivalent results, but that remains to be verified empirically.

From the point of view of modeling, the essential feature of unobserved heter-

ogeneity is that the coefficients of the utility function (taste parameters) vary randomly among individuals. Typically, it is assumed that the coefficients follow some convenient, smooth distribution such as the normal. There was a feeling among some members of the workshop, however, that the distribution of tastes among individuals is lumpy and is better captured by a few discrete market segments than by a smooth distribution. If tastes are lumpy, then identifying the market segments may be very important for marketing applications. In making this decision, criteria such as costs of misclassification and stability of segments should be considered along with the amount of variance captured, which can be enhanced by increasing the number of segments.

Unfortunately, discriminating empirically between smooth and discrete distributions can be very difficult. One possible solution to this problem is to attempt to identify variables responsible for variations in tastes and to use these variables to form market segments. This would amount to basing market segments on observed, rather than unobserved, heterogeneity. However, it is not clear that any set of available variables will ever explain more than a very small fraction of taste variation among individuals.

Other possible solutions to the problem of possible lumpiness in distributions of tastes are:

1. One might capture unobserved heterogeneity through information on consumers' consideration or choice sets. For example, choice probabilities might be made conditional on consideration or choice sets, and consideration/choice sets might be modeled conditional on individual characteristics (Ben-Akiva and Shocker 1990).
2. Semiparametric estimation methods that do not require distributional assumptions might be used. Such methods would not lead to identification of market segments, but they would prevent inconsistent parameter estimates from being obtained as a result of misspecification of a parametric distribution of tastes.

Often, common-sense approaches may be used to minimize potential problems in estimation and interpretation. For example, it can be difficult to compare parameters across households (or segments) when the household (segment) level models have different levels of "noise" or unexplained variance. One way to alleviate the problem is to fix one coefficient and then compare the others. If, for example, the coefficient for price is set to unity, then brand-specific utility can be interpreted as willingness to pay.

A variety of issues were raised and left unresolved in our discussions of choice models incorporating unobserved heterogeneity. For example, in implementing logit models, differences among buyers may exist in both slope (price/promotion sensitivity) and intercept (brand-specific utility/loyalty) terms. Questions pertinent to such models would include:

1. Does the impact of promotion depend on loyalty differences between brands or rate of purchase/consumption across buyers, or both?

2. Do search costs vary across buyers? Are search costs related to brand loyalty and/or promotion sensitivity?
3. Is there an interaction between brand-specific utility and price sensitivity specific to that brand? For example, is the price slope for national brands greater than that for private labels (slope heterogeneity across brands)?

### **3. Environmental nonstationarity**

Environmental non-stationarity refers to changes in the external environment, as opposed to changes in the "internal environment" such as those that drive consumer variety seeking. The "external environment" effects might be driven by marketing mix activity (advertising, promotion), changes in demographics, weather (e.g., a freeze in orange growing countries), politics (the creation of a European market in 1992), etc. Most consumer choice models to date, however, focus on the effects of marketing mix activities.

Several models consider the lagged effect of promotion on consumer inventories and purchase timing (e.g., Blattberg, Eppen and Lieberman 1982, Neslin, Henderson and Quelch 1985, Lattin and Bucklin 1990). Such models suggest that consumers either take advantage of a promotion to stock up on a promoted product (thus removing him/her from the market in the near future) or that consumers postpone their purchase in anticipation of a coming promotion.

There is a reasonable amount of debate regarding the effect of advertising on sales as seen through UPC scanner data (Tellis 1988, Abraham and Lodish 1990). The precise way that advertising should be measured and response models should be built are at question.

We should also consider the endogeneity of independent variables. For example, "coupons, advertising and promotions directed at specific individuals may, to an extent, be a function of their choice probabilities. . . There is need to worry about the possible endogeneity of advertising and promotion variables, and the consequent simultaneous equation biases in their estimated effects." [Ratchford 1990, p.3]

Finally, through competitive action and reaction, the marketing "frame of reference" for a group of consumers may change. For example, in a particular market, consumers may expect Product X to cost \$1.20 a box. If an aggressive Every-Day-Low-Price grocer enters the market and all other grocers respond by reducing their prices across the board, consumer expectations for the price of Product X may fall to \$1.07. This change in expectations due to the change in the retail market should be reflected in consumer choice models (Winer 1986).

### **4. Interaction between state dependence and unobserved heterogeneity**

In most applications, it is difficult to argue convincingly that unobserved heterogeneity is not present. Therefore, if there is also a possibility of state dependence,



it is necessary to consider models that include both effects. Models that include both state dependence and unobserved heterogeneity present severe conceptual, statistical and computational problems (Horowitz 1990). These are:

1. Unobserved heterogeneity creates positive serial correlation among choices by the same individual. State dependence can also create positive serial correlation. Therefore, discriminating between the two effects empirically can be very difficult.
2. In models with unobserved heterogeneity, with or without state dependence, it is necessary to integrate out the random effects associated with the heterogeneity. This typically requires multivariate integration, which is prohibitively time consuming when standard numerical integration procedures are used.
3. In models with both state dependence and unobserved heterogeneity, current choices may be influenced in a very complicated way by choices made in the arbitrarily far distant past. In particular, choices made long before data acquisition began may influence the choices observed in a panel.

The only solution to the first of these problems is to use data sets consisting of long panels with large numbers of individuals. The scanner panel data sets used in marketing have these characteristics and may prove suitable for discriminating between state dependence and unobserved heterogeneity. The empirical research needed to know whether this possibility will be realized has not yet been carried out.

The second problem is computational. A recent promising development is the method of simulated moments (MSM) (McFadden 1989). This is essentially a Monte-Carlo procedure in which the need for complicated numerical integration is avoided by randomly sampling the distribution of random effects. The sampling is done in a way that economizes on computation time by avoiding the need for large Monte Carlo samples. The MSM is very new and there has been little experience in applying it to real data sets. It is too early to know whether it will work well for models with many random effects and large numbers of alternatives, such as are encountered in marketing.

The third problem is the well-known initial conditions problem of models with state dependence and unobserved heterogeneity. Essentially, the problem is to calculate the probability of the first *observed* choice by an individual conditional on the initial values of the explanatory variables and the random effects that represent unobserved heterogeneity. In most models with both state dependence and unobserved heterogeneity, calculating these probabilities is difficult or impossible owing to the complex way in which they can depend on presample information. Simplifications are possible in certain cases if one is willing to assume that the data generation process is in long-run equilibrium. Alternately, Heckman (1981) has proposed approximating the initial probabilities with a reduced-form function of the explanatory variables. This procedure worked satisfactorily in a simple Monte Carlo experiment reported by Heckman (1981), but there is no evidence on its performance in more complicated and realistic settings.

## 5. Conclusions

Estimation problems associated with choice dynamics can be attributed to three main sources: state dependence, environmental non-stationarity, and unobserved heterogeneity (and interactions among them). A variety of research issues and questions associated with these problems were identified. These result in research priorities for developing dynamic choice models, summarized below.

### 5.1. State dependence

1. Estimation of richer models of consumer variety seeking behavior, and consideration of the managerial implications of those models.
2. Consideration of the interaction of consumer variety seeking behavior with marketing control variables and with consumer state and trait variables.
3. Incorporation of learning effects (for example, learning effects on attributes or risk perceptions).
4. Separation (decomposition) of effects due to brand loyalty and heterogeneity in estimation of multinomial logit choice models.

### 5.2. Heterogeneity

1. Capturing differences/similarities among buyers. This will require approaches for simultaneously segmenting and modeling choice within segments.
2. Modeling choice probabilities as conditional on consideration sets (which in turn are conditional on buyer characteristics).
3. Modeling both slope and *intercept* differences among segments (e.g., does price sensitivity vary by brands and across segments).

### 5.3. Environmental nonstationarity

1. Removing potential endogeneity among "independent" variables (e.g., interactions among advertising and promotion) via simultaneous equation approaches.
2. Capturing effect of environmental changes in individual choice (e.g., changes in price expectations due to aggressive competition among retailers).
3. Focusing on longer-term effects (e.g., advertising effects may appear negligible when analyses are based on 52 weeks of scanner data).

The above priorities for development of models incorporating choice dynamics present difficult challenges. For example, in the case of unobserved heterogeneity and state dependence, the computational problem of handling unobserved heter-

ogeneity in models with many alternatives is present. The method of simulated moments may help with the computational problem. However, it is not yet known how will MSM will work in choice situations with a large number of alternatives.

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