An Exploratory Analysis of Some Dynamic Effects of Advertising on Fresh Meat Demand

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Supermarket scan data are combined with newspaper and broadcast advertising to evaluate possible short-run and long-run effects. This is the first study to report on a dynamic analysis that uses a more appropriate time frame -- weekly data. Results indicate significant own-advertising effects for the newspaper and little electronic media impact on sales.

Although consumer economists have built an extensive literature of applied demand studies, little attention has been directed toward incorporating advertising and other merchandising strategies into the analyses. With respect to food, the economics of information, changing consumption patterns, and the effects of the generic promotions have led to some preliminary analyses of advertising impacts (e.g., Buse; Capps; Capps and Nayga; Eastwood, Gray, and Brooker; Jensen and Schroeter; and Kinnucan, Thompson, and Chang). These studies have been limited in several important ways. Cross media effects have been omitted and limited measures of advertising have been used. Until recently, most of the research has been static. However, dynamic investigations (Kinnucan, Venkateswaran, and Chang; Thompson and Eiler; Ward; Ward and Dixon) have been for time periods that may not be consistent with the consumer's time horizon for foods (e.g., months or quarters) and have not allowed for possible different media effects. This paper reports on a preliminary study that incorporated some dynamic features for weekly food purchases and distinguishes between electronic and newspaper advertising.

The outline of the paper is as follows. Initially, the data and measures are described. Descriptive statistics are then presented. Pairwise correlations that provide dynamic insights are discussed. Results of regression analyses are outlined, and the consumer implications are presented.

Data

Two related data sets were combined in the study. Scan data from five supermarkets located in a metropolitan area in the Southeast were the source of the weekly sales and price information. The other was an advertising data base that comprised the print and electronic media promotions corresponding to the scan data. Each is briefly described below.

The supermarkets were part of the same chain. Two stores were in higher income areas, two in more moderate income areas, and one was on a border between high and low income neighborhoods. Data were obtained for each store beginning Sunday and ending Saturday. Weeks ending May 14, 1988 through June 29, 1991 comprised the time period. Out of the 161 weeks, there were eight for which none of the stores reported scan data sales.

Computer software used by the chain to generate the by-store corporate-level data only recorded the number of times individual bar codes were read by the scanners, called item movement (IM). Meat managers in the stores indicated that the distributions of package sizes for the various cuts did not change very much from week to week. Given this situation, IM was used as a proxy for pounds sold. Three fresh beef groups were created. IMs for 14 bar codes of ground beef were aggregated into ground, 23 for roast, and 45 for steak.

IM was converted to a per thousand customer basis, which has been found to be appropriate for demand analyses (Capps; Capps and Nayga). This was to adjust for differences in the number of shoppers patronizing the outlets and in the number of reporting stores for a week. For each of the bar codes in the groups, the IMs for the reporting stores were added together, divided by the customer counts of these stores, multiplied by a thousand, and aggregated.

Weighted prices were generated when the stores appeared to have slightly different prices. The weights were the store's share of that week's total IM for the respective product. Demand group weighted price series were calculated. These

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weights were the ratios of each bar code's IM to that of the respective IM.

Electronic media advertising by product by the chain for the area was provided separately from the scan data. The measure was the gross rating points (GRP) for the individual foods and covered the seven day period corresponding to the scan data week. GRPs for fresh beef cuts were aggregated to conform with the ground, roast, and steak groups.

Newspaper advertising occurred primarily through weekly inserts, although ads appeared in the daily paper on an irregular basis. Three measures were used: size of the ad in square inches, page on which the ad appeared, and the use of a color. Usually the chain advertised more than one cut within each group, and this is reflected in the coding scheme shown in Table 1.

Table 1
Advertisement Coding System.

Media	Description
Radio and Television	Gross rating points for specific products for each type of commercial. If more than one product in a demand category was advertised, the sum was used.
Newspaper	
Page	Page on which a product appears. No ad=0; regular paper ad=1; Other supplement page=2; front, middle, or last supplement page=3; other plus front and/or middle supplement, regular paper plus supplement=4, front and middle of supplement=5.
Space	Sum of the square inches of advertised products by demand category.
Color	No ad=0, single black and white=1, single color=2, more than one black and white=3, more than one color=4, and combination of black and white and color ads=5.

Because of colinearities among these measures, an index was generated. The index's minimum value was 0, indicating no newspaper ads for any cuts within the respective aggregate for the respective week, while the maximum value of 24 indicated three or more ads with colors other than black and white were on the front and middle pages of the supplement and regular paper. The index was designed to reflect increasing visibility as well as cost of the ads. Table 2 outlines the index.

Descriptive Statistics

Ground beef had the largest weekly IM per thousand customers (Table 3). IM for steak was about 55 percent of that for ground, and roast IM

Table 2
Index of Newspaper Advertisements*

Page	Page Color	Color Code	Code	Index
No ad	None	0	0	0
Paper only	B&W	1	1	1
	C	1	3	2
		5	3	
Other supplement page only				
	B&W	2	1	4
		3	5	
	C	2	2	6
		4	7	
		5	8	
Front, middle, last page only of supplement				
	B&W	3	1	9
		3	10	
	C	2	11	
		4	12	
		5	13	
Front, middle, last page only plus an other supplement page				
	B&W	4	1	14
		3	15	
	C	2	16	
		4	17	
		5	18	
Front plus middle of supplement				
	B&W	5	1	19
		3	20	
	C	2	21	
		4	22	
		5	23	
Holiday	C	6	24	

*See Table 1 for an explanation of codes.

was approximately 19 percent of ground IM. The coefficients of variation showed that roast IM was relatively more volatile than either ground or steak. Average prices for the three products reflected the expected differences in price levels. Price coefficients of variation were comparable and relatively low. The average values of the advertising index showed that ground was promoted at a higher level than roast or steak. GRPs also revealed a higher level of ground advertising vis-a-vis roast and steak. For all advertising variables, it appeared that ground beef promotions were more frequent and less variable than promotions for roast and steak.

Graphs of the three IM and price series are shown in Figures 1-3. No explicit vertical scales are provided due to the proprietary nature sales. For the first six months IMs were relatively low, especially for ground beef. Inspections of the graphs suggested there was no consistent monthly pattern. However, there was a

Figure 1. Ground Item Movement and Price

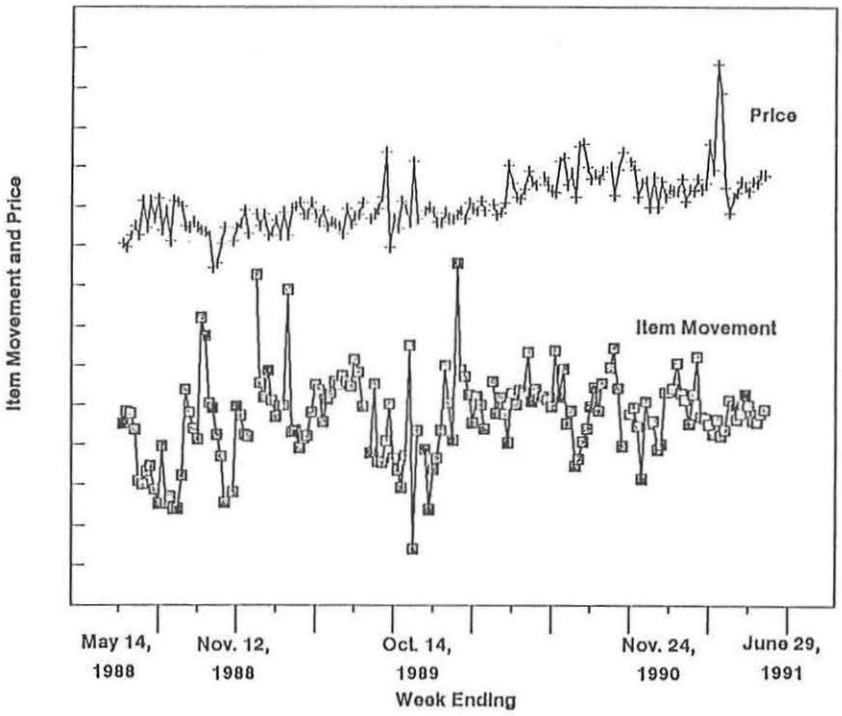

Figure 2. Roast Item Movement and Price

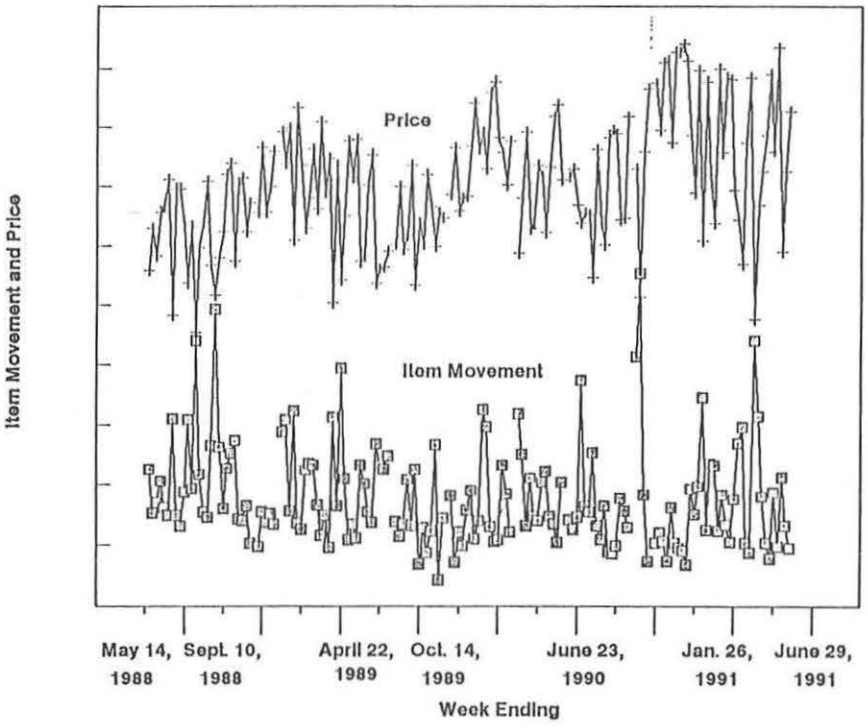

Figure 3. Steak Item Movement and Price

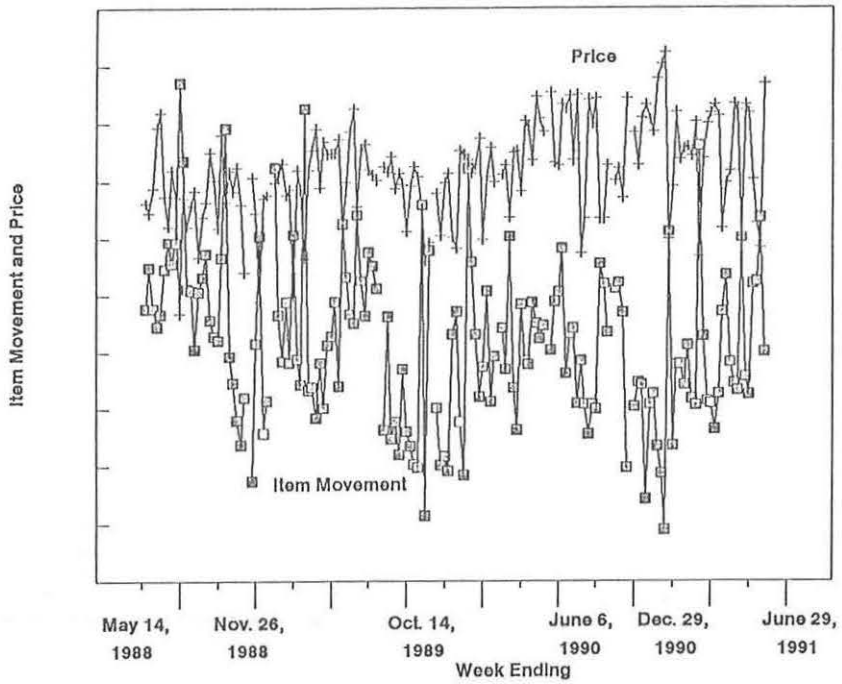

Table 3
Descriptive Statistics.

Variable	Mean	Min	Max	Std. Dev.	C. Var.
IM					
Ground	94.36	24.88	171.12	21.83	.23
Roast	18.00	4.31	55.35	8.76	.48
Steak	51.67	18.98	97.09	14.50	.28
Price					
Ground	2.07	1.69	4.19	.31	.15
Roast	2.35	1.51	3.13	.36	.15
Steak	4.09	2.84	5.12	.42	.10
ADINDEX					
Ground	10.75	0.00	24.00	5.08	.47
Roast	8.28	0.00	23.00	6.59	.80
Steak	9.18	0.00	23.00	7.52	.82
GRP					
Ground	121.12	0.00	1000.00	183.17	1.51
Roast	51.24	0.00	750.00	134.16	2.62
Steak	30.75	0.00	759.00	103.99	3.38

tendency for some months to be better or worse than others. For example, steak seemed to do relatively better in the second quarter versus the of the data. Thanksgiving was a period of low fourth. The patterns also suggested stock adjustment behavior. Ground and roast prices trended upward, whereas the aggregate steak prices had no trend. All three figures suggested negative own-price IM relationships.

Pairwise correlations are shown in Table 4. Positive IM correlations suggest there were tendencies to purchase the groups together, and these were greater for ground and steak. Own-price and IM correlations were negative, with the strongest inverse patterns for roast, followed by steak. There was little tendency for ground IM and price to move in a linear fashion. Cross-IM and price correlations were fairly low, suggesting little tradeoff.

The advertising correlations are interesting. Own ADINDEX and GRP correlations with IM suggest positive effects of the advertising, although the steak GRP-IM value is very small. Cross-group effects are also close to zero with the exception of ground ADINDEX and steak IM. Notice that the own-ADINDEX and GRP correlations with price for ground and steak are not negative, whereas those for roast are. An interpretation is that the chain advertises specific cuts and may lower these prices and at the same time raise the prices of other cuts in the same aggregate. Both the ADINDEX and GRP correlations indicate independence across the beef groups and little coordination across the two media for the same group.

Table 5 presents the simple correlations between IMs and the respective lagged GRP series. Ground has the expected pattern of positive and declining correlations as the lag increases. Roast and steak correlations are negative beyond the current period. This suggests there may be a slight tendency to purchase during the week of the broadcast and then not purchase subsequently. The

Table 4
Pairwise Correlations

	Item Movement			Price			Index			GRP		
IM	G	R	S	G	R	S	G	R	S	G	R	S
Ground	1.00											
Roast	.37	1.00										
Steak	.46	.36	1.00									
Price												
Ground	-.03	-.18	-.20	1.00								
Roast	.13	-.62	-.18	.28	1.00							
Steak	.19	-.01	.-46	.30	.29	1.00						
Index												
Ground	.15	.08	.25	.07	-.13	-.10	1.00					
Roast	-.07	.52	.00	-.06	-.54	-.11	.03	1.00				
Steak	-.09	-.05	.50	-.08	-.11	.49	.19	.00	1.00			
GRP												
Ground	.11	-.16	-.03	.22	.12	.12	.34	-.20	.02	1.00		
Roast	.02	.43	.07	-.05	-.36	-.04	.00	.22	.11	-.14	1.00	
Steak	.06	-.12	.04	.01	.13	-.04	.01	-.04	.09	-.05	-.06	1.00

Table 5
Item Movement and Lagged GPR Correlations: Ground, Roast, and Steak.

	Item Movement		
Lagged GRPi	Ground	Roast	Steak
Current	.11	.43	.04
One Week	.13	-.04	-.14
Two Weeks	.10	-.15	-.12
Three Weeks	.03	-.02	-.14
Four Weeks	.08	-.07	.12
Five Weeks	.03	-.03	-.07

current period roast IM and GRP correlation is much higher than for the other two. This is initial evidence that the broadcast media does not have a uniform impact on sales across food categories.

A Meat Demand Model

The approach taken in this exploratory study was to follow the conventional practice of assuming that fresh beef is separable from other goods. Over the time period for which data are available, there was little change in consumer income, so this variable could be eliminated from the demand relationships. The nature of the fresh beef industry is such that there are no branded products, processor promotional campaigns, or coupons. Implicit in the use of chain level regressions is the assumption that food shoppers are store loyal. This is supported by an industry study that found nearly three-fourths of the customers do not compare prices across stores (Cox and Foster) and by Funk, Meilke, and Huff who found that competitors' meat prices were highly colinear.

Based on the framework developed by Holdren and modified by Capps and Nayga, the following analytical model was developed. The quantity demand is expressed as a linear function of a price vector and a vector of nonprice variables that affect demand, shown as equation (1).

$$IM_{i,t} = f(P_t, ADINDEX_{i,t}, GRP_{i,t}, TG, QT, IM_{i,t-j}). \quad (1)$$

where:

IM = item movement.
P = vector of weighted average prices.
ADINDEX = vector of newspaper advertising indices.
GRP = vector of gross rating points.
TG = dummy variable for Thanksgiving.
QT = vector of dummy variables for quarters.
i = fresh beef aggregate subscript (i=ground, roast, steak).
t = week subscript.
j = lag subscript (j=0,...,5).

Viewed from the consumer's perspective, there is quite a difference between newspaper and electronic media food advertising. The former is considered to be a high involvement way of reaching shoppers, and the supplements and regular paper ads tend to focus on price information that pertains to the respective week. The latter is a lower involvement approach that focuses more on building store image (e.g., Rotschild). These observations indicate that there is no lag structure associated with newspaper advertising, although one may be present for the broadcast media. However, Table 5 suggests that, although electronic advertising may increase customer counts, it does not affect item movement per thousand customers.

Based on the preliminary analyses of the data, a dummy variable for Thanksgiving was included to account for this holiday when fresh beef sales are typically low. Dummy variables for quarters were also included to account for seasonal factors associated with each cut. Initial regressions led to the incorporation of the third quarter in all

three equations and the second quarter in the steak regression.

Several regressions were estimated that incorporated alternative lag structures and measures of electronic advertising. These alternatives focused on one to five week lags based on the patterns of weekly IMs. Another formulation included the sum of the GRPs for each week to allow for the possibility that the electronic media's store image was more important than the message for the separate groups. A dummy variable was also created to denote the presence/absence of the broadcast media. Alternative distributed lag structures were estimated with IM being lagged from one to five weeks. Autocorrelation was present in the roast regressions. The remedy was to include a binary variable for the unusually high (H) and low (L) IM weeks. There were six instances where H=1 and one where L=1. This was justified by the unique roast IM series vis-a-vis the other two groups. There were no pronounced troughs for roast comparable to those for ground and steak. In addition, the roast IM series had a much higher coefficient of variation. These observations suggested that the OLS algorithm adjusted to the six high peaks and single low week, leading to autocorrelation. Table 6 presents the estimated equations that provided the best overall fits for each fresh beef aggregate.

Given the dynamic structure, the coefficients should be interpreted as measures of short-run effects. In all three cases the overall F statistics are significant. The R^2s are reasonably high in light of the relatively high variability present in each series. Due to the presence of the lagged dependent variable, Durbin's h statistic is used, and the inference to be drawn is that autocorrelation is not present in any equation.

Each own-price coefficient is significant and has the expected sign. Only steak had a significant cross-price coefficient, and it was positive in the roast equation. This leads to the inference that as the price of steak rose, food shoppers increased their purchases of roast. An interpretation is that consumers may have had target amounts of fresh beef aggregates they

Table 6
IM per Thousand Customers Regression Results: Ground, Roast, and Steak (t values in parentheses) and [long-run coefficients in brackets].

Variable	Ground	Roast	Steak
Intercept	92.887*	38.681*	105.600*
	(3.12)	(5.13)	(5.63)
Price			
Ground	-23.076*	-2.431	-11.919
	(-1.90)	(-0.77)	(-1.64)
	[-32.283]		
Roast	.573	-11.341*	.916
	(.09)	(-6.96)	(.26)
		[-12.883]	
Steak	4.841	2.088*	-11.551*
	(1.01)	(1.69)	(-3.79)
		[2.372]	[-13.619]
ADINDEX			
Ground	.645*	.030	.429*
	(1.92)	(.34)	(2.10)
	[.902]		[.507]
Roast	-.392	.119	-.216
	(-1.37)	(1.62)	(-1.28)
Steak	-.167	-.044	.434*
	(-.64)	(-.65)	(2.64)
			[.512]
GRP			
Ground	.006	-.004*	-.006
	(.62)	(-1.81)	(-.96)
		[-.005]	
Roast	.013	.007*	.004
	(1.07)	(2.21)	(.53)
		[.008]	
Steak	.004	-.003	-.004
	(.29)	(-1.00)	(-.46)
TG	-20.363*	-5.778*	-11.338*
	(-2.52)	(-2.84)	(-2.33)
QT			
2			5.871*
			(2.56)
3	-11.192*	-3.519*	.152*
	(-2.73)	(-3.50)	(2.56)
H		17.287*	
		(6.97)	
L		-13.793*	
		(-2.83)	
$IM_{i,t-1}$	.285*	.108*	.152*
	(3.71)	(1.98)	(2.28)
F	5.34*	18.24*	9.22*
R^2	.33	.62	.46
Durbin's h	.25**	1.73**	1.27**

* Significant at the .10 level.
** Not significant at the .05 level.

wanted to purchase with fixed food budgets. Insignificant cross-price coefficients were consistent with the results of Capps and Nayga; Funk Meilke and Huff; Marion and Walker.

Own newspaper advertising was positive and significant for ground and steak. The larger marginal effect was for ground, followed by steak. The only significant cross-advertising effect was

for ground advertising on steak where increased ground advertising led to increased steak IM. Insignificant cross effects in the other instances led to inferences that these promotions did not affect sales beyond their own groups. A similar pattern was found by Capps and Nayga.

The only significant GRP impacts were in the roast equation. Food shoppers responded positively to the roast advertising via the electronic media, but broadcast media ground advertising decreased roast IM. The result is consistent with the correlation patterns in Table 4. This supports the arguments that broadcast promotions are really directed toward presenting different information to consumers than newspaper promotions and that the effects also differ by food group.

With respect to the dummy variables, the following coefficients were significant. TG is associated with significantly lower IMs, with the largest decline for ground followed by steak and then roast. The third quarter has lower ground and roast IMs, while steak IM is considerably higher in the spring and somewhat higher in the summer. The latter is consistent with consumers purchasing more during the return of warmer weather for grilling. Lower sales of ground and roast in the third quarter could reflect a switch to other foods that require less cooking.

IM lagged one period is significant in each equation. The magnitudes of the coefficients reflect a declining geometric lag structure. Table 6 presents the long-run estimated coefficients for the significant variables in brackets. In all instances these impacts are larger than those for the short run, reflecting the additional time consumers have to make adjustments.

Elasticities were estimated for the significant price, ADINDEX and GRP short-run and long-run coefficients (Table 7). Roast was most elastic, that for steak was nearly unitary, and that for ground was inelastic. This suggests that food shopperes were most responsive to changes in the own-price of roast and least responsive to the own-price of ground. An interpretation is that ground may be considered in terms of a more staple fresh beef aggregate and that food shoppers were much more willing to change their roast purchases vis-a-vis steak then ground. The advertising elasticities are all quite small. Due to the indexing scheme, the values themselves should not be given much consideration. However, their relative values suggest that consumers were about as responsive to ground as to steak paper ads on a percentage basis. The GRP elasticities indicate that promoting fresh beef via the broadcast media does not bring about large percentage increases in IM per 1,000 customers and suggest there are tradeoffs.

Consumer Implications

This preliminary analysis provides some useful insights regarding consumer demand for fresh beef and chain level advertising. It is the first study that explicitly examines dynamic own- and cross-advertising effects for the newspaper and broadcast media. The results also are based on weekly scan data which are more consistent with consumer planning horizons and the advertising information.

Table 7
Price, ADINDEX, and GRP Estimated Elasticities[a].

	Elasticity		
	Ground	Round	Steak
Price			
Ground	-.506 [-.708]		
Roast		-1.481 [-1.682]	
Steak		.474 [.539]	-.914 [-1.078]
ADINDEX			
Ground	.075 [.105]		.091 [.108]
Roast			.077 [.099]
GRP			
Ground		-.027 [-.034]	
Roast		.020 [.023]	
Steak			

[a]Evaluated at the sample means. Based on significant coefficients in Table 6.

Significant, positive own-newspaper advertising effects indicate that consumers have responded positively to fresh beef promotions through this medium. Insignificant cross-group paper effects imply that food shoppers are cut-loyal. That is, they use the paper ad information for decision making with respect to the groups but a paper ad for one cut does not affect the others. This suggests that the paper promotions affect the timing of purchases but not the type of fresh beef to buy. Electronic media effects are much more limited. Food shoppers do not seem to use the information contained in the electronic medium product promotions for ground and steak, but there is a small positive own impact on roasts. An interpretation is that the broadcast media are used by supermarkets to build store image and to keep the chain visible. To the extent that this is a successful strategy, more customers may result, but there is no (or little) increase in the purchases

of fresh beef on a per customer basis.

An overall implication is that newspaper advertising is used by food shoppers in their decision making for specific products. To the extent that such information can be used by food shoppers prior to entering the supermarket, this form of advertising is relevant and enhances the efficiency of food retailing for at home consumption. The electronic media expenditures, on the other hand, are less useful to food shoppers, although they may impact store choice.

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