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THE ANALYSIS OF SEPARATE PRICE AND ADVERTISING RESPONSES TO RETAIL GROCERY SPECIALS

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In our study we have attempted to analyze the response to advertised grocery specials to determine if there are separate and statistically identifiable responses to advertising and price reductions with some uniformity over several weeks' time and over several individual stores. This type of information would be extremely useful to the retail store manager as he attempts to establish a profit-maximizing mix of advertising and price reductions.

We found a firm that was operating nine stores distributed over the Phoenix metropolitan area. This firm was unusual in that it took careful inventories of a group of some 300 items that were frequently run on advertised specials. Many studies similar to the one we were undertaking have failed because the quantities used in those studies represented only deliveries to the store without adjustments for changes in inventory from the beginning to the end of the sales period. The selected firm was a member of a grocery wholesale cooperative and received prompt delivery of merchandise to its stores. The stores were only rarely out of stock of an advertised special item and then for only brief periods of time.

A "normal sales" level for each item and store included in the study was developed from the coop's computer tape records of deliveries to each store over the entire period of study, less deliveries in the sales weeks, and divided by the number of nonsales weeks in the entire period. To the extent that sales of an item in the week following a week that it is an advertised special fall below the "normal sales" level, then our measured responses to the advertising and price reductions are biased upward.

The strategy of the manager of these stores was to offer a varying mix of advertised specials of what he considered to be "staple items," and attempt to establish a low price image without stamps or games. At midweek all of the daily papers of Phoenix carried a two-page advertisement that is typical of chain stores in the area. Many of the advertised prices of the subject firm were the normal prices rather than price reductions.

Data on sales of advertised specials were gathered starting one week after January 1, 1966. The data for sales in the week preceding and the week following Easter were excluded from the analysis because it was believed that consumer decisions regarding food purchases would be atypical during this period. This resulted in 10 weeks of data preceding Easter and the study was continued until we had 10 weeks of data following Easter. The offering of stamps and games by competing stores was essentially constant during the 20 weeks included in the study.

Within each generic group, such as instant coffee, each brand and each size of package within each brand was considered to be a separate item. Of the more than 300 items advertised during the 20 weeks of the study, many were eliminated from the analysis because they were not advertised in at least three weeks or there were price reductions in only one or two weeks. We felt that observations of the effects of advertising or price reductions on only one or two weeks would not give a reliable basis for forecasting future responses.

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The general function used as the basis for the analysis was as follows:

$$\log_e Q_{it} - \log_e Q_{iN} = b_0 + b_1 (\log_e P_{it} - \log_e P_{iN}) + b_2 A_{it-1}$$

where:

Q_{it} = quantity of an advertised special item i sold in week t.

Q_{iN} = "normal" sales per week of item i as defined earlier in the text.

P_{it} = price of item i in week t.

P_{iN} = normal price of item i.

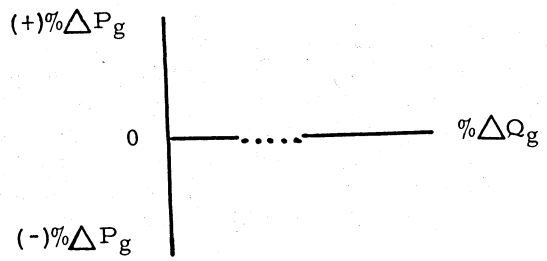
A_{it-1} = a zero-one variable with a value of 1 if item i was advertised in the week preceding week t and 0 otherwise.

On the assumption that consumers consider items within a generic group to be close substitutes, we placed the remaining items together in their respective groups. This grouping of items, and the fact that there were nine individual stores, resulted in a range of 27 to about 150 observations per group.

The subtraction of the $\log_e$ of one number from the $\log_e$ of another number yields essentially a percentage deviation from the first number, and substituting the subscript "g" for "i" in the above equation for the grouping of individual items yields the following equation.

$$\%\triangle Q_{gt} = b_0 + b_1 \triangle\% P_{gt} + b_2 A_{gt-1}$$

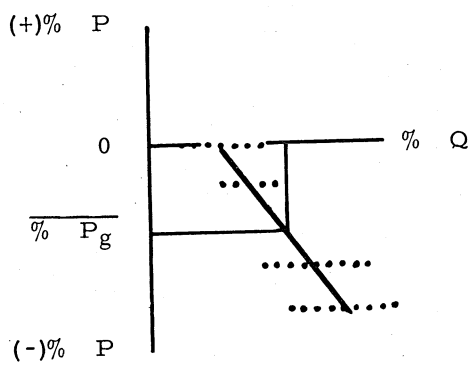
Figure 1, as follows, illustrates the nature of the observations of a group g with an advertising response but no price reduction.



The average %△Q is calculated--which is the average advertising response--and a standard t test is applied to determine if this differs significantly from zero.

We believe that least-squares regression analysis using the above equation represents a valid means of identification and measurement of separate advertising and price responses from groups in which some items have had the prices reduced below normal. An additional restriction was imposed by eliminating those groups with price reductions where there were less than three different percentages of price reduction.

Figure 2, as follows, illustrates a group with price reductions of zero and three different percentages in four weeks.



advertising effect = b_0

price effect = $(b_1)(\overline{\%\ P})$

In this case the regression coefficient b_0 represents an estimate of the advertising response with no reduction in price. A standard t test can be used to determine if the regression constant, b_0, is significantly different from zero.

The coefficient b_1 is the price elasticity of demand for the generic group. If this regression coefficient is significantly different from zero, we can define a price effect as the average price reduction multiplied by the elasticity or price effect = $(b_1)(\overline{\%\Delta P})$. In Figure 2, the distance from the horizontal intercept of regression line to the vertical line drawn to the regression line represents the average price effect.

If, for a specific group, we have several observations of price reductions and coefficients b_0 and b_1 are significantly different from zero, then we have a basis for making a discrimination between price and advertising responses for the generic group.

Table 1 lists all groups with no price reduced items, no items advertised in two consecutive weeks and all items advertised at least three of the 20 weeks. All of the 12 groups in this category had advertising responses that were significantly different from zero at the one percent level. The smallest increase in sales attributed to advertising was waffles with 27 percent, and the highest was 300 percent for cookies.

Table 2 includes all groups with no price-reduced items, some items that were advertised in two consecutive weeks in at least three instances and all items were advertised in at least three of the 20 weeks. In all but one case, in the first week of advertising of frozen fish, all of the advertising responses were significantly different from zero at the one percent level. The increased sales due to advertising in the second consecutive week is approximately the same as for the fitst week with the exception of frozen fish and marshmallows with what appears to be a cumulative effect of advertising, and wrapping paper and prepared potatoes, both easily stored, with a substantial reduction in the second week.

Table 3 lists all groups with some items advertised and reduced prices in at least three weeks. Also, each group has at least three different percentages of

Table 1. Groups of Items Without Price Reductions and Never Advertised in Two Consecutive Weeks

Group	Average % Increase in Quantity Sold by Advertising
Cream Cheese	79.5*
Canned Soft Drinks	44.5*
Frozen Meat	185.4*
Frozen Fowl	63.4*
Waffles	37.0*
Syrup	126.1*
Olives	98.4*
Salad Dressing	185.2*
Rice	64.5*
Diet Food	111.4*
Bath Soap	78.8*
Cookies	301.4*

Table 2. Groups of Items Without Price Reductions But Sometimes Advertised in Two Consecutive Weeks

Group	Average % Increase in Quantity Sold		
	All Special Weeks	By First Week of Advertising	In Second Consecutive Week of Advertising
Frozen Fish	42.6	a	47.1*
Marshmallows	-3.1	-14.9*	37.4*
Packaged Dinners	80.7	4.4*	2.8*
Popcorn	84.0	76.4*	88.7*
Preserves	91.9	103.7*	81.2*
Dried Fruit	97.8	100.8*	95.5*
Canned Mexican Food	77.0	80.0*	70.9*
Wrapping Paper	149.0	207.8*	116.9*
Prepared Potatoes	97.8	123.4*	79.8*
Frozen Juices	63.7	51.8*	74.6*
Noodles	80.5	79.1*	83.2*

* Significantly different from zero at the one percent level.
a/ Not significantly different from zero at the five percent level.

Table 3. Groups of Items with Price Reductions and Advertising

	Average % Increase in Quantity Sold			Average % Price Reduction	Price Elasticity of Demand
	All Special Weeks	From Advertising	From Price Reduction		
Biscuits	120.5	a	131.8	51.6	-2.55*
Tea	67.6	a	50.6	2.0	-25.54*
Dog Food	36.5	a	32.6	8.7	-3.75*
Cake Mixes	218.4	110.8	107.5	22.4	-4.80*
Canned Milk	119.2	73.3*	45.9	35.6	-1.29*
Sugar	165.2	111.6*	53.6	27.5	-1.95*
Margarine	311.4	303.3*	a	18.8	a
Butter	11.2	a	a	2.9	a
Lunch Meat	29.6	40.8*	a	1.7	a
Sausage	61.6	36.0*	15.3	3.3	-4.69*
Frozen Pies	42.6	a	10.1	1.8	-5.44*
Peanut Butter	55.1	49.2*	9.3	3.8	-2.44*
Pickles	132.5	137.8*	a	3.8	a
Sandwich Spread	191.7	84.8*	85.8	34.5	-2.48*
Detergents	99.1	79.4*	a	20.1	a
Coffee	27.7	13.2*	3.4	.6	-5.19*
Canned Meat	185.4	197.0*	a	.9	a
Canned Fruit Drinks	114.0	88.8*	30.2	10.5	-2.87*
Frozen Vegetables	75.8	62.9*	a	5.4	a
Canned Vegetables	75.5	71.8*	7.0	2.5	-2.83*
Paper Products	47.9	49.6*	11.8	7.0	-1.69*
Canned Fruit	78.5	a	24.4	5.0	-4.89*
Frozen Dinners	78.4	49.2*	35.4	13.4	-2.64*
Tomato Products	65.7	41.0*	33.9	11.3	-3.01*
Canned Fish	95.5	68.8*	a	20.4	a

* Significantly different from zero at the one percent level.
a/ Not significantly different from zero at the five percent level.

price reduction. Of the 25 groups in this category, 19 have significant advertising responses, 17 have significant price responses, and for 12 groups it is possible to differentiate the total response into separate advertising and price responses. For the cake mix group, the average response in weeks of advertised specials was a 218 percent increase in sales; of this increase 110 percent is attributed to advertising and 107 percent to price reduction. The average price reduction was 22 percent and the price elasticity of demand for cake mixes was -4.8. All 17 groups with elasticities of demand significantly different from zero were significant at the one percent level and had values in the range of -1.29 to -25.54.

The hypothesis most conclusively supported by this research must be that the shoppers in general have a poor grasp of normal prices. That they believe that an advertised price is a reduced price must follow from the research results which found that there would be significant responses to advertising with no price reductions in 41 of 48 groups of items. Fourteen of the advertising responses were at least 100 percent increase over normal and two were more than 300 percent.

The rather high elasticities of demand that we found suggest that the firm could increase profits by using more and larger price reductions in its advertised specials. But here the reduced margin per unit sold must be considered along

with the increased total quantity of sales in the group. If the margin after variable costs is slightly less than 10 percent, it would require a price elasticity of demand in the range of -10 to -20 before profits could be increased for a specific item by reducing the price of that item. The possibility of increasing profits from a specific item by reducing its price appears remote. The benefits of price reduction must come from increased sales of items without price reductions.

The advertising response is achieved with no reduction in price and only a very small added cost of advertising. The results of this study suggest that the subject firm, in terms of a profit maximizing objective, is well justified in advertising large numbers of items with no price reduction. At the same time, we believe that there must be some optimum number and size of price reductions below which the customers will be attracted to the stores in smaller numbers and reduce purchases of nonprice reduced items, thus reducing profits from the entire store operations.