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Information processing theory and findings on advertising response suggest a nonlinear response to repetitive ad exposure, mediated by brand loyalty. The response can occur in either or both of the hypothesized stages of purchase: brand choice and quantity choice. A tobit-type analysis of scanner purchases (with TV exposures) of a mature product category appears to support these hypotheses. The effect of advertising is generally nonlinear and its impact on volume purchased is mediated by brand loyalty. Advertising seems to reinforce preference for current brands rather than stimulate brand switching. However, features, displays, and especially price have a stronger impact on response than does advertising. The effect of brand loyalty dominates that of the other variables.

## Advertising Exposure, Loyalty, and Brand Purchase: A Two-Stage Model of Choice

Despite extensive research on advertising, managers and public policy makers face considerable uncertainty about its role in contemporary markets. Does advertising repetition help? Who responds to repetitive advertising? Do established brands have stronger response to advertising?

Two standard measures of advertising are used in market studies: advertising expenditures and gross rating points (GRP's), a product of the reach of a medium and the average of a distribution of exposures it delivers to an audience. These measures of advertising intensity are based on the assumption that all audiences respond equally to ad stimuli. However, casual reflection suggests there may be an "advertising-prone" segment just as there is a "coupon-prone" segment. Indeed, behavioral theory and laboratory studies indicate that response to advertising exposure is nonlinear and stronger among subjects familiar with the brand or message (Sawyer 1981; Simon and Arndt 1980).

Current market share models of advertising do not

allow for systematic differences in response pattern between established and new brands (see review by Assmus, Farley, and Lehmann 1984). This issue has generated controversy in the literature. Some researchers argue that advertising differentiates products and thus works as a barrier to entry (Bain 1956; Comanor and Wilson 1967). The latter authors also suggest that possible scale diseconomies, greater risk, or other higher costs of advertising work against smaller, new entrants. However, other researchers suggest that advertising is information (Nelson 1970, 1974) that facilitates the entry of new brands (Telser 1964). After an extensive literature review, Simon and his associates (Simon 1980; Simon and Arndt 1980) conclude that there are no economies of scale in advertising that favor large-share brands. Nevertheless, such research continues to be controversial (e.g. Bloch 1980; Comanor and Wilson 1979; Simon 1980).

There are several reasons for the lack of closure on these issues. First, the field studies generally used aggregate data or indirect measures that led to ambiguous conclusions (Comanor and Wilson 1979). Second, as Parsons and Schultz (1976) point out, econometric research in the area has emphasized the testing of statistical models more than their formulation with behavioral theory. Third, the behavioral studies have been somewhat removed from field settings, so their implications are not immediately apparent. Actually, several researchers (e.g., Comanor and Wilson 1979; Little 1979) have called for a recalibration of advertising models based

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on behavioral findings and disaggregate field data (e.g. scanner data).

The study reported here addresses the preceding issues, extending the literature in three ways. First, behavioral research on repetitive advertising exposure is reviewed to develop relevant hypotheses. Second, recent developments in choice modeling are used to formulate a test of these hypotheses. Third, the hypotheses are tested with individual brand choice data recorded with cable-scanner technology. The data make possible a within- and between-subject and a within- and between-brand analysis; the design minimizes the problems of collinearity and causality that limited previous econometric research. In short, the study integrates experimental research on attitudinal response to ad exposure (Sawyer 1981) with econometric research on market share response to ad expenditures (Assmus, Farley, and Lehmann 1984).

### *EFFECTS OF MESSAGE REPETITION AND BRAND LOYALTY*

#### *Theory*

Early experimental research in this area focused on the effects of mere exposure (often of nonsense syllables) on subject's response. Sawyer's (1981) review concludes that affective response to such repetitive exposure mostly follows an inverted-U or logarithmic curve, with increasing favorable response followed by increasing negative response. In more recent studies, researchers have attempted to unravel the reasons for the nonlinear response by using intelligible messages as the stimuli. Several explanations have been forwarded for this response pattern (Sawyer 1981), the best known being Krugman's (1972) three-exposures hypothesis, the modifications of Berlyne's two-factor theory (Stang 1973, 1975), and Cacioppo and Petty's (1979, 1985) elaboration likelihood model (ELM) of attitude change. The following explanation integrates these ideas.

When exposed repeatedly to a favorable ad,<sup>1</sup> subjects are likely to respond positively at first because they have more opportunity for attention, retention, and cognitive elaboration. The first one or two exposures may merely draw attention to the brand name, whereas subsequent exposures ensure that the message gets across and that subjects have time to evaluate it. Further repetition has no beneficial effect and may have a negative effect, because subjects are no longer stimulated to new elaboration and tire of hearing the same message.

<sup>1</sup>Manufacturers are assumed to use ads that are favorable to the product overall. Cacioppo and Petty (1985) demonstrate how repetition of "weak arguments" leads to negative response even initially. However, their "weak arguments" may be indistinguishable from unfavorable associations or implications about the stimulus. Here, we also do not account for mood, persuasiveness, comparative information, or other content issues, which may be important mediators of response.

This theory suggests that the subject's prior disposition is an important moderator of ad response (Cacioppo and Petty 1985; Sawyer 1981). If the subject is a loyal user of the brand or is otherwise familiar with it, the positive response to exposure is likely to be higher and the optimum number of exposures lower. The mediating role of brand loyalty or familiarity may be due to several factors. First, exposure, attention, comprehension, and retention are selective processes, operating in favor of relevant behavior, such as brands currently used by individuals (Assael 1983, p. 115-27; Engel and Blackwell 1982, p. 276-89). Second, cognitive consistency theories suggest that individuals may further bias these processes to support continued use of preferred brands (Calder 1981). Third, cognitive elaboration is likely to be initially richer for brands with which subjects have more extensive experience in different contexts (Cacioppo and Petty 1985). For these reasons, messages about brands with which subjects are more familiar or loyal are likely to lead to more positive affect and behavior.

#### *Prior Empirical Evidence*

Earlier reviews of the literature (Belch 1982; Cacioppo and Petty 1985; Naples 1979; Sawyer 1981; Simon and Arndt 1980; Stephens and Warren 1984) cite 38 primary studies on consumer response to the repetitive exposure of ads or messages. A review of these primary studies shows they involved a variety of environments, media, and measures, though 27 were in the laboratory. The review leads to several interesting conclusions. First, all except one of the studies (Mitchell and Olson 1977) found some positive response to message repetition. Second, 20 of the 29 studies that had more than two levels of exposure found a nonlinear response pattern (either logarithmic or inverted U). Third, of the studies with more than two exposure levels, all of the field studies found a nonlinear response but only half of the laboratory studies did. The findings may have differed because laboratory studies generally use fewer repetitions and more commonly use fictitious brands, thus being less likely to cause tedium and negative affect.

Fourth, the studies tested for the effects of more than a dozen moderator variables, the most frequently used being brand loyalty or a related construct such as brand familiarity, preference, or newness. The findings strongly support the hypothesis that repetition leads to a more positive response for more familiar or frequently used brands. These studies used various criterion variables, from attitude to sales, as the subsequent summary indicates.

Belch's (1981) experiment on comparative advertising showed that repetition of television ads led to less favorable attitudes for a new brand as subjects' loyalty for the established brand increased. In a study of 1000 commercials, Stewart and Furse (1986) found that brand-differentiating messages were more effective for more extensively used or familiar brands. Calder and Sternthal's (1980) study on television commercial wearout indicated

that the repetition of ads led subjects to a more positive evaluation for a familiar brand but to a more negative evaluation for an unfamiliar one. In another experiment, Craig, Sternthal, and Leavitt (1976) found that subjects also could recall repetitive ad information better for familiar brands. In a field experiment, Politz (1960) found that repetitive magazine ads led to about five times more brand-evoking for established brands than for newer or less established ones. Ray and Sawyer's (1971) shopping experiment indicated that recall of repetitive advertisements was generally higher for well known brands than for less well known brands. In another shopping experiment, Sawyer (1973) found the repetition of supportive ads affected the purchase intention of users more than that of nonusers of the brand. A study on the AdTel data (1974) showed that brand users had a sharply increasing probability of purchase with increasing exposures to TV ads, whereas nonusers had only a small initial increase. In a field experiment based on GRP's, Raj (1982) found that more loyal consumers of the brand had higher aggregate sales response to advertising.

All of these findings strongly suggest that brand loyalty enhances the effect of repetitive ad exposure. However, with the exception of McDonald's (1971), none of the studies analyzed the effect of advertising exposures on individual brand choice in a competitive field setting. Though McDonald pioneered the analysis of purchase response to ad exposures in the field, he focused only on brand switching (excluded repeat purchases), did not control for other marketing activity, and used self-reports. Researchers have emphasized the importance of testing advertising theories in more realistic choice contexts (Stewart and Furse 1986). The current study tests how advertising exposure affects brand choice in a competitive market, where we can statistically control the effects of other marketing variables and analyze the heterogeneity of these effects by consumer loyalty. The subsequent sections explain the model, results, and implications of the study.

### THE EMPIRICAL MODEL

#### Data

The data consist of scanner records for household purchases of 12 key brands of toilet tissue over 52 weeks. The category contains newer brands (generally with smaller shares), including one recently introduced. Purchases are recorded in absolute units (number of rolls), dollar volume, and dollar volume purchased with manufacturer coupons, features, or displays. The latter three variables are dummied, with the variable being 1 for a brand in a week if at least one panelist buys the brand on that basis for the week and 0 otherwise. From the available data, the weekly price of a brand is defined as a panelist's dollar volume (net of coupons) divided by units purchased. The price of a brand not purchased by a panelist in a week is the modal price paid by panelists who buy the brand in that week. The price of a brand

not purchased by any panelist in a week is the modal price of that brand for the whole year.

The data also include weekly TVmeter records of exposures to TV ads, determined by the household's TV viewing and a brand's airing of commercials. Besides the variation of exposures by households, advertising intensity varies across large share brands, across small share brands, and over time for those brands. LNA (Leading National Advertisers) reports indicate that TV advertising accounted for 99% of the total advertising of more than \$33 million in the product category in 1982.

The original sample consisted of almost 1000 panelists who shop across different stores in a test city. Only those panelists whose TVmeter worked for at least two days a week, every week of the whole year, were selected. An analysis of demographic and behavior characteristics between the two subsamples indicated no substantive differences, confirming that the failure of the TVmeter was a random process. About 10% of the panelists with fewer than five purchases per year, as well as the observations of the remaining panelists for those weeks when they made no purchases, were eliminated.<sup>2</sup> These selection rules yielded a sample of 251 panelists and 2634 purchase occasions. Two of the 12 brands were excluded because they had negligible purchases.

#### Specification

*Three rival models of purchase.* The dependent variable is volume, measured as the number of rolls ( $S$ ) of a brand ( $j$ ) that a panelist ( $i$ ) purchases in a week ( $t$ ). Volume depends on a hypothesized set of ( $k$ ) independent variables,  $X_{kijt}$ , that include brand- and consumer-specific characteristics. There are at least three ways to model volume. First, in a simple model,

$$(1a) \quad S_{ijt} = \sum_k \beta_{1k} X_{kijt} + e_{ijt},$$

where  $e_{ijt}$  are errors and  $\beta_{1k}$  are coefficients to be estimated. If we assume the  $e_{ijt}$  are independently, identically, and normally distributed with zero mean and constant variance, this model can be estimated consistently by a least squares regression of  $S_{ijt}$  on  $X_{kijt}$  so that

$$(1b) \quad E_1(S_{ijt}) = \sum_k \hat{\beta}_{1k} X_{kijt}$$

where  $E$  represents expectation and the numerical subscript represents the model number.

Second, volume can be modeled as the outcome of two independent events or purchase stages, brand choice and units bought. Casual reflection on one's own trips to the grocery store suggests that a consumer must not

<sup>2</sup>The former selection rule restricts the generalizability of the results to regular purchasers of the product, who are the main concern of such studies anyway. The latter selection rule introduces a selection bias (Heckman 1979) but greatly reduces the statistical analyses, as the number of choice observations is otherwise very large (panelists  $\times$  weeks  $\times$  10 brands). Both selection rules are common in marketing (e.g., Guadagni and Little 1983), but the bias they introduce needs further study.

only choose from among a plethora of brands given the competitive scenario prevailing on each trip, but also must decide how much to buy. Brand choice can be defined as a dummy variable, coded 1 if panelist  $i$  chooses brand  $j$  in period  $t$  and 0 otherwise. It can be modeled conveniently as the probability of choice,  $P(C_{ijt})$ , given a subset of brand and consumer characteristics in  $X_{kijt}$ . Units bought (independent of brand) can be defined as the non-zero values of  $S_{ijt}$  and modeled as a function of another subset of  $X_{kijt}$ . Following the logic in equation 1, we can obtain an expected value of volume independent of brand choice,  $E(S_{ijt})$ . In this case,

$$(2) \quad E_2(S_{ijt}) = P(C_{ijt}) \times E(S_{ijt}), E(S_{ijt}) > 0.$$

Third, the two stages of choice may not be independent of each other. For example, consumers may buy more of the brands they prefer, but less of the brand they try or of a premium brand chosen for special occasions or family members. If quantity selection is conditional on brand choice, by conditional probability rules equation 2 becomes

$$(3) \quad E_3(S_{ijt}) = P(C_{ijt}) \times E(S_{ijt}|C_{ijt}).$$

Because  $P(A|B)P(B) = P(B|A)P(A) = P(A \text{ and } B)$ , the final result does not change if consumers' brand choices are conditional on units bought. However, the latter situation is unlikely for the following reasons. First, though buyers may have preferences for both brands and quantities, the former are likely to be stronger. Second, the product is low priced and frequently purchased, with brands generally available in a few standardized sizes. Buyers therefore are more likely to adjust the quantity they purchase on the basis of brand choice than they are to compromise on brand preference. In the subsequent discussion, "units bought" refers to the consumer's decision on quantity separate from brand choice and "volume purchased" refers to the joint outcome of units and brand choice.

Which of these three models is the most appropriate is an empirical issue that is tested in this study. However, for our type of data, statistical theory tends to favor the third model. Because the values of the dependent variable, volume, cannot be negative and 90% of them are zero, in any week only one brand generally is purchased. Econometricians refer to such a variable as "censored" and assign it to the class of "limited dependent variables" (Maddala 1983, p. 1-6).<sup>3</sup> The estimation of limited dependent variables by simple linear models (e.g., equation 1) may yield biased estimates. In our case, the bias occurs because the observed behavior on each

purchase flows from and only partly measures a panelist's unobserved preferences for each of the brands. Though the brand chosen is the buyer's most preferred, his or her preferences for the other nine are not observed and may not all be equated to the zero value one finds in the data.

The analysis of behavior in two stages has substantive benefits beyond the statistical issues of bias and predictive efficiency. First, one can identify the different variables that affect each stage of the choice process. For example, brand loyalty is likely to affect brand choice; inventory level and volume loyalty (preference for certain quantities) are likely to affect units bought. Second, the effects of the marketing variables are likely to be different in each stage. For example, displays and features may affect mainly brand switching whereas price discounts may also affect units bought by both switchers and regular buyers. Third, one can separate the competitive effects primarily revealed in brand choice from the intensity of preference primarily revealed in units bought. This distinction is particularly important for interpreting the role of advertising in consumer choice.

*Elaboration of the logit (or first-stage) model.* Because  $C_{ijt}$  is dichotomous, linear models of  $P(C_{ijt}|\sum_k \beta_{2k} X_{kijt})$  yield inefficient estimates. Under the assumption that buyers purchase the brand with the highest utility ( $V_{ijt}$ ), which consists of a deterministic component ( $\sum_k \beta_{2k} X_{kijt}$ ) and a random component ( $u_{ijt}$ ) that follows a Gumbel or type I extreme value distribution, McFadden (1974) showed that the following conditional logit model provides consistent estimates of  $P(C_{ijt})$ .

$$(4) \quad P(C_{ijt} = 1) = \exp(\beta_{2k} X_{kijt}) / [\sum_j \exp(\sum_k \beta_{2k} X_{kijt})]$$

$$(5) \quad V_{ijt} = \sum_k \beta_{2k} X_{kijt} + u_{ijt}$$

where:

$\beta_{2k}$  is a set of coefficients to be estimated and  $u_{ijt}$  are disturbances assumed to be independently, identically, and Gumbel (or type 1 extreme value) distributed.

In words, the probability that subject  $i$  chooses brand  $j$  in period  $t$  is the probability that the perceived utility of that brand,  $V_{ijt}$ , estimated by the choice characteristics,  $X_{kijt}$  (subject to some error,  $u_{ijt}$ ), exceeds the utility of any other brand.

*Elaboration of the two-stage (or tobit) model.* Tobin (1958) pioneered a maximum likelihood solution to overcome the bias from estimating equation 3 by equation 1.<sup>4</sup> Heckman (1976, 1979) described a simple, more

<sup>3</sup>There is a difference between "censored" samples in which only the dependent variable's values are unobserved below some threshold and "truncated" samples in which all variables have unobserved values below some threshold value of the dependent variable. The resulting bias, variously called censoring, truncation, or selection bias, is due to the interdependence of the errors in two equations, the quantity equation and the choice equation that censors quantity (e.g., Maddala 1983, p. 149-53).

<sup>4</sup>Since then researchers have developed a family of models to solve related problems with limited dependent variables, which Amemiya (1984) classified into five groups of tobit models. Goldberger (1964) first referred to these models as tobit models, because Tobin's (1958) solution was similar to a probit formulation. In marketing, Winer (1983) and Gilley and Leone (1985) applied the Heckman solution to the problems of panel attrition and item nonresponse, respectively. In the subsequent discussion, the notation is adapted to the brand choice problem.

general, two-stage solution involving a probit model in the choice stage and a linear regression on *nonzero* values in the quantity stage. To model quantity, he showed that

$$(6) \quad E(S_{ijt}|C_{ijt} = 1) = (\sum_k \beta_{3k} X_{kijt} + \beta_4 \Phi_{ijt}/\Phi_{ijt})$$

where:

- $\beta_{3k}$  is a set of unbiased coefficients to be estimated,
- $\beta_4$  estimates the dependence of units bought on brand choice, and
- $\Phi_{ijt}$  and  $\Phi_{ijt}$  are the density and distribution functions evaluated at  $V_{ijt}$ .

Lee (1983) extended that analysis to the case in which the first stage is a logit model. If we model brand choice as a logit model described in equations 4 and 5 (Lee 1983; Little 1985), then

$$(7) \quad \Phi_{ijt} \text{ reduces to the probability of brand choice modeled in equation 4.}$$

$$(8) \quad \phi_{ijt} = \log[1 + \exp(-\sigma V_{ijt})]/\sigma - (-V_{ijt})\exp(-\sigma V_{ijt})/[1 + \exp(-\sigma V_{ijt})]$$

where:

$$(9) \quad \sigma^2 = \Pi^2/3 \text{ is the variance of the logit model.}$$

Maddala (1983 p. 222) showed that the joint outcome, volume, can be estimated consistently on *all* of the observations by the following simple reformation of equation 3.

$$(10) \quad E_3(S_{ijt}) = \{P(C_{ijt} = 1) E(S_{ijt}|C_{ijt} = 1)\} + \{P(C_{ijt} = 0) E(S_{ijt}|C_{ijt} = 0)\}$$

The second half of the right side of equation 10 = 0, because  $S_{ijt} = 0$  if  $C_{ijt} = 0$ . By substituting equations 6 and 7 in 10 and simplifying,

$$(11) \quad E_3(S_{ijt}) = \sum_k \beta_{3k} \{\Phi_{ijt} X_{kijt}\} + \beta_4 \phi_{ijt}.$$

Note that Heckman's model (equation 6) estimates only the units bought conditional on brand choice using positive values of volume, whereas Maddala's model (equation 11) estimates the joint event of volume purchased (using all values) given interdependence of these two events. In practice, one first estimates equation 4 to obtain the predicted utilities ( $\hat{V}_{ijt}$ ) and choices ( $\hat{C}_{ijt}$ ). One then computes  $\Phi_{ijt} X_{kijt}$  and  $\phi_{ijt}$  and regresses  $S_{ijt}$  on the latter variables to obtain unbiased estimates of the coefficients of volume purchased. The Heckman and Maddala approaches thus solve the censoring problem described in equation 3 by an ingenious two-stage estimation that is analogous to the two-stage least squares solution to correlated errors in structural equations.

#### Operationalization

The analysis (including the measurement of ad exposures) is at the weekly level because much of the ac-

tivity, including shopping by subjects and changes in other marketing variables, takes place on a weekly basis. Therefore, the effect of weekly ad exposures is managerially the most relevant measure. Marketing variables, brand loyalty, and brand-specific constants are hypothesized to be the factors in  $X_{kijt}$  that affect brand choice. Fortunately, suitable data on the first are available, including records for advertising exposures, price, displays, features, and manufacturer coupons. A quadratic term, (exposure)<sup>2</sup>, serves to capture the nonlinear effect of advertising. Similarly, volume loyalty, household inventory, price, and advertising are hypothesized to affect units bought. (Exploratory analysis suggests that coupons, features, and displays do not increase units bought. The result may be due to the fact that we do not have measures for value of coupons or type of display and feature.) All of the preceding independent variables are hypothesized to affect the joint outcome, volume purchased.

To avoid using current or future information to predict the present choice, we develop the brand loyalty measures on only the first 20 weeks and reserve the last 32 weeks to estimate the model parameters. We operationalize brand loyalty in two ways. One measure of long-term loyalty ( $LY_l$ ) is each panelist's simple average share of volume purchased of each brand over the first 20 weeks.

$$(12) \quad LY_{lij} = \sum_{t=1-20} S_{ijt} / \sum_{j=1-10} \sum_{t=1-20} S_{ijt}$$

A short-term measure of loyalty ( $LY_s$ ) is a moving average of past brand purchases initialized over the first 20 weeks, similar to a measure used by Guadagni and Little (1983); thus,

$$(13) \quad LY_{sij(t-1)} = \alpha C_{ij(t-1)} + (1 - \alpha) LY_{sij(t-1)}$$

where  $\alpha$  is assumed to be .25, because the fit of the moving average process is insensitive to values between .2 and .3.

If brand preference is nonstationary or a first-order process, the moving average measure will be more appropriate; otherwise the simple average will be adequate. Finally, to test the hypotheses about advertising, the model incorporates interaction terms for advertising  $\times$  loyalty. In this operationalization, loyalty serves two key purposes. First, as a covariate in the choice process, loyalty captures inertia or repeat purchasing. In other words, the effects of marketing variables are estimated after brand and volume preference are held constant. Second, as a measure of the panelist's usage or preference for a brand, the coefficients of the interaction terms indicate whether response to ad exposure is different across levels of loyalty.

To capture the consumer's preference for certain quantities, we operationalize a "volume loyalty" variable in the same way as the long-term brand loyalty variable—the average weekly sum (over all brands) of quantity purchased in the first 20 weeks. Volume loyalty is primarily a function of a household's purchase frequency, consumption, and stockpiling of the product.

*Hypotheses*

The hypotheses follow from the theory and operationalization of the empirical model. First, the third model of choice should provide a better fit than the first two. Second, response to advertising is initially positive. Third, response to repetitive advertising is nonlinear, displaying a logarithmic or an inverted-U rather than a linear pattern. If the quadratic term is not significantly different from zero, the response is linear; if it is significantly negative but very small in relation to a positive linear effect, the response can be considered to level off for some finite level of exposures; if it is negative and large in relation to the the positive linear effect, the response resembles an inverted U. Fourth, response is stronger (rises and falls more steeply) for brands a panelist uses more, as operationalized by the panelist's brand loyalty.

**RESULTS**

*Test of Rival Models*

We can compare the models in three ways: measures of fit, comparison between actual and predicted market shares, and visual plots of the latter. The measures of fit<sup>5</sup> clearly suggest the superiority of model 3.

| Model   | Mean Square Error | R <sup>2</sup> |
|---------|-------------------|----------------|
| Model 1 | 3.7               | .26            |
| Model 2 | 3.9               | .24            |
| Model 3 | 3.5               | .31            |

Fisher's z-transformation can be used to test for the significance of pairwise differences, if any, between the models' R values. The test (on 26,340 observations) yields a z-value of 8 for model 3 over model 1 and 11 for model 3 over model 2, confirming the superiority of model 3. Second, for each model, we can estimate the predicted weekly market share {E(MS)} by brand over the 32 test periods by aggregating predicted volume over the panelists:

$$(14) \quad E(MS_{jt}) = \sum_i E(S_{ijt}).$$

Actual market shares can be calculated in the same way. Weekly brand market shares are managerially relevant and easier to inspect graphically. The correlations between predicted and actual shares for the 10 brands are mostly higher for model 3. Third, visual checks of the plots of actual versus predicted market shares confirm the superiority of model 3. Therefore we can validly consider the volume purchased as the outcome of two interdependent decisions, brand choice and units bought conditional on brand choice. For brevity, let us examine

<sup>5</sup>Because the data show sharp weekly fluctuations, tests of non-nested models that are sensitive to turning points are preferable. The simulations by Rust and Schmittlein (1985) indicate that as number of observations increases, alternate tests of non-nested models are not superior to the MSE criterion.

the specific analyses of only brand choice and volume purchased.

*Multinomial Brand Choice*

Table 1 reports the analysis of brand choice. Because the hypotheses are directional, the tests of significance are at the .05 level (one tail) of the null hypothesis that the coefficients are greater (or less than) zero. The linear and quadratic terms of the main and interactive effects of advertising exposure are not significant. However, with a logarithmic transformation of exposure, the main effect of advertising is significant. Only the latter model is reported here. In terms of t-statistics or partial correlation coefficients, brand loyalty is the best explanatory variable of brand choice. On the same bases, the next four important variables are features, display, price, and coupons in that order. The signs are in the expected direction. Of the two loyalty measures, short-term loyalty has slightly higher explanatory power than long-term loyalty. Because the long-term loyalty is easier to estimate and interpret, we proceed with that measure. The model can correctly predict 91% of brand choices.

*Joint Outcome: Volume Purchased*

The predicted choices are used to analyze volume by the Maddala two-stage model (see Table 2),<sup>6</sup> the analysis by the simple model 1 estimated by generalized least squares (GLM) is presented for comparison. Tests of significance are one tail at the .05 level or lower. Note first that the interaction effect of exposure × loyalty is moderately strong, significant, and positive as hy-

<sup>6</sup>Initial estimates of the two-stage approach are inefficient. However, if we iterate the process, the estimates converge to the tobit maximum likelihood estimates (MLE) (Amemiya 1984). The LI-FEREG procedure in SAS provided MLE estimates similar to those from the two-stage model. However, the MLE results are not reported because that procedure is experimental.

**Table 1**  
**MULTINOMIAL LOGIT RESULTS (OF EQUATION 4)<sup>a</sup>**  
**DEPENDENT VARIABLE: BRAND CHOICE (0, 1)**

| Independent variable     | β <sub>2</sub> | t-value           |
|--------------------------|----------------|-------------------|
| Brand loyalty, long-term | 3.92           | 43.6 <sup>b</sup> |
| Log(exposure)            | .28            | 2.2 <sup>c</sup>  |
| Log(exposure × loyalty)  | -.10           | -0.3              |
| Price                    | -3.83          | -4.0 <sup>b</sup> |
| Coupons                  | .23            | 3.2 <sup>b</sup>  |
| Display                  | .41            | 6.3 <sup>b</sup>  |
| Features                 | .55            | 7.7 <sup>b</sup>  |

Correct total predictions = 91%  
 Likelihood ratio statistic = 4916<sup>b</sup>  
 d.f. = 26,320

<sup>a</sup>Brand-specific constants not shown.

<sup>b</sup>Significant at the .0001 level.

<sup>c</sup>Significant at the .01 level.

**Table 2**  
REGRESSION RESULTS: COMPARATIVE ANALYSIS  
OF SIMPLE (EQUATION 1) AND TWO-STAGE  
(EQUATION 11) MODELS<sup>a</sup>  
DEPENDENT VARIABLE: VOLUME PURCHASED

| Independent variable                  | Simple model<br>equation 1 |                    | Two-stage model<br>equation 11 |                    |
|---------------------------------------|----------------------------|--------------------|--------------------------------|--------------------|
|                                       | $\beta_i$                  | t-value            | $\beta_{i,4}$                  | t-value            |
| Brand loyalty, long-term              | 4.81                       | 73.5 <sup>b</sup>  | 4.71                           | 34.6 <sup>b</sup>  |
| Volume loyalty, long-term             | .07                        | 16.7 <sup>b</sup>  | .45                            | 38.1 <sup>b</sup>  |
| $\phi_{ijt}$                          | —                          | —                  | .92                            | 5.7 <sup>b</sup>   |
| Exposure                              | -.00                       | -.0                | -.44                           | -1.9 <sup>c</sup>  |
| Exposure <sup>2</sup>                 | .00                        | .3                 | .08                            | 1.1                |
| Exposure × brand loyalty              | 1.23                       | 6.3 <sup>b</sup>   | 1.69                           | 4.2 <sup>b</sup>   |
| Exposure <sup>2</sup> × brand loyalty | -.27                       | -4.4 <sup>b</sup>  | -.31                           | -2.3 <sup>c</sup>  |
| Price                                 | -4.56                      | -10.5 <sup>b</sup> | -22.67                         | -19.1 <sup>b</sup> |
| Coupon                                | -.18                       | -4.3 <sup>b</sup>  | -.25                           | -2.5 <sup>c</sup>  |
| Display                               | .13                        | 3.3 <sup>b</sup>   | .13                            | 1.6 <sup>c</sup>   |
| Feature                               | .28                        | 6.4 <sup>b</sup>   | .39                            | 4.5 <sup>b</sup>   |
|                                       | $R^2 = 26\%$               |                    | $R^2 = 31\%$                   |                    |
|                                       | $F = 487^b$                |                    | $F = 566^b$                    |                    |
|                                       | d.f. = 19/26,220           |                    | d.f. = 21/26,218               |                    |

<sup>a</sup>Brand-specific constants not shown.

<sup>b</sup>Significant at the .0001 level.

<sup>c</sup>Significant at the .05 level.

pothesized. The exposure<sup>2</sup> × loyalty interaction is significant, supporting the hypothesized nonlinear effect. Because brand loyalty ranges from zero to one, the main effects of exposure must be interpreted as volume response to the exposure of untried brands (which have a brand loyalty of zero). The latter situation seems to induce an increasing response to exposure.

Analogous to the effect of loyalty on brand choice, volume loyalty has the most impact on volume purchased. The brand loyalty variable is also a significant explanatory variable, indicating that consumers buy larger quantities (per purchase occasion) of brands they prefer. The significance of the coefficients of brand loyalty and  $\phi_{ijt}$  supports the two-stage model. The price coefficient in this model is much stronger than that in brand choice. In contrast, coupons, features, and displays have a relatively smaller effect. The negative sign of the coupon variable is probably due to measurement error, because we know whether coupons were available but not their value. The model explains 31% of the variation in volume.

Besides the improvement in measures of fit, the differential effects of the independent variables across the choice and volume equations and across the two models of volume provide further justification for analyzing purchase in two stages (Heckman 1979). Note especially in Table 2 that the coefficient of price by the two-stage model is several times higher than the -4.6 from the simple model. The reason for the difference is that the two-stage model more effectively captures the total sensitivity of consumers to price in terms of units bought and brand choice.

The exposure coefficients in Table 2 suggest a nonlinear response to ad exposure mediated by brand loyalty, with an optimum level of between two and three exposures a week for panelists loyal to the brand. The exponential curve represented by the main effects of exposure can be interpreted as the response to brands the consumer has not tried. The plots of the raw data in Figure 1 display this pattern vividly. Besides the primary response for high loyalty brands, the plots also suggest an increasing response for untried and low loyalty brands. These results are consistent with the literature and confirm conventional advertising wisdom that established brands need only reminder advertising whereas new brands need heavy advertising. However, the data are weak beyond five exposures a week, so conclusions about the latter curve must be made with caution.

#### Robustness of Results

Several tests were carried out to determine the stability of the exposure effects. First, a covariate for the TV viewing time of each panelist controlled for the potential bias that would occur if those who watched more television also purchased in greater volume. The coefficients of the linear and quadratic terms of viewing were not significant, whereas the effects of exposure × loyalty were basically unchanged. Second, covariates for frequency of purchase or inventory level controlled for potential effects of these variables on volume purchased. The effects of exposure × loyalty remained approximately the same. Third, a covariate "non-exposure" recorded the number of weeks subjects were not exposed to the brand, as a measure of within-subject ad flights. Interactions of non-exposure with the other exposure variables approached significance, but did not affect the loyalty × exposure variables.

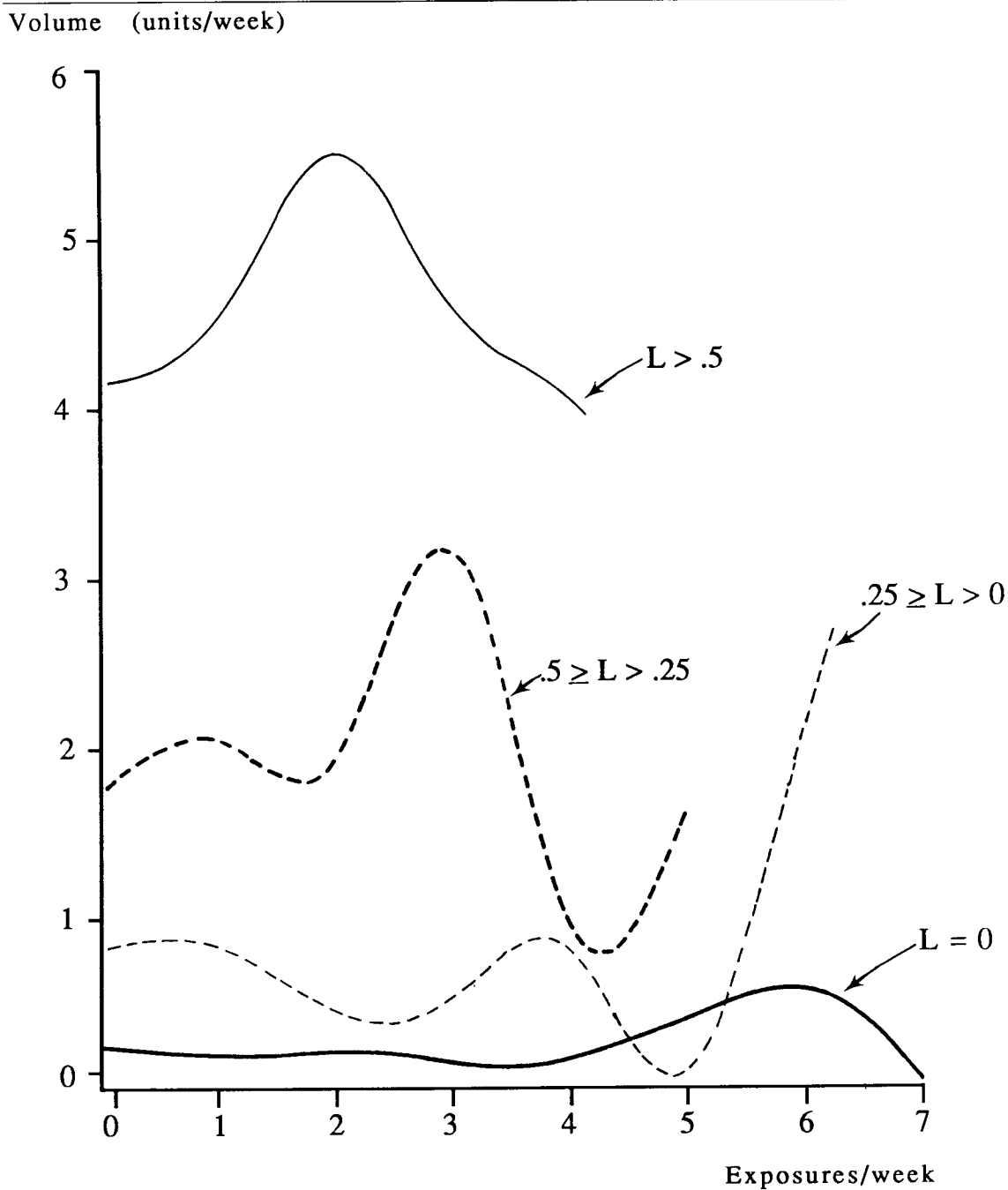
Fourth, indices of multicollinearity indicated no problem of collinearity between the ad exposure terms and the other marketing variables. Fifth, to test for an artifactual nonlinear response due to extreme values of ad exposure, the second stage was rerun with advertising truncated at the level of eight exposures. The results were not substantially different. However, because the exposure effects are weak, they contribute little to explained variation or predictive validity and may not be generalizable.

#### DISCUSSION

##### Consistency of Results

The most interesting conclusion from the analysis is that loyalty is a significant moderator of the effects of ad exposure, with buyers responding more strongly to brands to which they are more loyal. This result also has support in many of the experimental and field studies reviewed. Another important result is that behavioral response to advertising exposure is probably nonlinear, like the attitudinal and cognitive responses found in numerous experimental studies. The finding that about two to

Figure 1  
PLOT OF RAW DATA:  
VOLUME RESPONSE VERSUS AD EXPOSURE  
BY BRAND LOYALTY<sup>a</sup>



<sup>a</sup>L = brand loyalty.

three exposures is optimum is similar to McDonald's (1971) results from a field study on the London diary panel.

Though some of the preceding results are as hypothesized, the difference in results across stages of the analysis is unexpected and may appear counterintuitive. Only the main effect of advertising has a moderate effect on brand choice and only the interactive effect with loyalty has an effect on volume purchased. In other words, advertising has a small effect in winning new buyers but a relatively stronger effect in reinforcing intensity of preference. There may be some external support for this counterintuitive result. First, the only field study that addressed this issue (Raj 1982) also found advertising exposure to be more effective in increasing volume purchased than in promoting brand switching. Second, the result may not be inconsistent with the theory and the previous two results. If advertising affects loyal buyers more than nonloyal buyers, we should expect it to affect the quantity purchased of the preferred brand rather than which brand is purchased. The increasing response to exposure of untried brands is also unexpected, but may not be unreasonable. Because of consumer inertia and selective information processing, untried brands probably require very high levels of exposure before they begin to get their message across and induce trial. Indeed, it is consistent with conventional wisdom that new brands need heavy advertising.

The differential effects of the other marketing mix variables are more intuitive. Thus price affects the quantity purchased more than brand switching, but coupons, displays, and features primarily affect brand switching. Also, one would expect the more visible of these four variables to have the greater impact on brand switching. Features in local media therefore are likely to be the most effective and in-store displays the next most effective, whereas price changes by themselves are not easily noticed. The negative effect of coupons and the relatively weaker effects of displays and features in the model of volume may be due to their measurement as dummy variables (present or not). The variables do not measure the coupon size (which is incorporated in the price paid), the type of display, or the value featured, aspects that are more likely to affect volume. However, the imperfect measurement of these variables is still an improvement over previous models, in which promotion is often calibrated jointly and sometimes partly inferred from the dependent variable.

An important observation is that advertising is not the strongest determinant of purchase behavior. Without question, loyalty is the strongest determinant of purchase behavior: brand loyalty on brand choice and volume loyalty on units bought. The other marketing variables, especially price, are also more effective than advertising. The effects of the loyalty variables are not merely definitional—all of the loyalty variables are defined carefully on behavior that is prior to that being predicted. The strong effect of loyalty indicates that the prepon-

derance of purchase behavior is characterized by inertia or predetermined preferences.

#### *The Problem of Causality*

Most econometric studies that use aggregate advertising measures have problems of reverse causality because managers often set advertising budgets in expectation of sales. The analysis of scanner data by the logit model overcomes the problem by simultaneously incorporating a between-subjects and between-brands design and a within-subjects and within-brands design over time. It is unlikely that managers set advertising exposure levels in expectation of purchases at such disaggregate levels. The between-brand analysis and the interaction with loyalty control for artifactual findings that arise if heavier users of a brand are heavier viewers of television. The between-brand analysis also provides greater power and efficiency than a separate analysis for each brand; when combined with the loyalty interaction, it generates a unique design to analyze the differential response to ad exposure.

#### *Implications*

Does advertising repetition help? How does it vary across market segments? The study provides some answers to these questions, subject to the limitations cited hereafter. Advertising appears effective in increasing the volume purchased by loyal buyers but less effective in winning new buyers. For loyal buyers, high levels of exposure per week may be unproductive because of a leveling off of ad effectiveness. Given the effectiveness of the other marketing variables, especially in brand switching, a reasonable strategy would be to promote trial with displays, features, and coupons and then motivate repurchase and more intensive purchases with advertising.

Is advertising a barrier to entry? The study provides some insight to this problem of public policy. To the extent large share brands have more loyal buyers, advertising works more to their advantage than to that of small share brands. Indeed, the correlation between brand loyalty and brand share (of volume purchased in the first 20 weeks) is relatively very high (.44), lending support to such a hypothesis. However, the findings indicate that it is not advertising's power of differentiation that is responsible for such effects, as many economists assume, but the fact that consumer behavior is more responsive to messages of preferred brands. Even new entrants or smaller firms could have effective response to advertising from buyers loyal to their brands. Because advertising does not strongly influence brand switching, it does not facilitate market entry; displays, features, and coupons are more effective in that respect. Overall, because advertising is one of the less important determinants of purchase behavior, its power to deter or facilitate entry, or otherwise affect purchase behavior, appears limited. Because loyalty is such a strong determinant of purchase behavior, the order in which brands enter the market is

probably an important factor in competition.

Could advertising create brand loyalty? From the results, such an interpretation seems implausible, at least in the current mature stage of the product life cycle. Because advertising has only a small effect on current purchase, and current purchase has a major impact on future purchase (as determined by the loyalty variable), advertising could not cause brand loyalty. Moreover, a review of past empirical analyses indicates that such delayed effects of advertising are small and decay rapidly (Assmus, Farley, and Lehmann 1984; Clarke 1976, 1982; McDonald 1971). Therefore, advertising appears unlikely to have some cumulative effect that leads to loyalty. One cannot predict the role of advertising in the early stage of the studied product's life cycle. However, the data do include new brands. To the extent they have lower brand loyalty, which does not enhance current response to ad exposures, advertising does not appear to create brand loyalty even for new products. Because loyalty is estimated on an independent prior 20 weeks, brand loyalty appears to be responsible for advertising effects.

#### Limitations

Though the study results are generally consistent with the theory and literature, the conclusions are tentative, given the limitations that are typical of such econometric studies. First, the domain of the data is limited. It covers only a single year's history of a frequently purchased, mature product category, for a sample of consumers in a single market. Though scanner data have not been shown to have any major sampling limitations, a fuller understanding of these issues must await replications. Second, the content of the advertising is not considered. Including such information would revolutionize our testing of advertising effects and is probably the most promising research direction. Third, the role of advertising in the early stage of the life cycle should be captured. Fourth, many improvements in method are possible, such as incorporating purchase timing, panel attrition, advertising carryover, and interactions among and nonlinear response to the other marketing variables.

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