Fresh Fish Sales as a Function of Promotion in a Portland, Oregon, Grocery Chain

Special Report 372
October, 1972
Agricultural Experiment Station
Oregon State University, Corvallis
TABLE OF CONTENTS

I. Introduction 1

II. Advertised-Price Elasticity as a Determinant of Advertising Discount Policy 1

III. Advertised-Price Elasticity and Price Elasticity of Demand 4

IV. The Data and the Assumptions 5

V. Red Snapper 12

VI. Sole 16

VII. Silver Salmon 16

VIII. Summary 17

IX. References 18

Prepared by S. S. Batie, Graduate Student, and F. J. Smith, Associate Professor and Marine Economist, Department of Agricultural Economics, Oregon State University.

Supported in part by the National Oceanic and Atmospheric Administration (administered by the U.S. Department of Commerce) Institutional Sea Grant 2-35187.
Introduction

Retail grocers advertise seafood both with and without price discounts, not always knowing which is more profitable. This report provides some information which will guide retail grocers in making seafood promotion decisions and assist others attempting similar studies.

The five-year experience of a twenty-store Portland, Oregon, grocery chain indicated that 1) when a seafood item was advertised, the item's sales increased; 2) it was more profitable to advertise silver salmon with a price discount than without a price discount; and 3) it was more profitable to advertise sole and red snapper without a price discount.

Advertised-Price Elasticity as a Determinant of Advertising Discount Policy

This report examines the marketing of three fish items in order to determine which advertised price policy would result in the largest total revenue from each item. It is possible, of course, that a retailer may not wish to obtain the largest total revenue from each item if such a policy conflicts with his overall market strategy. Nevertheless, information of the effect of an advertised price policy on total revenue is needed if a retail grocer is to make an informed decision regarding advertised price discounts. It is quite possible, for example, that an advertised price discount will not increase sales enough to compensate the grocer for the price reduction. Or it is also possible that total revenue could rise with an advertised price increase because sales do not decline significantly. A retail grocer will want to know which result he can expect from a given policy.

The retail grocer, therefore, requires a measure of the change in total revenue (price multiplied by sales) expected from a change in advertised price. Advertised-price elasticity provides a convenient estimate of
this change because it measures the percentage change in sales that results from a percentage change in advertised price. With an estimate of the expected change in sales due to the change in advertised price, it is a simple matter to calculate the expected change in total revenue as a result of the advertising policy.

Figure 1a may help to clarify this. The figure portrays a demand curve for an advertised grocery item; the advertised-price elastic and inelastic portions of the curve are identified. In conjunction with Figure 1a, Figure 1b illustrates the relation between total revenue and elasticity measurements. When advertised-price elasticity ($\eta_a$) is greater than 1.00, or elastic, total revenue moves inversely with advertised price changes. As advertised price rises, total revenue falls. As advertised price falls, total revenue rises. When advertised-price elasticity is inelastic (less than 1.00), total revenue moves directly with changes in advertised price. As advertised price falls, so does total revenue, and vice versa. Total revenue is at a maximum where advertised-price elasticity is equal to 1.00. These relations are summarized in Table 1.

It is apparent that the retail grocer would be benefited by knowledge of advertised-price elasticities of his advertised items. However, it is important to realize that the concept of elasticity does not incorporate costs; therefore, determination of elasticity figures will not determine net revenues resulting from advertising.

Nevertheless, after the decision to advertise an item has been made, the manager of a grocery store can use elasticity measures to determine

---

1/ Technically, this should read "is at the absolute value of -1.00," since advertised-price elasticities of normal goods are always negative. If this is kept in mind, no confusion results from referring to elasticities as absolute values.
Figure 1. Total revenue and price elasticity of demand.
Table 1

Advertised-Price Elasticity

<table>
<thead>
<tr>
<th>Advertised Price Rise</th>
<th>$\eta_a &gt; 1.00$ Elastic</th>
<th>$\eta_a = 1.00$ Unitary Elasticity</th>
<th>$\eta_a &lt; 1.00$ Inelastic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advertised Price Discount</td>
<td>Total Revenue Declines</td>
<td>Total Revenue Constant</td>
<td>Total Revenue Increases</td>
</tr>
<tr>
<td></td>
<td>Total Revenue Increases</td>
<td>Total Revenue Constant</td>
<td>Total Revenue Declines</td>
</tr>
</tbody>
</table>
whether or not to advertise with price discounts. If advertised-price
elasticity is greater than 1.00 (elastic), total revenue would be increased
by decreasing the advertised price. Conversely, if advertised-price elas-
ticity is less than 1.00 (inelastic), total revenue would be decreased by
decreasing the advertised price.

Advertised-Price Elasticity and Price Elasticity of Demand

Figure 2 demonstrates the difference between advertised-price elasti-
city\(^2\) and the more familiar price elasticity of demand.\(^3\) \(D_1\) is the demand
curve for a fish item when no advertising is undertaken. Successful adver-
tising will result in a shift of \(D_1\) to, say \(D_2\). This shift (1) implies that
a larger quantity \((Q_2)\) is being demanded after advertising than was demanded
\((Q_1)\) at the same price before advertising. This is termed the advertising
effect. If, in addition to simply advertising, a price reduction \((P_1 \text{ to } P_2)\)
is offered on the fish item, there will be an additional increase in quantity
demanded \((Q_2 \text{ to } Q_3)\) reflected in a movement down \(D_2\) (2). This is the adver-
tised-price effect. A measure of the advertised-price effect on total
revenues of such a movement along curve \(D_2\) would be advertised-price elasti-
city. The effect on revenue of a movement along curve \(D_1\) would be measured
by price elasticity. The price elasticity of a movement from \(P_1 \text{ to } P_2\) on
demand curve \(D_1\) need not be equal to the advertised-price elasticity of the
same price change on curve \(D_2\).

The Data and the Assumptions

Information was obtained from a large food chain operating in the
Portland, Oregon, metropolitan area. Weekly inventories and normal prices of

\(^2\) Defined as the percentage change in quantity sold that results from a
percentage change in advertised price.

\(^3\) Defined as the percentage change in quantity sold that results from a
percentage change in price, ceteris paribus.
red snapper, sole, and silver salmon were obtained for each store. Weekly wholesale purchases were used as an estimate of weekly sales. This proxy variable was not likely to introduce much bias because fish are extremely perishable and rarely frozen for future sales.

Advertised prices for the period of study were obtained by consulting the two major newspapers in which advertisements for the food chain were carried, The Oregonian and the Oregon Journal. All stores observed the same pricing policy. The information included 254 weeks of data from November, 1963, to December, 1968 (Christmas weeks and Thanksgiving weeks were excluded from the analysis, since it was assumed that purchases would be atypical during these weeks).

It was also assumed that (1) regular and advertised price of substitute and complement goods did not affect the sales of "special" fish items in the studied stores and (2) advertisements of competing stores did not significantly affect the sales of the studied food chain.

In an attempt to remove the effect of population growth in the area, the quantity-sold figures were deflated by the number of stores which increased from 16 to 20 over the period of analysis.

Nominal prices varied over the period of study from 39¢ to 59¢ for red snapper, 59¢ to 89¢ for sole, and 59¢ to 89¢ for silver salmon. Nominal prices were chosen as the price variable for the regression, since the effect of real price changes (36.41¢ to 73.43¢ (1956-59 = 100)) on sales response was not significantly (1% test level) different from the effect of nominal price changes.

Though retail stores are not required by law to properly name their fish items, it was assumed that these fish are respectively of the family Scorpaenidae (rockfish), Pleuronectidae (flounders), and Salmonidae (salmons).

To the extent that these assumptions are invalid, there should be a larger amount of total variation in sales that remained "unexplained" than would otherwise be the case, as well as possibly some bias in the coefficient estimates. Bias would result only if the omitted variables are correlated with the included variables.
Figure 2. The advertising and price effect.
Real disposable per capita income, which rose from $1,985 to $2,349 (USBS Survey of Current Business) from 1963 to 1968 was included in the analysis as an independent variable.

A single-equation least-squares regression of the functional form $Q = f (\ln P, A_1, A_2, A_{t-1}, S, \ln Y)$ was used to analyze the data where

$Q =$ quantity sold
$P =$ price
$A_1 = 1$ if advertised first half of the week
$0$ otherwise
$A_2 = 1$ if advertised second half of the week
$0$ otherwise
$A_{t-1} = 1$ if advertised anytime the previous week
$0$ otherwise
$S = 1$ if available in fresh form (applicable only to silver salmon)
$0$ otherwise
$Y =$ income.

The use of the single-equation least-squares model was justified since advertisements are not a function of sales. The food chain did not pay for advertising on a per advertisement basis; rather, it was on a 12-month contract rate determined by a minimum number of agate lines of advertising used during those 12 months. Also, because advertising was on a contract basis, dummy variables were used as advertising variables to determine the effect of advertising during different parts of the week: $A_1 = 1$ if advertised first half of the week (Monday or Tuesday) and 0 otherwise; $A_2 = 1$ if advertised last half of the week (Wednesday or Thursday) and 0 otherwise. Advertising did not take place over the weekend. The regressions which
resulted appear in Table 2.6/

The positive coefficients on the advertising dummy variables \((A_1, A_2, A_{t-1})\) for all three equations indicate that not only does advertising have a positive effect on sales, but also that there is a greater effect when advertising takes place the last half of the week \((A_2)\), than when it occurs during the first half of the week \((A_1)\).

Figure 3 shows the advertising effect in graphical form. For example, the red snapper demand curve without advertising is represented by \(D_1\) in Figure 3 \((Q = 3752.58 - 1878.94 \ln P + 1525.75 \ln Y)\). \(D_2\) is the demand curve that resulted with first half of the week advertising \((Q = (3752.58 + 399.93) - 1878.94 \ln P + 1525.75 \ln Y)\). \(D_3\) is the demand curve resulting from second half of the week advertising \((Q = 3752.58 + 844.66) - 1878.94 \ln P + 1525.75 \ln Y)\); \(D_4\) is the demand curve which resulted when all week advertising took place \((Q = (3752.58 + 399.93 + 844.66) - 1878.94 \ln P + 1525.75 \ln Y)\). The logarithm of \(Y\) is held constant along all curves and is equal to 7.8329.7/

The coefficients in logarithm of price (Table 2) provide estimates of the

---

6/ These regressions assume a parallel shift in the demand curve. An attempt was made to determine slope change both by separation of the data and then by including a slope dummy variable. In both cases, severe multicollinearity problems resulted. With the data on hand, there was no resolution of this problem; therefore, the advertised-price elasticities obtained from aggregated data were used for the study.

7/ Average income for the period studied.
Table 2. Regressions.

**Red Snapper**

\[ Q = 3752.58 - 1878.94 \ln P^{**} + 399.93 A_1^{**} + 844.66 A_2^{**} \]
\[ + 159.67 A_{t-1}^{**} + 1525.75 \ln Y^{*} + e \]
\[ R^2 = 75.95\% \]
\[ r = 0.6240 \]
\[ F = 156.63 \]

**Sole**

\[ Q = -6039.95 - 161.47 \ln P + 234.38 A_1^{**} + 423.47 A_2^{**} \]
\[ + 37.77 A_{t-1}^{*} + 920.27 \ln Y^{**} + e \]
\[ R^2 = 62.38\% \]
\[ r = 0.4982 \]
\[ F = 82.24 \]

**Silver Salmon**

\[ Q = -2900.74 - 4814.52 \ln P^{**} + 200.50 A_1^{*} + 1310.30 A_2^{**} \]
\[ + 489.34 S^{**} + 3154.91 \ln Y^{**} + e \]
\[ R^2 = 79.86\% \]
\[ r = 0.5184 \]
\[ F = 188.75 \]

* * Significantly different from zero at 5% test level.
** ** Significantly different from zero at 1% test level.
Figures in parentheses = standard deviation.
$D_1$ = No Advertising Demand Curve
$D_2$ = Advertising First Half of Week Demand Curve
$D_3$ = Advertising Second Half of Week Demand Curve
$D_4$ = Advertising All Week Demand Curve

Figure 3. Shifts in the demand curves for fish: The advertising effect.
advertised price elasticities for each of the three fish items, \( \frac{\partial^2}{\partial \text{price}^2} \) for each of the four demand curves. These are presented in Tables 3, 4, and 5.

Red Snapper

"Nonadvertised" red snapper fillets sales had a price-elasticity significantly different from 1.00, (1% test level)(Table 3). When advertising took place, the resulting advertised-price elasticities (calculated at the mean) were not significantly different from 1.00. Therefore advertisements with a price discount did not increase gross receipts significantly more than advertisements without a price discount. The response to advertising, **per se**, (the "advertising effect") was large, as can be seen from the mean quantity figures for differing advertising policies. The mean pounds of red snapper sold per week increased 195% with an "advertised all week" policy compared to a "nonadvertisement" policy (2,417 versus 820 pounds per week). The influence of price discounts on gross returns was not positive, as can be seen by the inelastic advertised-price elasticities of demand. This can be summarized simply by stating that, in the red snapper case, advertising **per se** had a great effect in increasing sales, while an advertised-price discount contributed little to sales.

\[ \frac{\partial^2 Q}{\partial \text{price}^2} \]

where \( P_a \) = advertised price. Differentiating the red snapper regressions (Table 2) with respect to price, one obtains \( \frac{\partial Q}{\partial P_a} = -1878.94 \left( \frac{1}{P_a} \right) \). Therefore, in order to obtain an estimate of advertised-price elasticity, \( \frac{\partial Q}{\partial P_a} \times \frac{P_a}{Q} \), both sides of the resulting differential equation should be multiplied by \( \frac{P_a}{Q} \):

\[ \eta_p = \frac{\partial Q}{\partial P_a} \times \frac{P_a}{Q} = -1073.94 \left( \frac{1}{P_a} \right) \left( \frac{P_a}{Q} \right) \]

\[ = -1873.94 \left( \frac{1}{Q} \right). \]

Using mean quantities as the divisors (Q), elasticities for the various advertising policies (for the mean price of 46.2¢) can thus be determined.
### Red Snapper

**Table 3. Advertised-Price Elasticity Estimates for Red Snapper**

<table>
<thead>
<tr>
<th>Demand Curve (Fig. 3)</th>
<th>Advertisement Policy</th>
<th>Mean Quantity Sold</th>
<th>Advertised-Price Elasticity</th>
<th>Implication of an Advertised Price Discount</th>
</tr>
</thead>
<tbody>
<tr>
<td>D₁</td>
<td>Not Advertised</td>
<td>( Q_{\text{ave}} = 820.41 \text{ lbs. wk.} )</td>
<td>2.29** ¹⁰/</td>
<td>--</td>
</tr>
<tr>
<td>D₂</td>
<td>Advertised First Half of Week</td>
<td>( Q_{\text{ave}} = 1439.25 \text{ lbs. wk.} )</td>
<td>1.305</td>
<td>Total Revenue Constant¹¹/</td>
</tr>
<tr>
<td>D₃</td>
<td>Advertised Second Half of Week</td>
<td>( Q_{\text{ave}} = 1979.94 \text{ lbs. wk.} )</td>
<td>.949</td>
<td>Total Revenue Constant¹¹/</td>
</tr>
<tr>
<td>D₄</td>
<td>Advertised All Week</td>
<td>( Q_{\text{ave}} = 2416.81 \text{ lbs. wk.} )</td>
<td>.777</td>
<td>Total Revenue Constant¹¹/</td>
</tr>
</tbody>
</table>

**Significantly different from 1.00 at 1% test level.**

**Note:**
- **With a Mean Price of 46.2¢/lb.**
- **¹⁰/ This is a price elasticity rather than an advertised-price elasticity since D₁ is the demand curve for no advertising.**
- **¹¹/ Although 1.305, .949, .777 are not equal to 1.00, they are not (statistically) significantly different from 1.00, therefore total revenue would remain (nearly) constant with an advertised-price discount.**
Table 4. Advertised-Price Elasticity Estimates for Sole\textsuperscript{12/}

<table>
<thead>
<tr>
<th>Demand Curve (Figure 3)</th>
<th>Advertisement Policy</th>
<th>Mean Quantity Sold</th>
<th>Advertised-Price Elasticity</th>
<th>Implication of an Advertised Price Discount</th>
</tr>
</thead>
<tbody>
<tr>
<td>D\textsubscript{1}</td>
<td>Not Advertised</td>
<td>Q\textsubscript{ave} = 468.93 lbs/wk.</td>
<td>.344** \textsuperscript{13/}</td>
<td>--</td>
</tr>
<tr>
<td>D\textsubscript{2}</td>
<td>Advertised First Half of Week</td>
<td>Q\textsubscript{ave} = 733.53 lbs/wk.</td>
<td>.220**</td>
<td>Total Revenue Decline</td>
</tr>
<tr>
<td>D\textsubscript{3}</td>
<td>Advertised Second Half of Week</td>
<td>Q\textsubscript{ave} = 958.05 lbs/wk.</td>
<td>.169**</td>
<td>Total Revenue Decline</td>
</tr>
<tr>
<td>D\textsubscript{4}</td>
<td>Advertised All Week</td>
<td>Q\textsubscript{ave} = 940.00 lbs/wk.</td>
<td>.171**</td>
<td>Total Revenue Decline</td>
</tr>
</tbody>
</table>

** Significantly different from 1.00 at the 1% test level.

\textsuperscript{12/} With a Mean Price of 77.3¢

\textsuperscript{13/} This is a price elasticity rather than an advertised-price elasticity since D\textsubscript{1} is the demand curve for no advertising.
Silver Salmon

Table 5. Advertised-Price Elasticity Estimates for Silver Salmon

<table>
<thead>
<tr>
<th>Demand Curve (Figure 3)</th>
<th>Advertisement Policy</th>
<th>Mean Quantity Sold</th>
<th>Advertised Price Elasticity</th>
<th>Implication of an Advertised Price Discount</th>
</tr>
</thead>
<tbody>
<tr>
<td>D₁</td>
<td>Not Advertised</td>
<td>$Q_{ave} = 690.00 \text{ lbs/ wk.}$</td>
<td>6.98** 15/</td>
<td>--</td>
</tr>
<tr>
<td>D₂</td>
<td>Advertised First Half of Week</td>
<td>$Q_{ave} = 1559.88 \text{ lbs/ wk.}$</td>
<td>3.086**</td>
<td>Total Revenue Increase</td>
</tr>
<tr>
<td>D₃</td>
<td>Advertised Second Half of Week</td>
<td>$Q_{ave} = 2769.71 \text{ lbs/ wk.}$</td>
<td>1.738**</td>
<td>Total Revenue Increase</td>
</tr>
<tr>
<td>D₄</td>
<td>Advertised all Week</td>
<td>$Q_{ave} = 2824.62 \text{ lbs/ wk.}$</td>
<td>1.704**</td>
<td>Total Revenue Increase</td>
</tr>
</tbody>
</table>

** Significantly different from 1.00 at the 1% test level.

14/ With Mean Price of 76.3¢

15/ This is a price elasticity rather than an advertised-price elasticity since $D₁$ is the demand curve for no advertising.
Sole

If two items are similar to one another but one is higher priced, the higher-priced item is expected to have a more elastic demand than the lower-priced item. Since sole is a groundfish similar to red snapper, it was thought originally that sole would have a more elastic advertised-price elasticity than red snapper. This, however, was not the case. In fact, the values were very inelastic (1% test level) (Table 4).

A possible explanation for this unexpected result is that red snapper is purchased by low-income groups and is regarded as a relatively high-priced item, whereas sole is purchased by higher-income groups and is regarded as a low-priced product. Some support is lent to this explanation by the results of a fish consumer study conducted by Darrel A. Nash (1970) of the Bureau of Commercial Fisheries:

Income . . . is not shown to be as strong a factor in explaining purchases as is sometimes ascribed to it. There is a general increase in purchases as income rises but not without encountering decreases in some income classes . . . Flounder (which includes sole), halibut, . . . , salmon seem to be positively related to income; . . . and red snapper, catfish, and whiting are purchased mostly by lower-income households . . . Red snapper and; to a degree, whiting show that the higher-income households purchase a higher-priced product. (Nash, 1970, p. 15)

The sole results imply that, like red snapper, it was more profitable to advertise without a price discount.

Silver Salmon

The advertised-price elasticities for silver salmon were quite elastic (1.704 to 6.98; see Table 5). This implies that advertising with a price discount resulted in increased gross receipts relative to advertising with no price discount.

Also, as shown in the Table 2 regression, more sales resulted when silver salmon were in season (i.e. the summer months). Sales increased an average of 489 pounds/week during this period (the coefficient on the season dummy variable, S).
Summary

Estimates of advertised-price elasticity of demand for fish enable a decision-maker to determine whether or not gross revenues from fish will increase as a result of an advertised price discount as compared to advertising without a price discount.16/

This study, which concentrated in a twenty-store food chain in Portland, Oregon, concluded that red snapper and sole had inelastic advertised-price elasticities of demand over the study period. Silver salmon, in contrast, had elastic advertised-price elasticities of demand. This means that short-run gross revenues would increase if an advertisement for silver salmon included a price discount. Conversely, sole and red snapper would have larger gross returns if the advertising strategy did not include a price discount.

16/ This is true provided the assumptions as given on page 6 are valid.
REFERENCES


Morris, James L. and Robert S. Firch. 1967. The analysis of separate price and advertising responses to retail grocery specials. Phoenix. 9 p. (Arizona. Agricultural Experiment Station. Journal article no 1227)


