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AN EMPIRICAL COMPARISON OF AWARENESS FORECASTING MODELS OF NEW PRODUCT INTRODUCTION

VIJAY MAHAJAN, EITAN MULLER AND SUBHASH SHARMA
Southern Methodist University
The Hebrew University of Jerusalem
University of South Carolina

Five awareness forecasting models embedded in their respective new product introduction models are compared. Conditions which govern the differences in the awareness estimates provided by the various models are delineated. Managerial implications of the results are discussed.

(Awareness Forecasting; New Product Introduction; Word-of-Mouth; Diffusion)

1. Introduction

In modeling the adoption of a new brand, an analyst may consider a consumer moving through three stages in the process of becoming a customer of the brand. These stages are: awareness, trial and repeat. Since the sales or market share estimates based on trial and repeat are contingent upon the estimates developed for the awareness level, selection of a particular awareness model can influence the predictions. For a practitioner, the main question is which of the several awareness models should he use and why. What we show in this paper is that the models can perform differently when applied to the same set of data. We discuss the reasons why it is so and under what circumstances do we expect the differences to be large.

It should be noted, however, that although consumer awareness is an integral stage of the growth pattern of a new brand, not all of the new product introduction models proposed over the years explicitly consider the awareness stage in modeling the growth of a brand. For example, out of the nine test-market models for new product introduction reviewed by Narasimhan and Sen (1983), only four include a separate awareness stage. Similarly, out of the 13 repeat purchase models reviewed by Wind (1981, Chapter 15) and Mahajan and Muller (1982), less than half include a separate awareness stage. Consequently, our study is restricted to the awareness models embedded in the following new product introduction models: AYER (Claycamp and Liddy 1969), TRACKER (Blattberg and Golanty 1978), NEWS (Pringle, Wilson and Brody

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1982), LITMUS (Blackburn and Clancy 1982) and Dodson and Muller (1978).[1] Furthermore, because of the nature of the available data and lack of modeling details, our analysis is confined to the advertising component of these models.

2. The Models

Brand awareness (unaided plus aided) in a target market can be generated by advertising, free samples, coupons, word-of-mouth communication and other marketing activities such as in-store displays. All of these marketing vehicles are awareness generating stimuli. However, the awareness generated is subject to decay due to forgetting over time. The awareness level due to advertising generated in a given time period depends upon the amount of advertising dollars and the quality of the advertising campaign. However, there may be diminishing returns to advertising. In addition, prior to the start of advertising for a new brand, some level of measured initial brand awareness may also exist due to "yea-saying," confusion of the brand name, etc. Furthermore, for a target market, there may be a limit to the maximum level of awareness due to a number of factors such as lack of interest in the product category or "nay-saying" (Pringle, Wilson and Brody 1982).

In order to capture the dynamics of brand awareness, the various models examined in this paper vary in terms of the (a) awareness generating stimuli included in the analysis, (b) specification or estimation of initial awareness and (c) response functions. A brief description of these models (relevant to the study) follows.

TRACKER (*Blattberg and Golanty* 1978)

The model suggests that a consumer can become aware of the new product primarily through advertising. The following representation is used to specify the relationship between awareness and GRP's (gross rating points):

$$A_t - A_{t-1} = (1 - e^{\alpha - \beta \mathrm{GRP}_t})(1 - A_{t-1}) \quad \text{or} \tag{1}$$

$$\ln \frac{1 - A_t}{1 - A_{t-1}} = \alpha - \beta \mathrm{GRP}_t , \tag{2}$$

where A_t is the fraction of the target market aware of the new product at time t and α and β are constants. The model assumes decreasing marginal returns to advertising and maximum level of 100% awareness. It does not explicitly consider the effect of free samples and coupons.

The parameter α is assumed to represent the effect of no advertising on awareness. Hence, if α is positive, then awareness declines when there is no advertising. If α is negative, awareness increases when there is no advertising. In general, it is assumed that $-\infty < \alpha < \infty$. The parameter α, in our judgment, has a further interesting interpretation. Since it is designed to capture increase or decrease in awareness when there is no advertising, it essentially captures two additional awareness components. That is, word-of-mouth communication and forgetting. Let $\alpha = L - b$, where L represents a *constant* forgetting effect and b represents a *constant* word-of-mouth effect on the awareness process. Hence, if L is greater than b, α is positive and awareness declines. On the other hand, if word-of-mouth effect dominates, then b is greater than

[1] In addition to these models, the new product introduction models proposed by Urban (1970, SPRINTER), Assmus (1975, NEWPROD), and Mahajan and Muller (1982) also include a separate awareness stage. In Urban's SPRINTER, awareness stage is broken into several categories according to the source of information. In NEWPROD, Assmus assumes that a consumer can become aware through advertising, coupons or free samples. Mahajan and Muller decompose the awareness stage into three categories of favorable, neutral and adverse awareness. Because of unavailability of data and/or unspecification of response functions, these models could not be included in the study.

L, α is negative and awareness increases when there is no advertising. Hence, the parameter α measures the net effect of forgetting and word-of-mouth communication. However, the model assumes that the impact of these two awareness components is *independent* of the awareness level.

The parameter β represents the responsiveness of awareness to advertising. It is assumed that $\beta > 0$, indicating that advertising increases awareness. TRACKER estimates initial awareness, A_0, by considering it a model parameter. Furthermore, equation (2) can be estimated by using ordinary least squares procedures. Note again that the model does not explicitly consider the distribution of free samples and coupons, and assumes the effect of word-of-mouth communication and forgetting to be constant over the entire awareness time horizon.

Given the limited number of survey observations (three per brand), the model parameters are estimated by pooling observations for different brands in a product category. This estimation strategy clearly assumes that the parameters are homogeneous across brands.[2]

NEWS (Pringle, Wilson and Brody 1982)

BBDO's NEWS considers brand awareness to be generated by advertising and promotional efforts such as free samples and coupons. The model explicitly considers decay in retention due to forgetting. However, it assumes that initial awareness level, prior to the start of advertising, A_0, is not subject to decay. The model excludes awareness generated via word-of-mouth communication. The total awareness, A_t, at any time t is given by

$$A_t = AV_t + AP_t(A^* - AV_t) \tag{3}$$

where AV_t represents total brand awareness at time t due to advertising, A^* is the maximum level of awareness and AP_t is the fraction aware due to promotion. Brand awareness from advertising is treated as having three components:

$$AV_t = AN_t + AE_t + AR_t, \tag{4}$$

$$AN_t = (A^* - A_{t-1})(1 - e^{-\beta \mathrm{GRP}_t}), \tag{5}$$

$$AE_t = (A_{t-1} - A_0)(1 - e^{-\beta \mathrm{GRP}_t}), \tag{6}$$

$$AR_t = K(A_{t-1} - A_0 - AE_t) + A_0, \tag{7}$$

where AN_t = previously unaware consumers who become aware due to the current period's advertising, AE_t = previously aware consumers who, by exposure to the current period's advertising, retain their awareness, and AR_t = previously aware consumers who, though not exposed to the current period's advertising, retain their awareness. In equations (5)–(7), β represents responsiveness of awareness to advertis-

[2] In NEWPROD, Assmus (1975) specifies the following equation to describe the number of consumers becoming aware through advertising, i.e., $a_t = (1 - e^{-Id_t})U_t$ where

a_t = number of persons gaining awareness in period t,
I = quality of advertising campaign,
d_t = advertising dollars in period t,
U_t = number of consumers still unaware in period t.

If we assume that the term Id_t, measuring advertising intensity and quality, can be expressed as a linear function of GRP_t, the model can be rewritten as:

$$A_t - A_{t-1} = (1 - e^{\alpha - \beta \mathrm{GRP}_t})(1 - A_{t-1}) \quad \text{or} \quad \ln \frac{1 - A_t}{1 - A_{t-1}} = \alpha - \beta \mathrm{GRP}_t$$

which is identical to the equation used in TRACKER.

ing with diminishing returns and K is the retention rate (or $L = (1 - K)$ is the forgetting rate).

The use of the NEWS awareness model requires estimation or specification of A^*, A_0, K and β. We understand that A^* and K are estimated judgmentally on the basis of company experience and secondary data. Initial awareness, A_0, is determined by using a consumer survey and the parameter β is estimated using a numerical search procedure (Pringle, Wilson and Brody 1982). Unlike TRACKER, NEWS uses data that relate only to the specific new brand under consideration to estimate β. Hence, about two to four observations are generally available to estimate the parameter. The NEWS approach to parameter estimation is completely different from TRACKER where observations on several brands in a product category are pooled to estimate parameters. The developers of NEWS suggest that data on "similar" products may not be applicable to the new product under consideration and hence the need to calibrate the model for each product using judgmental estimates (Pringle, Wilson and Brody 1982, p. 7).

The NEWS awareness model appears to be very different from the other awareness models. However, as derived below, the model is very similar to TRACKER and can be estimated by using ordinary least squares procedures. Ignoring for simplicity the effect of promotional awareness in equation (3), substitution of equations (4)–(7) into equation (3) yields

$$\begin{aligned} A_t &= (A^* - A_{t-1})(1 - e^{-\beta \mathrm{GRP}_t}) + (A_{t-1} - A_0)(1 - e^{-\beta \mathrm{GRP}_t}) \\ &\quad + K\big(A_{t-1} - A_0 - (A_{t-1} - A_0)(1 - e^{-\beta \mathrm{GRP}_t})\big) + A_0 \\ &= (A^* - A_{t-1})(1 - e^{-\beta \mathrm{GRP}_t}) + (A_{t-1} - A_0)(1 - e^{-\beta \mathrm{GRP}_t}) \\ &\quad + K(A_{t-1} - A_0)e^{-\beta \mathrm{GRP}_t} + A_0 \\ &= (A^* - A_{t-1})(1 - e^{-\beta \mathrm{GRP}_t}) + A_{t-1} - (1 - K)(A_{t-1} - A_0)e^{-\beta \mathrm{GRP}_t} \quad \text{or} \end{aligned}$$

$$A_t - A_{t-1} = (A^* - A_{t-1})(1 - e^{-\beta \mathrm{GRP}_t}) - (1 - K)(A_{t-1} - A_0)e^{-\beta \mathrm{GRP}_t}. \tag{8}$$

Note that conceptually the only difference between equation (8) and TRACKER's equation (1) is the second term. The NEWS model subtracts forgetting from "learning" and explicitly considers forgetting to be dependent on the awareness level. Further simplification of equation (8) yields

$$\ln \frac{(A^* - A_t)}{(A^* - A_0) - K(A_{t-1} - A_0)} = -\beta \mathrm{GRP}_t . \tag{9}$$

If it is assumed that $K = 1$ (no forgetting), equation (9) reduces to

$$\ln \frac{A^* - A_t}{A^* - A_{t-1}} = -\beta \mathrm{GRP}_t . \tag{10}$$

Equation (10) is similar to the TRACKER's equation (2) when $A^* = 1$ and $\alpha = 0$. Given estimates for A^*, A_0 and K, equation (9) can be estimated by using ordinary least squares procedures. If only A^* and K are known, A_0 can be considered as an additional parameter in equation (9) and by incrementally varying A_0 the model can still be calibrated like the TRACKER awareness model by using ordinary least squares procedures.

As compared to TRACKER, the awareness model embedded in NEWS is more complete. It explicitly considers maximum level of awareness, awareness level dependent forgetting, and promotional awareness. However, as also noted by Narasimhan and Sen (1983), the parameter estimates based on a very small number of observations can be unstable.

LITMUS (*Blackburn and Clancy* 1982)

Like the NEWS model, LITMUS considers awareness generation through advertising, promotion and/or coupons and assumes these to be independent effects. The consumer is assumed to become aware because of either advertising, promotion and coupons operating alone or any combination of these three stimuli resulting into a total of seven awareness categories. The fraction of *new* awareness in each one of these seven categories in period t, a_{it}, $i = 1, \ldots, 7$, is given by

$$a_{it} = P_{it} U_t , \tag{11}$$

where P_{it} is the probability of new awareness in category i and U_t is the unaware fraction. Hence, the total incremental awareness in time period t is:

$$A_t - A_{t-1} = \left[\sum_{i=1}^{7} P_{it} \right] U_t . \tag{12}$$

The model does not include awareness due to word-of-mouth communication. Although in relating awareness to trial, the model acknowledges the incorporation of forgetting (Blackburn and Clancy 1982, p. 54), further details on its actual measurement and its precise delineation and estimation in the awareness model will be helpful. No details are provided regarding the data sources (except that some are historical and some are actual in-market experience), estimation procedure, estimation or specification of initial awareness and incorporation of promotional effects. However, we understand from its developers that since the model actually evolved from NEWS, its data sources and estimation procedures are similar to NEWS. The model specifies the following advertising response function:

$$P_{At} = 1 - e^{-\alpha_1 \alpha_2 \cdot a \cdot \mathrm{GRP}_t} \tag{13}$$

where P_{At} is unconditional probability of awareness due to advertising, a reflects advertising impact, α_1 represents the attention power of advertising with respect to the industry (average = 1.0), and α_2 reflects attention power of the media (average = 1.0). Assuming $\beta = \alpha_1 \alpha_2 \cdot a$ and $U_t = A^* - A_{t-1}$, and considering only the awareness due to advertising, substitution of equation (13) into equation (11) and further simplification yields

$$\ln \frac{A^* - A_t}{A^* - A_{t-1}} = -\beta \mathrm{GRP}_t \tag{14}$$

which is the NEWS model, equation (10), with $K = 1$.

Dodson and Muller (1978)

The model proposed by Dodson and Muller (1978) is a multistage innovation diffusion model of new product acceptance. The driving behavioral element in the model is word-of-mouth communication. In fact, the model assumes that the primary objective of advertising and word-of-mouth communication is to generate awareness (Mahajan and Muller 1979). The model explicitly considers awareness level dependent forgetting and excludes brand awareness due to promotional activities. The model's awareness stage can be represented as:

$$\frac{dx_t}{dt} = -f(\text{advertising})x_t - b\frac{x_t}{N}(N - x_t) + (1 - K)(N - x_t) \tag{15}$$

where f is some function of advertising, x_t is the number of consumers who are unaware of brand at time t, b is the word-of-mouth coefficient, N is the total number of product category users and K is the retention rate (or $L = (1 - K)$ is the decay rate). Defining $A = 1 - x_t/N$ and dividing equation (15) by N, the discrete analog of equation (15) can be written as:

$$A_t - A_{t-1} = f(\text{advertising})(1 - A_{t-1}) + bA_{t-1}(1 - A_{t-1}) - (1 - K)A_{t-1}. \quad (16)$$

No details are provided regarding the estimation procedure, data sources, estimation or specification of initial awareness and the advertising response function. The model assumes maximum level of awareness to be 100%. In order to compare the model with the other awareness models, we specify $f(\text{advertising}) = 1 - e^{-\beta \text{GRP}_t}$ yielding the following model:

$$A_t - A_{t-1} = (1 - A_{t-1})(1 - e^{-\beta \text{GRP}_t}) + bA_{t-1}(1 - A_{t-1}) - (1 - K)A_{t-1}. \quad (17)$$

It should be noted that equation (17) varies from the NEWS awareness model, equation (8), on two dimensions. First, it includes the effect of word-of-mouth communication reflected by term $bA_{t-1}(1 - A_{t-1})$. Second, as compared to NEWS which considers decay only for the consumers who are made aware due to advertising (i.e., $(A_{t-1} - A_0)$), it considers forgetting for the entire population of the aware class. In the log form, equation (17) can be further simplified to

$$\ln \frac{(1 - A_t) + bA_{t-1}(1 - A_{t-1}) - (1 - K)A_{t-1}}{1 - A_{t-1}} = -\beta \text{GRP}_t. \quad (18)$$

If $b = 0$ and $K = 1$, equation (18) reduces to the specification used in TRACKER, equation (2), with $\alpha = 0$.

AYER (*Claycamp and Liddy* 1969)

As mentioned by its developers, the model was "designed to facilitate the planning and evaluation of alternative introductory compaigns for new consumer packaged goods." Furthermore, "since the primary purpose of the introductory campaign is to inform consumers about the product and stimulate early trial, and most campaigns are planned in terms of 13-week cycles," the model was designed to predict knowledge about product (advertising recall) and initial purchase at the end of 13 weeks.

The model expresses the level of advertising recall as a function of four independent variables. That is,

$$AR = a_1 + b_{11}(PP) + b_{12}(AHI * CE)^{1/2} + b_{13}(CP^*) + b_{14}(CI) \qquad \text{where} \quad (19)$$

AR = Percentage of consumers able to accurately recall advertising claims.
PP = Judged product positioning.
AHI = Average number of media impressions/household.
CE = Judged quality of advertising-copy execution.
CP^* = Coverage of consumer promotion containing advertising messages adjusted for type of promotion.
CI = Index of consumer interest in the product category.
a, b = Constants.

The relevant data for calibration are obtained through consumer surveys and management judgments and the model parameters are estimated by using least squares procedures. The reported empirical results suggested that media advertising followed by product positioning were relatively far more important in explaining advertising recall. The model does not explicitly consider forgetting and word-of-mouth communication.

Among the awareness models considered in this paper, this model differs on four dimensions. First, the model was used to predict advertising recall and initial purchase at one point in time (13 weeks) rather than over time. Second, the dependent variable used is advertising recall (and brand awareness may be one element of this) rather than brand awareness. Third, the independent variable used to measure advertising weight is AHI (average household impressions) rather than GRP's. Fourth, the model uses a square root transformation to represent diminishing returns to media weight. Acknowledging that advertising recall is a more stringent measure of consumer knowledge than brand awareness and GRP's may not be an efficient measure of advertising exposures than AHI (we understand that this measure adjusts GRP's based on the specific media vehicles), given the available data, we used the following equation to represent the advertising component of the model:

$$A_t = \alpha + \beta\left(\sum_{i=1}^{t} \mathrm{GRP}_t\right)^{1/2}. \tag{20}$$

Note that, consistent with the objective of the model, in order to forecast *total* awareness at the *end* of any time period t, equation (20) uses cumulative GRP's *up to* time t rather than GRP's for only time period t. The formulation does not require specification of initial awareness; although we understand from its developers that since what they measure is advertising recall rather than brand awareness, initial level is zero. The model does not specify the maximum level of awareness.

Summary

Table 1 summarizes the illustrative features of the five models discussed above. Some summary observations on these models are warranted:

(a) Except for TRACKER and Dodson/Muller all of the models suggest brand awareness adjustment due to sampling and/or couponing. None of the models explicitly considers the effect of distribution related stimuli such as in-store displays.

TABLE 1

*Illustrative Features of Various Awareness Models**

		Marketing Mix Variables Considered						
	Model	Advertising	Sampling	Couponing	Word of Mouth	Forgetting	Initial Awareness	Maximum Level of Awareness
1.	TRACKER** (Blattberg & Golanty 1978)	√	—	—	√	√	determined via estimation procedure	100%
2.	NEWS (Pringle, Wilson, & Brody 1982)	√	√	√	—	√	determined through consumer survey	judgementally determined
3.	LITMUS (Blackburn & Clancy 1982)	√	√	√	—	√	determined through consumer survey	judgementally determined
4.	Dodson & Muller (1978)	√	—	—	√	√	—	100%
5.	AYER*** (Claycamp & Liddy 1969)	√	√	—	—	—	zero	—

*(√) Indicates the features included. (—) Indicates not included or not specified (or detailed). None of the models explicitly includes the effect of distribution awareness stimuli such as in-store displays.

**TRACKER assumes that the impact of word-of-mouth communication and forgetting is constant over the entire time horizon.

***AYER measures advertising recall rather than brand awareness. Hence, the "initial awareness" level is zero.

(b) Only NEWS and Dodson/Muller explicitly considers forgetting or decay which is dependent upon the awareness level achieved. TRACKER assumes this to be constant over the entire awareness process. LITMUS acknowledges the inclusion of forgetting in its formulation.

(c) Only Dodson/Muller and TRACKER include the effect of word-of-mouth communication on awareness. However, TRACKER assumes this effect to be constant and independent of the awareness level achieved.

(d) Except for NEWS and TRACKER, none of the models include, specify or estimate initial awareness. NEWS measures it through consumer surveys and TRACKER estimates it by considering it as an additional parameter. The procedure used in LITMUS is suggested to be similar to NEWS. Since AYER measures advertising recall rather than brand awareness, initial level is assumed to be zero.

(e) Except for NEWS, LITMUS and AYER, all of the models assume maximum level of awareness to be 100%. NEWS and LITMUS determine this judgmentally or through secondary sources. AYER does not include this in its formulation.

(f) Except for AYER, all of the models use the exponential form to represent diminishing returns to advertising. AYER achieves this by using a square root transformation.

(g) Given judgmental and survey data, all of the models, except for Dodson/Muller, can be estimated by using least squares procedures.

3. Performance Evaluation

Given the conceptual and estimation differences between the models, the main question is which of the five models one should use. In order to evaluate this question, because of the nature of the available data and the lack of modeling details, our analysis is restricted to the advertising component of the awareness models. More specifically, the following practical questions are investigated:

(a) Does the square root transformation used in AYER, equation (20), as compared to the exponential form used in the other four models, better capture the dynamics of the relationship between advertising and awareness?

(b) Should the value of initial awareness level (except for AYER) be obtained through consumer surveys (as is currently done in NEWS) or estimated by considering it as an additional parameter of the model (as is currently done in TRACKER)?

(c) Does the precise delineation of the maximum level of awareness, forgetting, initial awareness, and word-of-mouth communication lead to better forecasts?

(d) Can reasonable forecasts be developed for a new brand by pooling observations on the other brands in the same product category (as is currently done in TRACKER)?

In order to investigate these questions, two data sets on awareness and advertising (GRP's) are used. The first data set, containing five observations, is for an individual brand (food category) and was provided by BBDO, Inc. It was indicated by BBDO that for this brand, based on consumer surveys and management judgement, $A_0 = 0.0$, $A^* = 0.9$ and $K = 0.9$.

The second data set is for an established product category containing seven brands and was provided by Golanty and Associates. Six of these brands contain three observations per brand and the seventh brand contains four observations. Since TRACKER assumes $A^* = 1.0$, $K = 0.0$ (no forgetting) and estimates A_0 via its estimation procedure, no estimates on these three parameters were available for this data set. Hence, a range of values on these parameters were assumed with the *minimum* values of $A_0 = 0.0$, $A^* = 0.9$ and $K = 0.9$.

Given 3–5 observations per brand, it was decided to compare the Dodson/Muller model, equation (17) or (18), without the word-of-mouth communication term, i.e.,

$b = 0$, and, hence, estimate the model, like other models, by ordinary least squares procedures. However, the impact of word-of-mouth communication on awareness forecasts is examined analytically in the Appendix. Furthermore, since awareness dependent forgetting is considered explicitly only in NEWS and Dodson/Muller, the same value of K was used in both the models. The LITMUS model was used without forgetting, i.e., equation (14).

3.1. *Empirical Results*

Tables 2–4 and Figure 2, and Tables 5–7 and Figure 3 provide the results for the brand (food category) data and the product category data, respectively, for the first

TABLE 2

Parameter Estimates for the Brand (Food Category) Data

	Parameters*			Fit Statistics**	
Model	A_0	α	β	r^2(adj)	Mean Absolute Error
TRACKER	0.00	− 0.2665 (0.3703)	0.0000116 (0.00033)	0.935	0.1075
	0.48	− 0.0969 (0.0724)	0.0000260 (0.00006)	0.970	0.0082
NEWS	0.00	—	0.0003922 (0.00013)	0.865	0.1032
	0.45	—	0.0001947 (0.00004)	0.911	0.0189
LITMUS****	0.00	—	0.0002602 (0.00015)	0.936	0.1766
	0.49	—	0.0001423 (0.00004)	0.953	0.0142
Dodson/Muller***	0.00	—	0.0003403 (0.00011)	0.867	0.1069
	0.45	—	0.0002654 (0.00005)	0.757	0.0262
AYER	—	0.3880 (0.0343)	0.0045660 (0.00064)	0.926	0.012

*Standard errors for α and β are given in the parentheses.

**The adjusted correlation coefficient (r^2) and mean absolute error are between actual awareness and predicted awareness.

***The model assumes that there is no word-of-mouth effect.

****The model assumes that there is no forgetting.

TABLE 3

Actual and Fitted Awareness for the Brand (Food Category) Data

		Fitted Awareness*								
Cumulative GRP's	Actual Awareness %	TRACKER 0.0	TRACKER 0.48	NEWS 0.0	NEWS 0.45	LITMUS 0.0	LITMUS 0.49	Dodson/Muller 0.0	Dodson/Muller 0.45	AYER
968	54	24	54	28	53	20	54	28	53	53
2154	59	43	59	50	60	39	60	49	60	60
2879	61	57	64	56	62	47	63	55	61	63
3329	67	67	68	57	63	52	64	56	60	65
5152	72	75	72	71	70	66	70	71	69	72

*The columns for each model (except for AYER) give the fitted values for the two different values of initial awareness, A_0.

TABLE 4

NEWS Parameter Sensitivity Analysis for the Brand (Food Category) Data

	Parameter Values				Mean Absolute Error
Case	A^*	A_0	K	β	
1	0.9	0.0	0.9	0.0003922	0.1032
2	0.9	0.0	1.0	0.0002602	0.1766
3	0.9	0.45	0.9	0.0001947	0.0189
4	0.9	0.45	1.0	0.0001553	0.0204
5	1.0	0.0	0.9	0.0003019	0.1277
6	1.0	0.0	1.0	0.0002031	0.2028
7	1.0	0.45	0.9	0.0001413	0.0195
8	1.0	0.45	1.0	0.0001127	0.0276

ANOVA Results

Parameter	Sum of Squares	df	Mean Square	F	p	ω^2
A^*	0.000	1	0.000	0.640	0.469	
A_0	0.035	1	0.035	50.162	0.002	0.79
K	0.003	1	0.003	4.678	0.097	
Error	0.004	4	0.001			
Total SS	0.042	7				

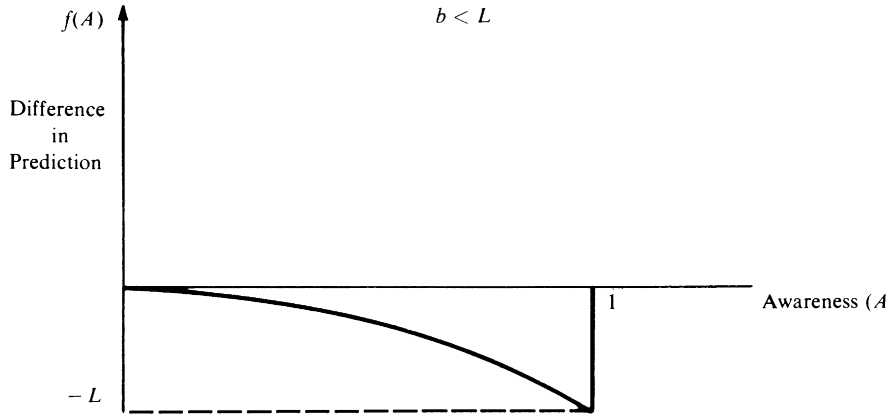
three questions posed earlier. Note that the results reported for the product category data are for the six brands (with three observations per brand). The seventh brand (with the maximum number of observations) was deleted to investigate the fourth question regarding the applicability of estimates based on pooled data for a new brand. The following comments on the results related to the first three questions are warranted:

(a) Both Tables 2 and 5 indicate that the square root transformation used in AYER correctly captures the dynamics of the relationship between advertising and awareness. The model yields right signs (positive sign) for the coefficients for both the brand (food category) data and the product category data.

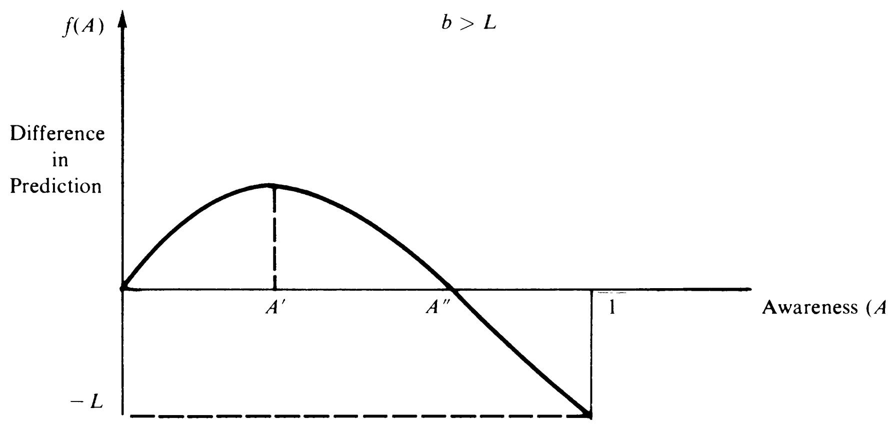
(b) For the other four models, Tables 2 and 5 give the parameter estimates and the fit statistics (the adjusted correlation coefficient and mean absolute error) by using $A_0 = 0$ and by considering A_0 as an additional parameter to be estimated. Both the tables assume that $A^* = 0.9$ for NEWS and LITMUS and $K = 0.9$ for NEWS and Dodson/Muller. The adjusted correlation coefficient (r^2), between actual awareness and predicted awareness, is reported rather than the standard R^2 since what we are trying to estimate is awareness and not some function of it such as $\ln\{(1 - A_t)/(1 - A_{t-1})\}$. The mean absolute error is also between actual awareness and predicted awareness.

The results suggest that, for both the data sets, the value of the estimated initial awareness (by considering it as a parameter) provides the best results (mean absolute error). The differences in the actual and fitted values reported in Tables 3 and 6, and Figures 2 and 3 further confirm this observation. Overall, all of *five* models provide pretty good results.

(c) In order to check the sensitivity of the forecasting errors to A^*, K and A_0, parameter estimates for NEWS (since it contains all of the parameters) were developed by considering minimum and maximum values of A^* and K, and two different values of A_0 (zero and estimated). These results (for 8 different combinations) are reported in Tables 4 and 7 for the two data sets, respectively. The ANOVA results (using arc sin transformation with radians) given in the same tables clearly indicate that the forecast-



Case 1: Word-of-Mouth Coefficient (b) is less than the decay rate (L)



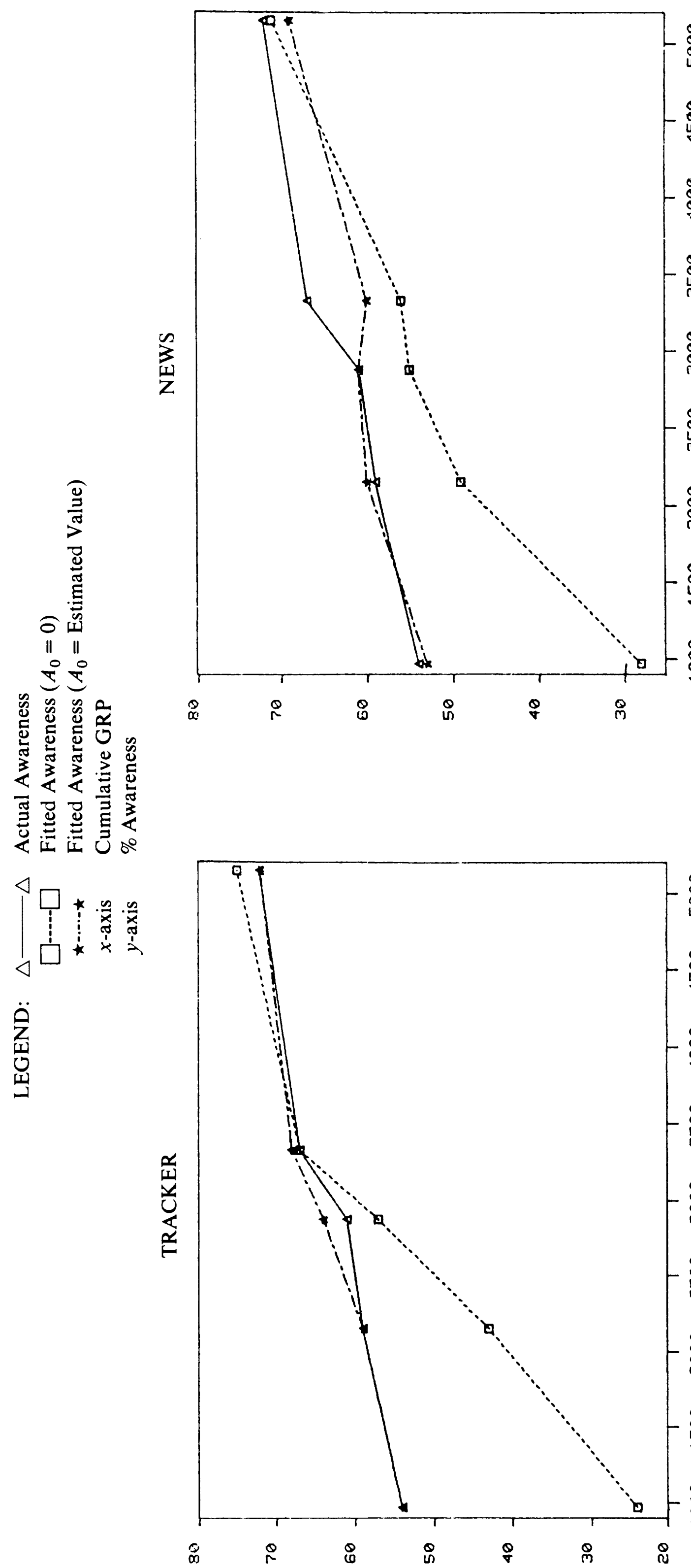
Case 2: Word-of-Mouth Coefficient (b) is greater than the decay rate (L)

FIGURE 1. Difference in Prediction Due to Word-of-Mouth Communication (Dodson/Muller vs. TRACKER).

ing efficiency of NEWS is sensitive only to the value of initial awareness. (The ANOVA results assume no interactions and report only main effects.)

The results discussed so far suggest that, for TRACKER, NEWS, LITMUS and Dodson/Muller, the key parameter is A_0. Furthermore, predictive efficiency of these models can be improved significantly by estimating A_0 (as is currently done in TRACKER). However, note in Tables 2 and 5 that the estimated values of A_0 for these models range from 45% to 50%. For a new product, this value is obviously too high. One possible explanation for such high values is that since, for both the data sets, the first observation on measured awareness ranges from 54% (for the brand (food category) data) to 81% (brand A_2 in the product category data), the estimated value of A_0 represents an estimate of "initial" awareness up to the period of first *measured* awareness rather than initial awareness before the introduction of the products. For example, for the brand (food category) data, the first observation on awareness was obtained in the second period of the introduction.

Given the above results, in order to investigate the fourth question, NEWS with $A^* = 1.0$ and $K = 1$ and AYER were used. Notice from equations (2), (9), (14), and (18) that with $A^* = 1.0$ and $K = 1$, NEWS is identical to TRACKER (with $\alpha = 0$), LITMUS and Dodson/Muller (with $b = 0$). Data from six brands were used to estimate β and A_0 with $\beta = 0.000560$ (0.0001) and $A_0 = 0.50$. These estimates, along with AYER estimates in Table 5, were then used to forecast the awareness for the


LEGEND:
△——△ Actual Awareness
□----□ Fitted Awareness ($A_0 = 0$)
★-·-·★ Fitted Awareness (A_0 = Estimated Value)
x-axis Cumulative GRP
y-axis % Awareness
TRACKER
NEWS
1000
1500
2000
2500
3000
3500
4000
4500
5000
20
30
40
50
60
70
80

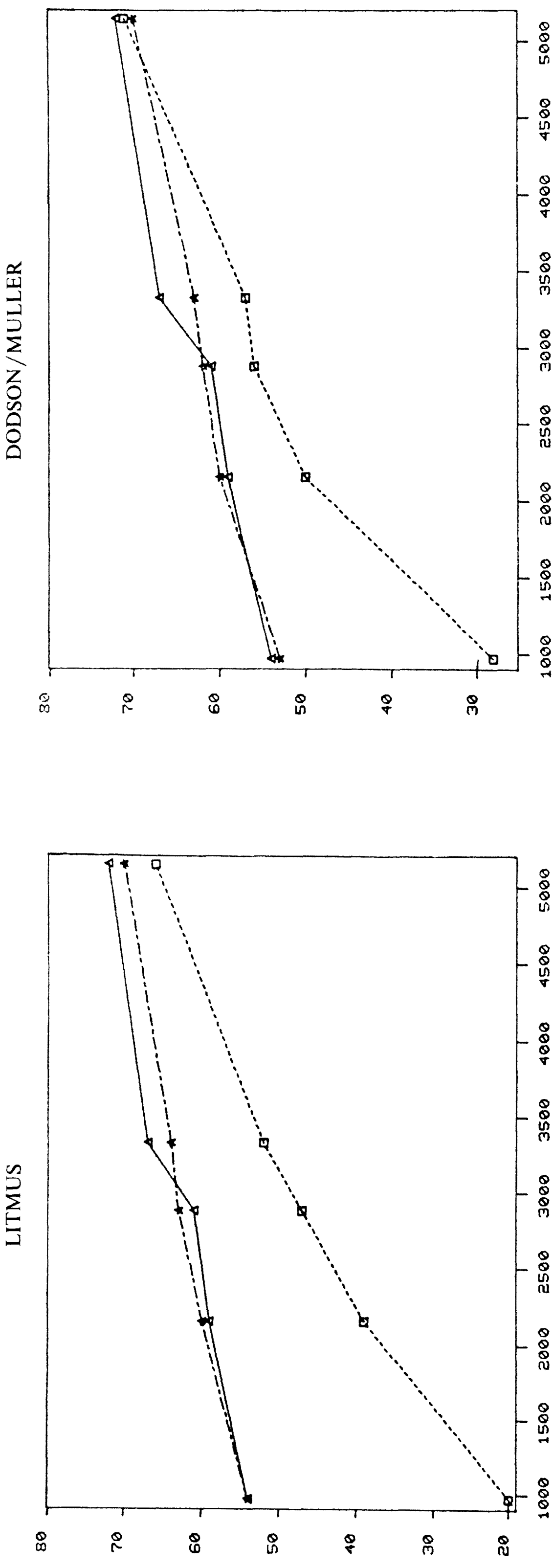
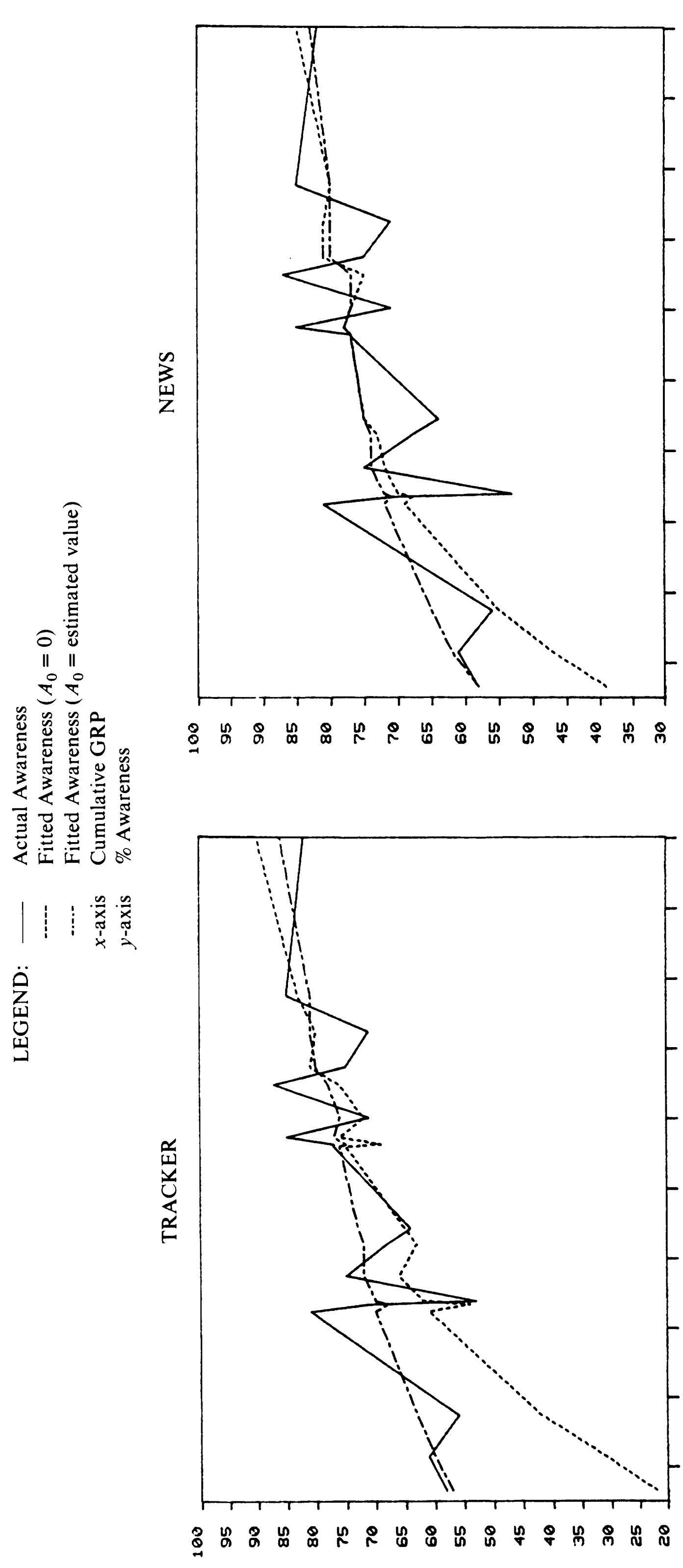


FIGURE 2. Actual and Fitted Awareness for the Brand (Food Category) Data.


LEGEND: —— Actual Awareness
----- Fitted Awareness ($A_0 = 0$)
-·-·- Fitted Awareness (A_0 = estimated value)
x-axis Cumulative GRP
y-axis % Awareness
TRACKER
NEWS
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30
400 600 800 1000 1200 1400 1600 1800 2000 2200

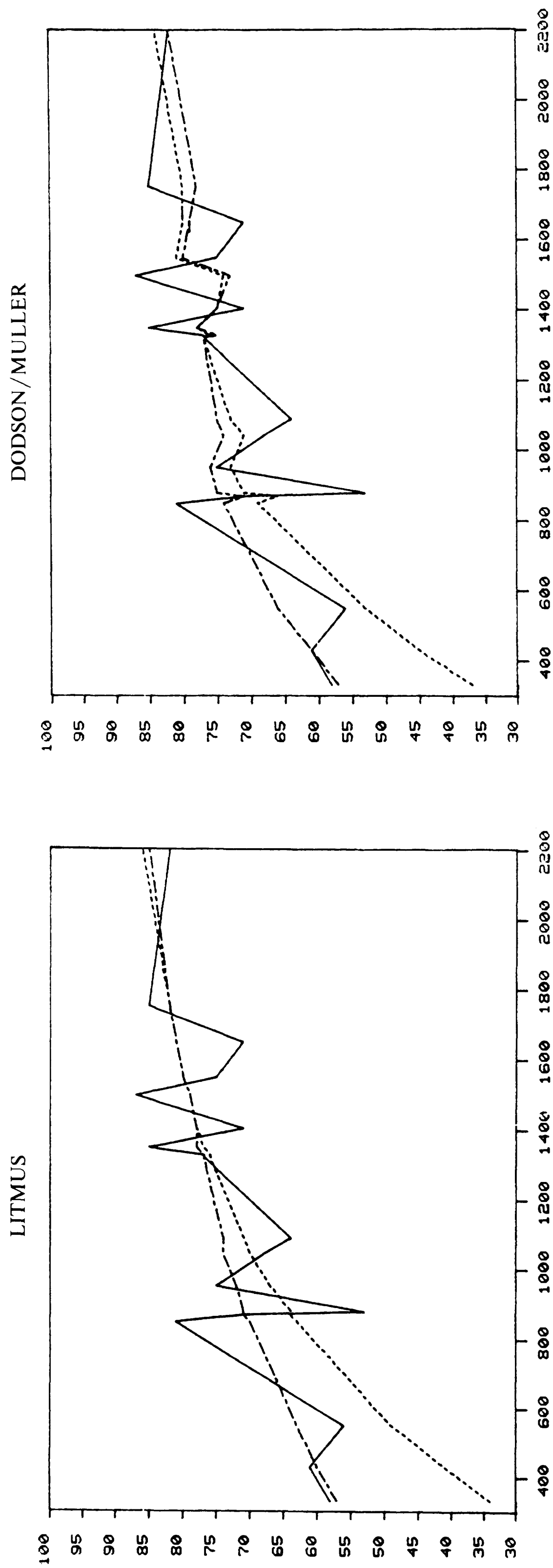


FIGURE 3. Actual and Fitted Awareness for the Product Category Data (6 Brands).

TABLE 5

Parameter Estimates for the Product Category Data (6 Brands)

Model	Parameters* A_0	α	β	Fit Statistics r^2(adj)	Mean Absolute Error
TRACKER	0.00	0.197521 (0.2604)	0.001337 (0.0004)	0.471	0.1115
	0.50	0.051417 (0.1521)	0.000647 (0.0002)	0.488	0.0565
NEWS	0.00	—	0.001717 (0.0002)	0.433	0.0738
	0.45	—	0.001086 (0.0002)	0.474	0.0577
LITMUS***	0.00	—	0.001416 (0.0002)	0.506	0.0838
	0.45	—	0.000962 (0.0001)	0.520	0.0559
Dodson/Muller**	0.00	—	0.001388 (0.0002)	0.434	0.0766
	0.45	—	0.001105 (0.0002)	0.382	0.0587
AYER	—	0.389649 (0.0820)	0.009903 (0.0024)	0.490	0.0576

*Standard errors for α and β are given in the parentheses. The first row for each model (except for AYER) assumes that $A_0 = 0$.

**The model assumes that there is no word-of-mouth effect.

***The model assumes that there is no forgetting.

TABLE 6

Actual and Fitted Values for the Product Category Data (6 Brands)

Brand	Cumulative GRP's	Total Actual Brand Awareness %	Fitted Awareness* TRACKER 0.0	TRACKER 0.50	NEWS 0.0	NEWS 0.45	LITMUS 0.0	LITMUS 0.45	Dodson/Muller 0.0	Dodson/Muller 0.45	AYER
A1	952	75	66	72	72	74	67	72	73	76	70
	1324	77	75	76	77	77	76	77	77	77	75
	1753	85	83	81	80	80	82	82	80	78	80
A2	850	81	61	70	69	72	63	70	69	74	68
	1350	85	76	77	78	78	77	78	78	78	75
	1500	87	76	78	75	77	79	79	74	73	77
A3	550	56	42	63	55	65	49	63	53	66	62
	1045	68	63	72	73	74	70	74	71	74	71
	1405	71	72	76	77	77	78	78	75	75	76
B1	330	58	22	57	39	58	34	57	37	57	57
	870	71	54	68	68	71	64	71	66	71	68
	1330	77	69	75	77	77	76	77	76	75	75
B2	430	61	31	60	47	62	41	60	45	61	60
	1090	64	65	73	75	75	71	74	73	75	72
	1650	71	80	80	81	80	81	81	80	79	79
C1	880	53	62	70	70	72	64	71	71	75	68
	1550	75	81	80	81	80	80	80	81	80	78
	2200	82	90	86	85	83	86	85	84	82	85

*The columns for each model (except for AYER) give the fitted values for the two different values of initial awareness, A_0.

TABLE 7

NEWS Parameter Sensitivity Analysis for the Product Category Data (6 Brands)

	Parameter				Mean Absolute Error
Case	A^*	A_0	K	β	
1	0.9	0.0	0.9	0.001717	0.0738
2	0.9	0.0	1.0	0.001416	0.0838
3	0.9	0.45	0.9	0.001086	0.0577
4	0.9	0.45	1.0	0.000962	0.0559
5	1.0	0.0	0.9	0.001214	0.0892
6	1.0	0.0	1.0	0.001018	0.1011
7	1.0	0.45	0.9	0.000701	0.0584
8	1.0	0.45	1.0	0.000626	0.0586

ANOVA Results

Parameter	Sum of Squares	df	Mean Square	F	p	ω^2
A^*	0.002	1	0.002	3.870	0.121	
A_0	0.025	1	0.025	46.133	0.002	0.77
K	0.001	1	0.001	1.134	0.347	
Error	0.002	4	0.001			
Total SS	0.030	7				

TABLE 8

Predictions Based on Pooled Data for the Seventh Brand in the Product Category Data

Brand	Cumulative GRP's	Actual Awareness	NEWS Predicted Awareness	AYER Predicted Awareness
C_2	1050	73	72	71
	1700	82	81	80
	2100	85	85	84
	3600	90	93	93
Mean Absolute Error			0.015	0.020
r^2			0.971	0.965

seventh brand. These results are reported in Table 8. The actual versus the forecast values and the fit statistics clearly suggest that for the product category under investigation, estimates based on the pooled data provide reasonably accurate forecasts. In order to further investigate the pooling issue, similar analyses were performed to predict awareness for *each* of other brands based on the estimates derived from the remaining six brands. The average mean absolute error was 0.068 for NEWS (brands $A_1 = 0.052$, $A_2 = 0.134$, $A_3 = 0.066$, $B_1 = 0.022$, $B_2 = 0.058$ and $C_1 = 0.079$) and 0.064 for AYER (brands $A_1 = 0.050$, $A_2 = 0.127$, $A_3 = 0.062$, $B_1 = 0.018$, $B_2 = 0.058$, $C_1 = 0.070$). These analyses again suggest that, for the product category under investigation, reasonable forecasts can be developed by using pooled data.

4. Conclusions

This paper compared five awareness forecasting models by fitting the models to two common sets of data on awareness and advertising. The results suggest the following:

(a) The square root transformation, used to represent diminishing returns to media weight, in AYER correctly captures the dynamics of the relationship between advertising and awareness.

(b) Predicted power of TRACKER, NEWS, LITMUS and Dodson/Muller is sensitive only to the value of initial awareness assumed or estimated to calibrate these models. In fact, best results are obtained by considering the initial awareness as an additional parameter in the models (as is currently done in TRACKER) irrespective of whether the models are developed for a specific brand or a product category (by aggregating data on all brands).

(c) For a new brand in a product category, reasonable awareness forecasts can be developed by aggregating data on the other brands in the product category.

Overall, all the models provide pretty good fits for both the brand and the product category data sets. The results suggest that in spite of involved dynamics of the brand awareness phenomenon, the relationship between awareness and advertising can be captured by the simple model specifications.

Given the nature of the available data, the explicit impact of the word-of-mouth communication on awareness could not be investigated empirically. However, conditions under which one would expect the models, with and without awareness level dependent word-of-mouth communication, to differ in predicting the awareness level were delineated.

Finally, the reported results are based on two data sets and, hence, warrant a certain degree of caution concerning the relative performance of the models. Furthermore, inclusion of other awareness stimuli in the respective models may alter the relative performance of the models. However, in spite of these limitations, the results do shed some light on the usage of these models to predict brand awareness.

Appendix. Difference in Prediction Due to Word-of-Mouth Communication

Since the impact of word-of-mouth communication on awareness could not be checked empirically, it might be of interest to try to predict under what circumstances will the difference in performance between the models be larger or smaller. More specifically, in order to assess the maximum potential difference, we will consider the difference between TRACKER and Dodson/Muller.

Denote by $f(A)$ the difference in the change in awareness level between the nonlog form of TRACKER, equation (1) with $\alpha = 0$, and the diffusion process with word-of-mouth communication and decay, equation (17). Thus (dropping the t subscript), $f(A) = bA(1 - A) - LA$ where $L = 1 - K$. The properties of $f(A)$ depend upon the relative values of b, L and A $(b, L > 0)$. Since A is bounded between zero and one, one can check the values of $f(0)$, $f(1)$, $f(A) = 0$ and $df/dA = 0$ to arrive at the following two cases (see Figure 1):

Case 1. If $b < L$, the difference between the two models will increase with A. That is, the two models will have similar prediction when A is small and will start deviating from each other when A is relatively large. In fact, the maximum difference will be at $A = 1$ when $f(A) = -L$ (see upper panel in Figure 1).

Case 2. If $b > L$, the difference between the two models will increase with A if (i) $A < A'$ and (ii) $A > A''$; where $A'' = 2A'$ and $A' = (b - L)/2b$ (see lower panel in Figure 2).

The explanation for Case 2 is straightforward. Note that $f(A) = 0$ when $A = A'' = (b - L)/b$; $df/dA = 0$ when $A = A' = (b - L)/2b$. Hence the difference between the two models increases up to A', decreases between A' and A'', and increases after A''. Hence the maximum difference occurs at either $A = A'$ when $f(A) = (b - L)^2/4b$ or $A = 1$ when $f(A) = -L$.

Hence, for a given data set, if b and L are known, given the information diffusion pattern, the maximum difference in the predictions generated by the two models can be easily estimated and explained.[3]

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[3]This paper was received January 1982 and has been with the authors for 3 revisions.

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