Effects of Price Specials on Volume of Sales of Frying Chickens

By Leo R. Gray

Every week, major food retailers have advertisements in local newspapers in which they feature commodities at special sale prices. Probes to measure the effects of advertising these price specials, however, are relatively recent in marketing economics research. What effect do retail price specials have on total sales in a market area, or in the whole Nation? A preliminary study that attempted an aggregate approach to this problem for frying chickens was published by the USDA in 1963.[1] A substantial increase in sales volume would be expected when fryers are featured as a special. Such a change in volume should exceed the normal increase expected from just lowering the price without featuring the item. As a result, the demand function at a designated price level during a special sales promotion should shift to the right—larger sales at the same price. The interaction of price and special sales advertising might also be expected to change the slope of the demand function in a direction that would indicate an increase in price elasticity of demand. These changes would occur if consumers spent a greater percentage of their incomes on fryers in sale weeks than in nonsale weeks.

THIS PAPER is concerned primarily with the development of an analytical framework designed to measure the effect of price specials and advertising on the volume of sales of frying chickens.[2] Accordingly, it presents an analytical model built around selected variables influencing demand. Coefficients for the variables were estimated mathematically and tested statistically to provide a measure of the forces influencing demand, and of shifts in demand associated with special sales promotion.

An empirical analysis, made by the method presented here, indicated that price elasticity of demand for frying chickens in the Washington, D.C., metropolitan area was around -1.75 in nonsale weeks. Special sales promotion resulted in a significant shift in the demand function during the sale weeks. But the analysis shows this shift to be largely parallel, with little change in slope.

Data and Variables

The major economic factors that influence the volume of sales in a given market area include the price of chicken, volume sold in the previous week, advertising, the price and volume of competing products, population, seasonal variation, and possibly other factors. The data available for this study include weekly volume of sales and prices of poultry in the Washington, D.C., metropolitan area. Aggregate estimates for the market area are based on a representative sample of firms for each week in 1960 and 1961. No information was collected on the volume and price of competing meats such as beef, pork, and other poultry. Population was assumed to be essentially unchanged for the specified market area. The following variables are included in the analytical model:

V_t=Weekly volume of estimated sales by all retailers in the market area.

v_t=Deviation from the average of weekly volumes for corresponding weeks of each year.

P_t=Weekly price, a weighted average of estimated selling prices of all retailers each week in the market area.

p_t=Deviation from the average of weekly prices for corresponding weeks of each year.

V_{t-1}=Weekly volume of estimated sales by all retailers in the market area in the previous week.

v_{t-1}=Deviation from the average of lagged weekly volumes for corresponding weeks of each year.

D_t=A dummy shift variable used to differentiate between a sale week and nonsale week. A week was classified as a "sale week" if four or more firms advertised frying chickens in selected newspapers. The sale week

[1] Leo R. Gray, "Retail Price Specials for Frying Chickens in Selected U.S. Cities," U.S. Dept. Agr., Econ. Res. Serv., ERS–101, January 1963, 24 pp.

[2] The author is grateful to Dr. James E. Martin, of the Department of Agricultural Economics, University of Maryland, for his guidance in the development of this paper.

was given a value of 1, the nonsale week zero.

SD_t= The dummy slope variable, which is the product of the price each week times the dummy shift variable (D_{1t}) for that week. For the dummy slope variable, the sale week was given a value of +1, and the nonsale week a value of −1. If the coefficient of the slope variable is significant, the slope of the demand curve for the sale week has changed significantly and will intersect rather than parallel the demand curve in the nonsale week. Otherwise there is no evidence that the slopes of the demand curves for sale and nonsale weeks are different.

In order to reduce the effect of seasonal variations during the year, variables for sales volume (V_t and V_{t-1}) and price (P_t) are represented in the analytical framework as deviations of the weekly volume and price from the average for the corresponding 2 weeks in 1960 and 1961. For example, the price variable for the first full week of June 1960 is the deviation of this weekly price from the average for the first full week in June 1960 and June 1961. The shift and slope variables used are as described above.

The Estimating Model

Weekly deviations in sales volume as described above were expressed as a function of the deviations in the weekly price, and in sales the preceding week, the dummy shift variable reflecting the "sale" and "nonsale" weeks, and the dummy slope variable. The functional relationship is expressed as follows:

$$V_t = a_0 + b_1 p_t + b_2 v_{t-1} + b_3 D_t + b_4 SD_t + u_t \quad (1)$$

Empirical estimates for the demand function specified in equation (1) were estimated by the least squares technique. Prices and volumes for firms advertising specials are aggregated with those for firms not featuring fryers, in order to arrive at a market area concept. In addition to the usual assumptions relating to least squares estimates, this aggregate approach also assumes that: (1) The model allows for consumers who shift their purchases from one store to another because of specials advertised in newspapers; (2) the lagged response of consumers to price changes is at least partially overcome by using aggregate data for 103 consecutive weekly observations; (3) the number of customers served includes all who purchased chickens in retail stores in the market area in 1960–61; and (4) the average price of whole fryers for the total market area would fall between the advertised and nonadvertised prices. Price data used in this study are for whole fryers, but the total volume of sales includes all forms of fryers sold. Prices of cutup fryers and parts are not included, because they are assumed to be based on and to follow closely the prices of whole fryers. The predictive equation estimated from the above model, showing the coefficients and tests of statistical significance ("t" values), is as follows:

$$\begin{aligned} v_t = -73.937 - &\underset{(-7.062)}{55.391 p_t} - \underset{(-4.645)}{0.340 v_{t-1}} \\ &+ \underset{(2.830)}{146.382 D_t} - \underset{(-0.676)}{5.307 D_{1t} p_t} \quad (2) \end{aligned}$$

The expected coefficient of determination (R^2) is equal to 0.483; the analysis of variance ($F^5{}_{98}$) is equal to 18.316; the "t" test values, with 98 degrees of freedom, are indicated by the numbers in parentheses under their respective coefficients.

Interpretation of Results

The general nature of the demand responses for the nonsale and the sale weeks, based on the above analysis, is illustrated in figure 1. Figure 1 was constructed by varying price (P_t) and holding all other variables in equation (1) at their 103-week mean values. This figure shows the demand shift associated with special sales promotion and price changes. For example, at a price of 33 cents per pound, the volume of sales in the special sale weeks averaged about 14 percent above the average for the nonsale weeks. The analysis suggests that the price of chicken was the major factor influencing the volume of sales. The price elasticity of demand was −1.75 as computed from the price coefficient in equation (2), with prices and volumes held at their means. This suggests that a 10 percent reduction in the price of chicken tended to step up consumption by around 17 or 18 percent (table 1).

The analysis also indicated that sales in the preceding week, though less important than price, were significantly related to the volume of sales in the current week. This influence was negative; when sales last week were 10 percent above

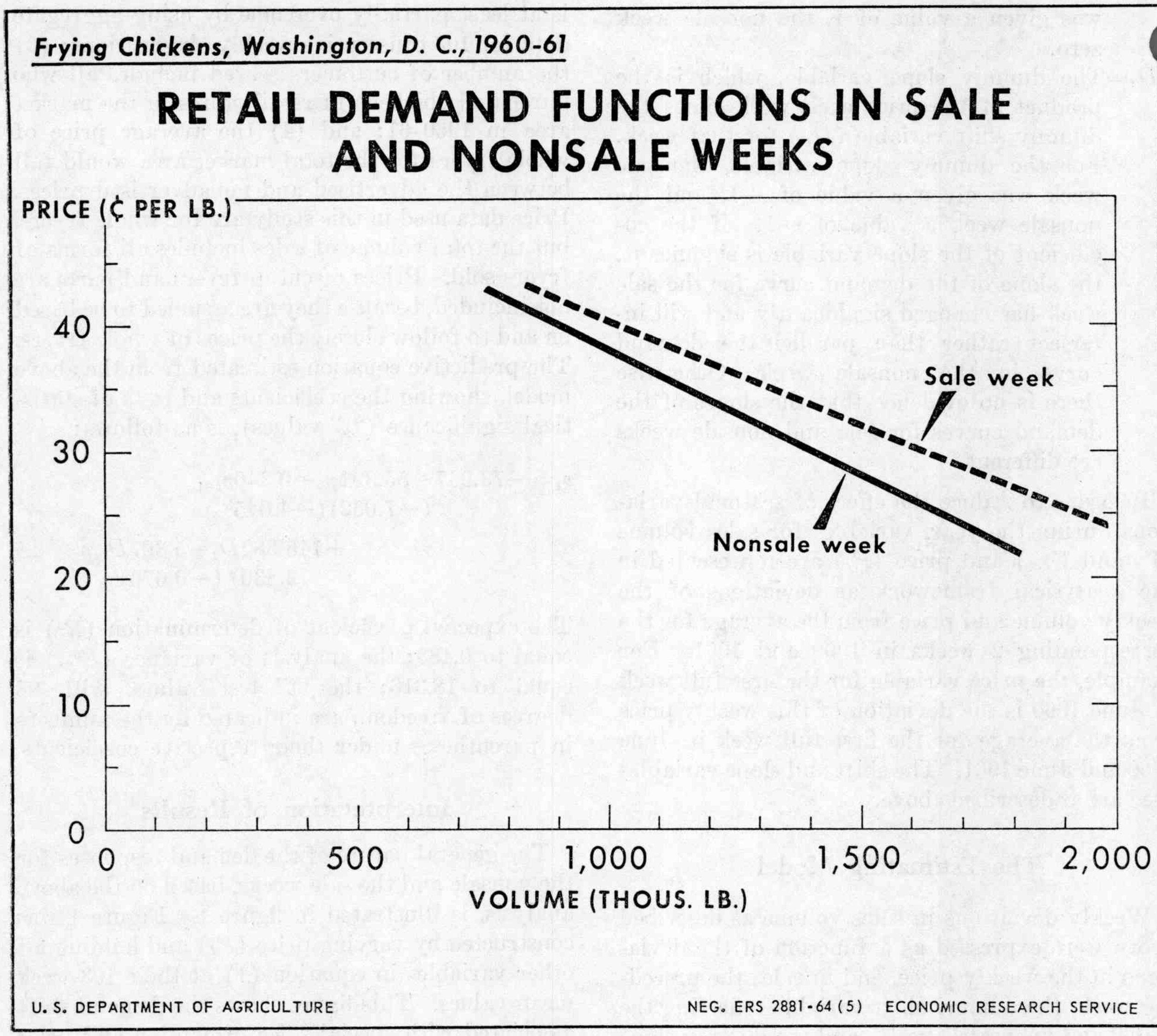


FIGURE 1

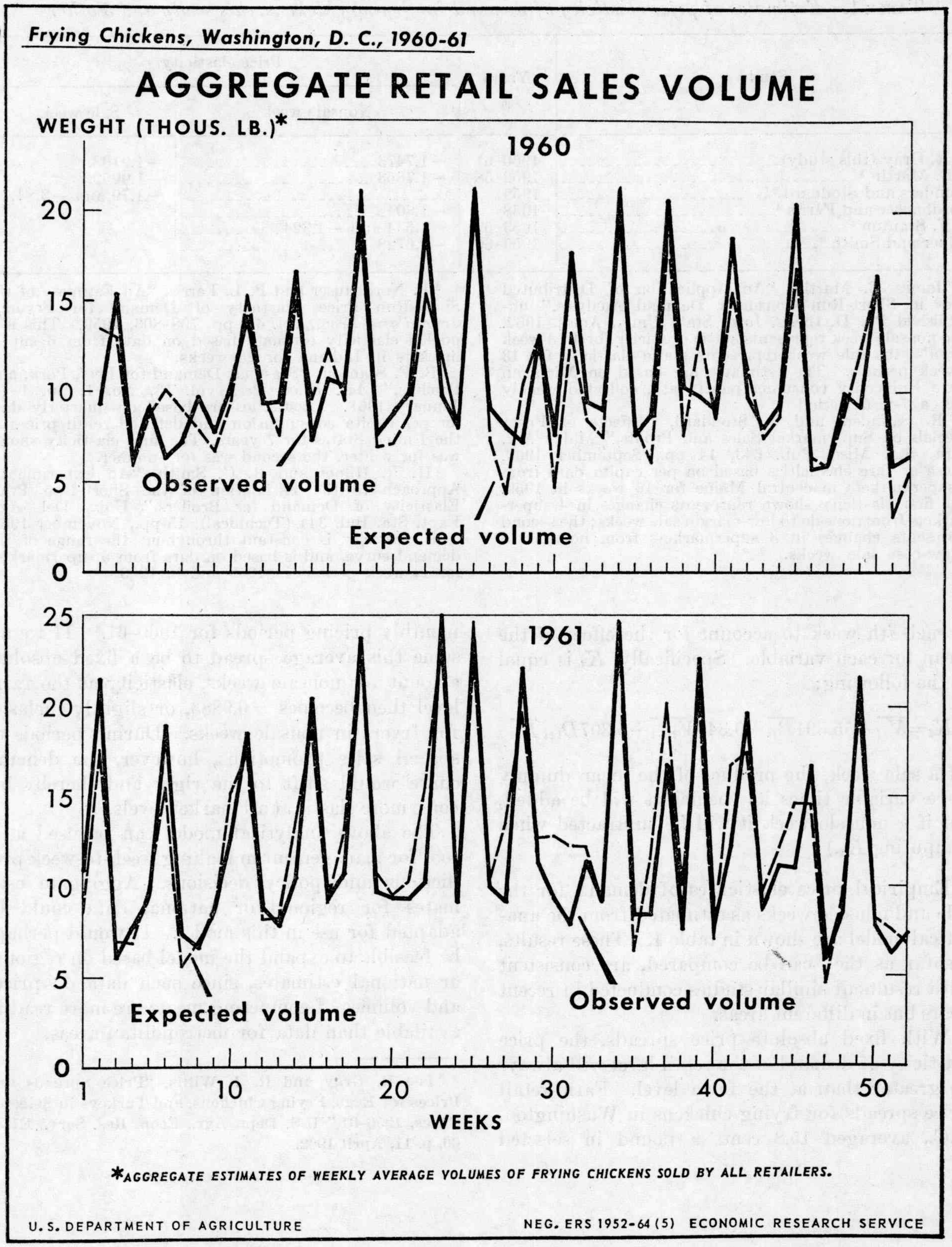
average, sales in the current week were reduced about 3½ percent. The expected coefficient (b_3) on the dummy shift variable (D_t) is positive and large, but its standard error is also large. Nevertheless, the "t" test shows that there was a significant shift to the right in the demand function from the nonsale to a sale week in response to special sales promotion. Since prices were usually reduced along with special sales advertising, the shift in the demand function reflects a sort of composite of the influence of both price and special promotion.

The expected coefficient (b_4) on the dummy slope variable (SD_t) is insignificant. Accordingly, it appears that the slope of the demand function in the special sale weeks was not significantly different from that in the nonsale week. This shift, with only a slight change in slope, also suggests little change in price elasticity of demand between the sale and the nonsale weeks.

Figure 2 shows estimates of the observed and expected weekly volumes of frying chickens sold by all retailers in the Washington, D.C., area in 1960–61. The expected volumes were computed using equation (3):

$$V_{ti} = -73.937 + K_i - 55.391(P_{ti}) - 0.340(V_{ti-1}) + 146.382(D_{ti}) - 5.307(D_{1ti}P_{ti}) \quad (3)$$

where K_i is the changing correction factor added



Frying Chickens, Washington, D. C., 1960-61
AGGREGATE RETAIL SALES VOLUME
WEIGHT (THOUS. LB.)*
1960
Observed volume
Expected volume
1961
Observed volume
Expected volume
WEEKS
*AGGREGATE ESTIMATES OF WEEKLY AVERAGE VOLUMES OF FRYING CHICKENS SOLD BY ALL RETAILERS.
U. S. DEPARTMENT OF AGRICULTURE
NEG. ERS 1952-64 (5) ECONOMIC RESEARCH SERVICE

FIGURE 2

TABLE 1.—*Estimates of price elasticity of demand for frying chickens, this study and 5 others*

Study	Years	Price elasticity	
		Nonsale week	Sale week
L. R. Gray (this study)	1960–61	−1.7473	−1.9108.
J. E. Martin [1]	1952–58	−1.7653	−1.9952.
Saunders and Stoddard [2]	1959		−1.79 and −3.84.
Nordhauser and Farris [3]	1958	−1.80	
B. F. Stanton [4]	1953–59	−1.534 and −1.324	
Hilner and Smith [5]	1959–60	−2.6728	

[1] James E. Martin, "An Application of Distributed Lags in Short-Run Consumer Demand Analysis," unpublished Ph. D. thesis, Iowa State Univ., Ames, 1962. The nonsale week represents static elasticity for 4 13-week periods; the sale week represents static elasticity for 13 4-week periods. The estimates are based on Michigan State University consumer panel data, collected weekly over a 7-year period.

[2] R. Saunders and E. Stoddard, "Effects of Fryer Specials on Supermarket Sales and Profits," Maine Agr. Expt. Sta. Misc. Pub. 643, 14 pp., September 1960. These are arc elasticities based on per capita data from 7 supermarkets in central Maine for 16 weeks in 1959. The first elasticity shown represents changes in 4 supermarkets from nonsale to low-margin sale weeks; the second represents changes in 3 supermarkets from nonsale to below-cost sale weeks.

[3] F. Nordhauser and P. L. Farris, "An Estimate of the Short-Run Price Elasticity of Demand for Fryers," *Jour. Farm Econ.*, vol. 41, pp. 798–803, 1959. This is a pooled elasticity estimate based on data from 6 supermarkets in Indiana for 23 weeks.

[4] B. F. Stanton, "Seasonal Demand for Beef, Pork, and Broilers," *Agr. Econ. Res.*, vol. 13, No. 1, pp. 1–14, January 1961. Elasticities are based on quarterly data for per capita consumption and deflated retail prices in the United States for 7 years. The first elasticity shown was for winter, the second was for summer.

[5] H. R. Hilner and R. C. Smith, "An Experimental Approach to the Estimation of the Short-Run Price Elasticity of Demand for Broilers," Univ. Del. Agr. Expt. Sta. Bul. 344 (Technical), 15 pp., November 1962. This elasticity is constant throughout the range of the demand curve, and is based on data from 5 supermarkets for 11-week periods in 1959 and in 1960.

in each ith week to account for the effect of the mean for each variable. Specifically, K_i is equal to the following:

$$K_i = \overline{V_{ti}} + 55.391\overline{P_{ti}} + 0.340\overline{V_{ti-1}} + 5.307 D_{1ti}\,\overline{P_{ti}}$$

(If a sale week, the product of the mean dummy slope variable times its coefficient will be added, but if a nonsale week it will be subtracted when computing K_i.)

Empirical price elasticities of demand for the sale and nonsale weeks as estimated from the analytical model are shown in table 1. These results, insofar as they can be compared, are consistent with results of similar studies conducted in recent years but in different areas.

With fixed absolute price spreads, the price elasticity of demand at the retail level will always be greater than at the farm level. Farm-retail price spreads for frying chickens in Washington, D.C., averaged 15.8 cents a pound in selected monthly pricing periods for 1960–61.[3] If we assume this average spread to be a fixed absolute amount for nonsale weeks, elasticity at the farm level then becomes −0.9883, or slightly inelastic for fryers in nonsale weeks. During periods of special sales promotions, however, the demand curve would shift to the right and thereby become more elastic at all market levels.

The above analytical model can be used as a tool for management in making week-to-week predictions and policy decisions. Aggregate estimates for regional or national data could be adapted for use in this model. It would perhaps be feasible to expand the model based on regional or national estimates, since such data on prices and volumes of competing meats are more readily available than data for metropolitan areas.

[3] Leo R. Gray and R. J. Willis, "Price Spreads and Prices for Eggs, Frying Chickens, and Turkeys in Selected Cities, 1956–61," U.S. Dept. Agr., Econ. Res. Serv., ERS-60, p. 11, April 1962.