AN ABSTRACT OF THE THESIS OF

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Title: ANALYSIS OF FRESH FISH SALES AS A FUNCTION OF PROMOTION IN THE PORTLAND METROPOLITAN AREA

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The objective of this study was to determine not only if gross receipts were increased by retail advertising of fish, but also whether or not discounting the price of fish in such advertisements further increased gross receipts. This objective was formulated into a testable hypothesis: "Advertisements of fresh fish which include a price discount increase gross receipts significantly more than identical advertisements without a price discount, *ceteris paribus*."

Two hundred and fifty-four weeks of sales information were collected for each of three fish items: red snapper, sole and silver salmon. The data were obtained from a large retail food chain which operated 20 stores in the Portland, Oregon, metropolitan area. The data were then analyzed with the aid of single equation least squares multiple regression techniques. The model was formulated from red snapper data and was then applied to

sole and silver salmon data.

The results indicated that for all three species of fish, advertisements without price discounts resulted in increased sales. More sales resulted when advertising took place over the last half of the week than when it took place over the first half; all week advertising resulted in more quantity sold than half week advertising. In the case of silver salmon, advertising with price discounts resulted in larger gross receipts than when price discounts were not included in the advertisement. The hypothesis, therefore, was not rejected in the case of silver salmon. The opposite was true, however, for sole and red snapper, as advertisements with price discounts resulted in less gross receipts received than if only the advertisement (without the price discount) had appeared. The hypothesis was rejected for red snapper and sole.

It is hoped that this information will be useful to both wholesalers and retailers of such fish items in planning their advertising and selling strategies.

Analysis of Fresh Fish Sales as a Function of Promotion in the Portland Metropolitan Area

by

Sandra Sutch Batie

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ANALYSIS OF FRESH FISH SALES AS A FUNCTION OF PROMOTION IN THE PORTLAND METROPOLITAN AREA

I. INTRODUCTION

Retail grocery stores frequently rely on newspaper advertisements as a means of promoting sales, and yet surprisingly little is known about the effectiveness of such advertising. That is not to say that the measurement of advertising effectiveness has been a neglected topic. However, results of such research have been inconclusive due to the inability of researchers to segregate the effects of advertising from the numerous other variables which influence sales.

Previous Research

Quandt (1964) stated that frequent failures in advertising research result from data contamination, failure to meet the preconditions for a statistical model, and/or a faulty underlying economic model. Data contamination includes such problems as inability to obtain the specific data necessary for demand estimation (e.g., disposable income, age distributions, dollar value of promotions) as well as inaccurate data (e.g., out-of-date census data, competitor's advertising budget). The second source of failure listed by Quandt, failure to meet the preconditions for a statistical model, is well illustrated by some studies which rely on single-equation statistical models, although a simultaneous relationship exists among the dependent and independent variables. Single equation statistical models assume that although the dependent variable is a function of the independent variables, the converse is not true. This precondition is obviously violated if the advertising expenditures are composed of a fixed percentage of sales, as is frequently the case (Bass, 1963, Griliches, 1961). A faulty underlying economic model is one which fails to include variables that significantly influence the dependent variable, and/or a model which fails to relate the variables with the proper structural form. An example of a faulty model is one which fails to include a sales decay parameter, for as Waugh (1957) succinctly stated: "advertisements never die, they just fade away." For this reason, the topic of a sales decay parameter (distributed lagged models) assumes prominence in much of the literature (Borden, 1942; Jastram, 1955; Jessen, 1961; Nerlove, 1961; Simon, 1969; Vidale and Wolfe, 1957).

Most grocery store advertisement models do not lend themselves to such criticism. They are ephemeral in character; and, as will be shown later, lend themselves well to single equation models. Although many authors have investigated advertising and promotion activities (e.g., Bass, 1963; Berremen, 1943;

Dickens, 1955; Holdren, 1964; Meissner, 1961; Palda, 1964; Telser, 1962; Wagner, 1941), few of these have dealt specifically with retail food stores advertising. However, Bob R. Holdren (1964) in a study of the market structure and behavior of retail food stores, concluded that price variables alone do not explain much of the total variation in sales. James L. Morris (1967) analyzed consumer response to advertised specials of nine stores in the Phoenix metropolitan area. In a later summary of his work, Morris concluded that:

> 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 an advertised price is a reduced price must follow .... 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. (Morris and Firch, 1967, p. 7)

It is not obvious from Morris' research that such a hypothesis is justified. Although there may not be a strict inverse relation between sales and prices, this does not necessarily imply that consumers have a vague perception of prices. Nor is it clear how firms can increase profits by larger price reductions if consumers do have a "poor grasp of normal prices." Katona (1960) suggested instead that:

> [A consumer's] scanning [of] newspaper ads for sales and discounts and adjusting one's shopping plans accordingly are likewise frequently habitual. (Katona, 1960, p. 144),

and that:

> It is not justified to assume that any and all changes in prices influence consumer behavior. (Katona, 1960, p. 194)

However,

> Advertising may affect the threshold [of perception] in as much as people become sensitive to widely advertised price reductions. (Katona, 1960, p. 194)

Engel (1968) also cautions that "in a given situation the price-sales relation needs to be empirically determined."

Advertising and Price Discounts

Typically, retail food store newspaper advertisements are of short duration, with "special" prices good for only a few specified days. Different grocery and food items take prominence in the advertisements as they are varied from week to week. The advertisements can generally be characterized as advertising with no competitive reactions: a short term advertised price discount will generally not be matched by a rival store's action (Holdren, 1964). This type of behavior by retail grocery firms has been cited (Morris, 1967) as evidence of the oligopolistic nature of the industry. If price discounts were permanent they would be matched by rival firms; and since industry demand curves for food items are inelastic (Brandow, 1961), such a rival firm reaction would likely be detrimental to all. Therefore, grocery firms compete not through price competition but with advertising and promotional activities, consumer conveniences, and product quality and variety differences.

Retail food stores use newspaper advertisements to promote an immediate and short term consumer response, as well as to encourage long term loyalty of the consumer to the store. The motivation for such promotion is to increase net revenues. This can be accomplished by a combination of: (i) increasing net revenue from the sale of the advertised item and/or (ii) increasing net revenues from the sale of nonadvertised items in the store. Advertisements increase total revenues from the sale of nonadvertised items in the store when they are successful in inducing new consumers to shop at the store and encouraging regular customers to increase their number of purchases made at the store. Net revenues increase when the increase in total revenue is more than enough to cover the increased advertising costs. Successful advertising results in a shift of the demand curves for grocery items to the right as well as an alteration of the curves' shapes by attracting new consumers and by changing consumers' tastes and preferences. Increases in total revenue will result from the sale of the advertised "special" if the quantity sold of the "special" increases <u>and</u> if the item has an elastic (greater than $|-1.00|$) <u>advertised</u>-price elasticity of demand.

Advertised Price Elasticity

Advertised price elasticity of demand is a measure of the responsiveness of quantity to a percentage change (i.e., price discount) in the price after advertising has taken place. It is defined as the percentage change in quantity of sales divided by the percentage change in the advertised price. If the advertised-price elasticity of a grocery item is greater than the absolute value of -1.00 (elastic), an advertised price discount will result in enough increased sales to increase total revenues from the sale of that item. Net revenues will increase if total revenues increase more than enough to cover increased advertising costs.

This investigation required an estimation of advertised-price elasticity of demand for the product. Throughout the study it was assumed that the commitment to advertising had been made, and the study addressed itself to the question of whether or not total revenue would be further increased by advertising fish with a price discount, given that the advertising will take place. The estimate of advertised price elasticity of demand will also enable an investigation of Morris' hypothesis concerning consumer perception of prices.

The products that were being investigated were fresh fish. Although it has been known for several years that U.S. per capita consumption of edible fish products has remained stable near 11 pounds per year (U. S. Commission on Marine Resources, 1969), and that per capita income, prices (of the product, substitutes, and complementary goods), and tastes and preferences affect the consumption of fish; much work remains to be done in looking beyond the aggregate figures and in examining individual species. The sensitivity of different species to price changes and advertising programs has been neglected with but a few exceptions.[1/]

Knowledge of variability in quantity response to changes in price and in the underlying determinants of demand is important to the seafood industry. For example, if a seafood item has a relatively inelastic price elasticity that can be made more elastic with advertising, then perhaps it would be beneficial to wholesalers to encourage promotion of seafood items on an independent basis or as a joint venture with retailers. An inelastic advertised-price elasticity (%ΔQ/%Δ Advertised Price), would imply that the retail store manager should not advertise with a price discount to obtain increased gross revenues from his advertisements.

1/ Some such exceptions are the recent work of the Bureau of Commercial Fisheries such as Waugh and Norton (1969) "Some Analyses of Fish Prices", as well as such articles as Nash (1967) "Demand for Fish and Fish Products with Special Special Reference to New England."

Objective and Hypothesis of the Study

The objective of this study was to analyze quantity response to newspaper advertisements of fresh fish. The study was aimed at investigating two separate responses to newspaper advertisements: (i) the response to the advertisement abstracted from any price or price discount and (ii) the response to the price after advertising has taken place. The research, however, did not attempt to investigate how consumption patterns can be permanently altered through promotions, nor how seafood consumption patterns vary with individual consumers' income levels or between ethnic groups. The research that was undertaken did not attempt to determine whether or not total (regional) demand for the product increased with advertising, but rather if promotion by one store can increase its profits on fresh fish, and, if so, what is the most efficient way in which an individual store can deal with seafood promotions.

The hypothesis was "Advertisements of fresh fish which include a price discount increase gross receipts significantly more than identical advertisements without a price discount, *ceteris paribus.*" Embodied in the hypothesis are two testable statements: (i) newspaper advertisements (with or without price discounts) increase gross receipts from the sale of an individual product and (ii) the advertised-price elasticity of fresh fish is greater than $|-1.00|$. Also examined was whether or not advertisements (with or without price discounts) also increase net receipts from the sale of an individual fish product.

II. RETAIL PRICING AND PROMOTION

Retail Pricing Policies

Holdren (1964) has stated that the market structure of retail grocery stores is one of monopolistic competition. If it were not for freedom of entry and "the very large number of variables", Holdren stated that he would consider the structure to be oligopolistic. However, price competition as such is rare among retail food firms, and instead firms place their competitive emphasis on more customer conveniences, product qualities and variety, advertising and promotional activities (DeLoach, 1960). The reason for this, Holdren contends, is that the market structure is imperfect enough that firms can survive even though they are non-optimizing. "Thus, rarely are firms in this market driven by necessity for survival to prove the nature of their opportunity space." (Holdren, 1964, p. 1311) He concludes that as long as this is the case the need for changing behavior is not apparent.

Even stores which are failing to achieve satisfactory profits rarely resort to price competition. Retail firms attempt instead to achieve a satisfactory gross margin (prices over costs), in the neighborhood of 20 percent; although any given store is likely to have a "widely different price structure" from another with approximately the same gross margin. An unsatisfactory profit rate is viewed as poor management or improper location rather than as a result of a nonoptimizing price policy.

In contrast to Holdren's opinion, other authors conclude that the lack of price competition is due to fear of "price wars" and reduced profits for all (Morris, 1967, p. 1). Presumably, these authors are implicitly assuming an oligopolistic structure.

The traditional textbook definition of monopolistic competition usually includes the assumption of a large number of sellers, each of whom "expects his maneuvering to go unnoticed by his rivals" (Ferguson, 1969, p. 291). Also, "price is the variable entrepreneurs manipulate in an effort to increase profit" (Ferguson, 1969, p. 291). Oligopoly theory assumes that firms realize that they are interdependent. "The rivals may spend their lives trying to 'second guess' each other; they may tacitly agree to compete by advertising but not by price changes; or, recognizing their monopoly potential, they may form a coalition and cooperate rather than compete" (Ferguson, 1969, p. 303). Further, ". . . . Practically speaking, active price competition is seldom if ever observed in oligopolistic markets. To be sure, price wars occasionally erupt; but this really does not indicate price competition. A price war indicates that the (probably implicit) communication channels among firms is temporarily out of repair" (Ferguson, 1969, p. 33).

Holdren states that "no oligopoly pricing pattern has been observed in any of the markets we have studied" (Holdren, 1964, p. 1308), but does not elaborate as to what he would consider to be an oligopoly pricing pattern. Since it is generally accepted that retail grocery firms do not engage in direct price competition, it would seem the conventional definitions imply an oligopolistic market structure as a characteristic of retail grocery stores.

Price Elasticity of Demand and Advertised-Price Elasticity of Demand

The concept of elasticity, although useful, does not determine the real profitability of advertising. Determining the profitability of advertising is a highly complex task which involves calculating the increase in net revenues from sales which are due to a given expenditure on a specific type of promotion. It involves evaluating the marginal revenue product of the promotional dollar in comparison with the marginal revenue product of that dollar in the next best alternative. Price elasticity of demand measures only the percentage change in quantity that accompanies a percentage change in price and hence is a measure of the expected change in total revenue with a given change in price. Figure 1, for example, demonstrates that total revenue is at a maximum when marginal revenue is equal to zero and price elasticity of demand is at

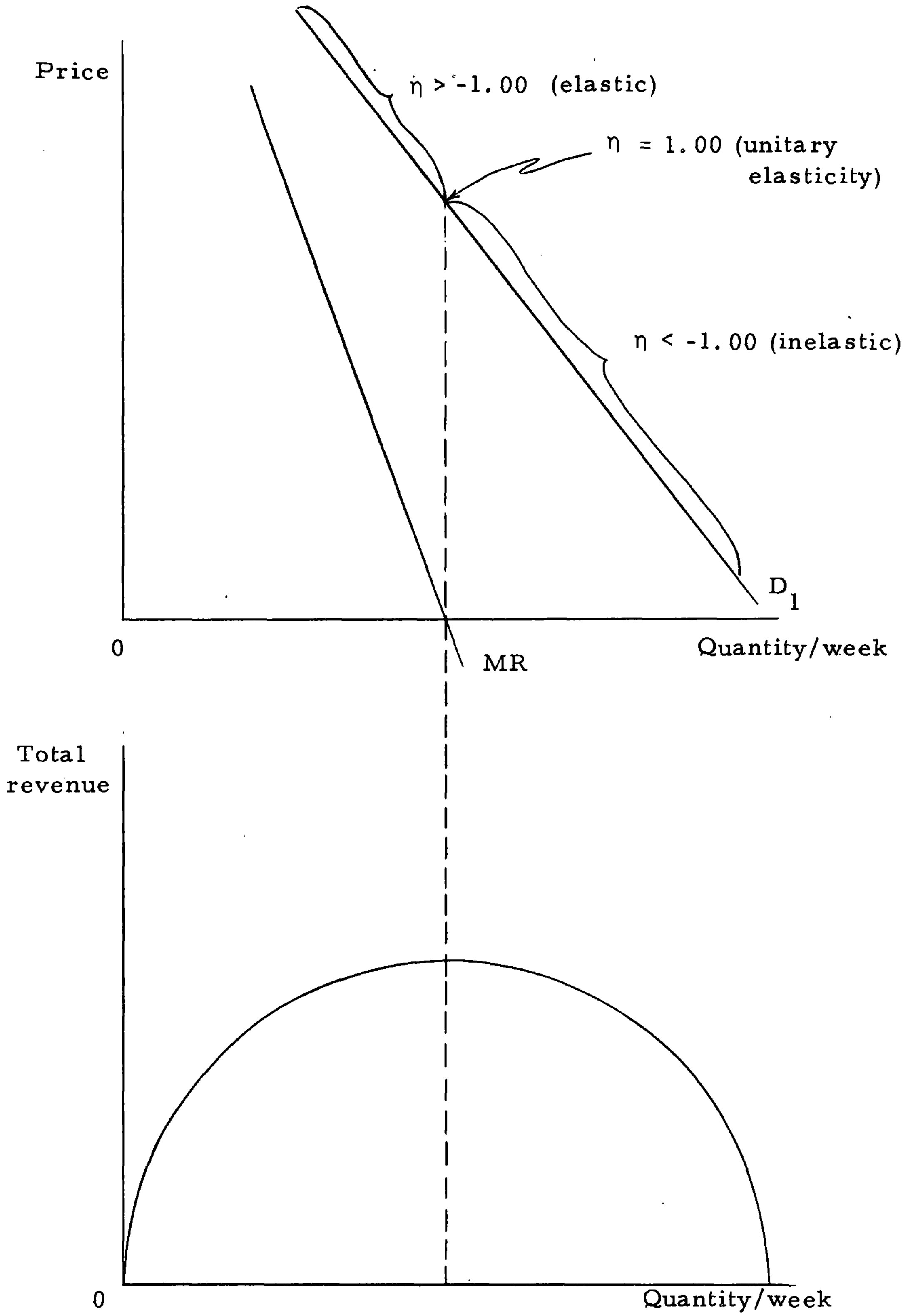

Figure 1. Total revenue and price elasticity of demand.

unitary elasticity (-1.00). However, elasticity measures do not incorporate costs, and therefore do not express the best policy in reference to profitability. The most profitable level of output is where marginal revenue equals marginal cost (and marginal revenue product is equal to marginal factor cost). This best profit equilibrium position will normally not be where price elasticity of demand equals -1.00 (unless the marginal cost of advertising at the equilibrium point is equal to zero).

However, once the decision to commit a certain level of resources to advertising has been made, the grocery firm can use elasticity of demand measures to determine whether or not to advertise items with price discounts.

Characteristically, price discounts on grocery items that are advertised as "specials" are of only short duration. This can be explained either by resorting to Holdren's explanation of non-optimization, or it can be attributed to the oligopolistic characteristics of the industry. That is, if grocery price discounts were permanent, they would be matched by rival firms. Since industry demand curves for grocery items in the aggregate are relatively inelastic (Brandow, 1961), such a rival firm reaction is likely to be detrimental to all.

The individual store's curve is far more elastic than the aggregate industry demand curve. In the short run, a firm can increase revenues with a temporary price discount if it is operating on that portion of its demand surface in which price elasticity is greater than $|-1.00|$. Compounding the problem is the uncertainty as to how advertising will affect the price elasticity of demand. Advertising may result not only in a shift of the demand curve for a product, but also in a change in the shape of the curve. Either change will affect elasticity.

Advertised-price elasticity[2/] of demand is defined as the percentage change in quantity of sales in response to a percentage change in advertised-price. If advertised-price elasticity is elastic (greater than $|-1.00|$) then advertising with a price discount will increase total revenues. If advertised-price elasticity is inelastic, then advertising with a price discount will decrease total revenues. Since the costs for such advertising policies should be identical, a grocery firm which maximizes profit would desire to advertise with price reductions only those items with advertised price elasticity greater than $|-1.00|$ (elastic).

Figure 2 demonstrates the differences between price elasticity of demand and advertised price elasticity of demand. D_1 is

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2/ The term advertising elasticity (in contrast to advertised-price elasticity) is avoided here, since this implies the percentage change in quantity as a result of a given percentage change in advertising expenditures, which is not the measure needed for this investigation.

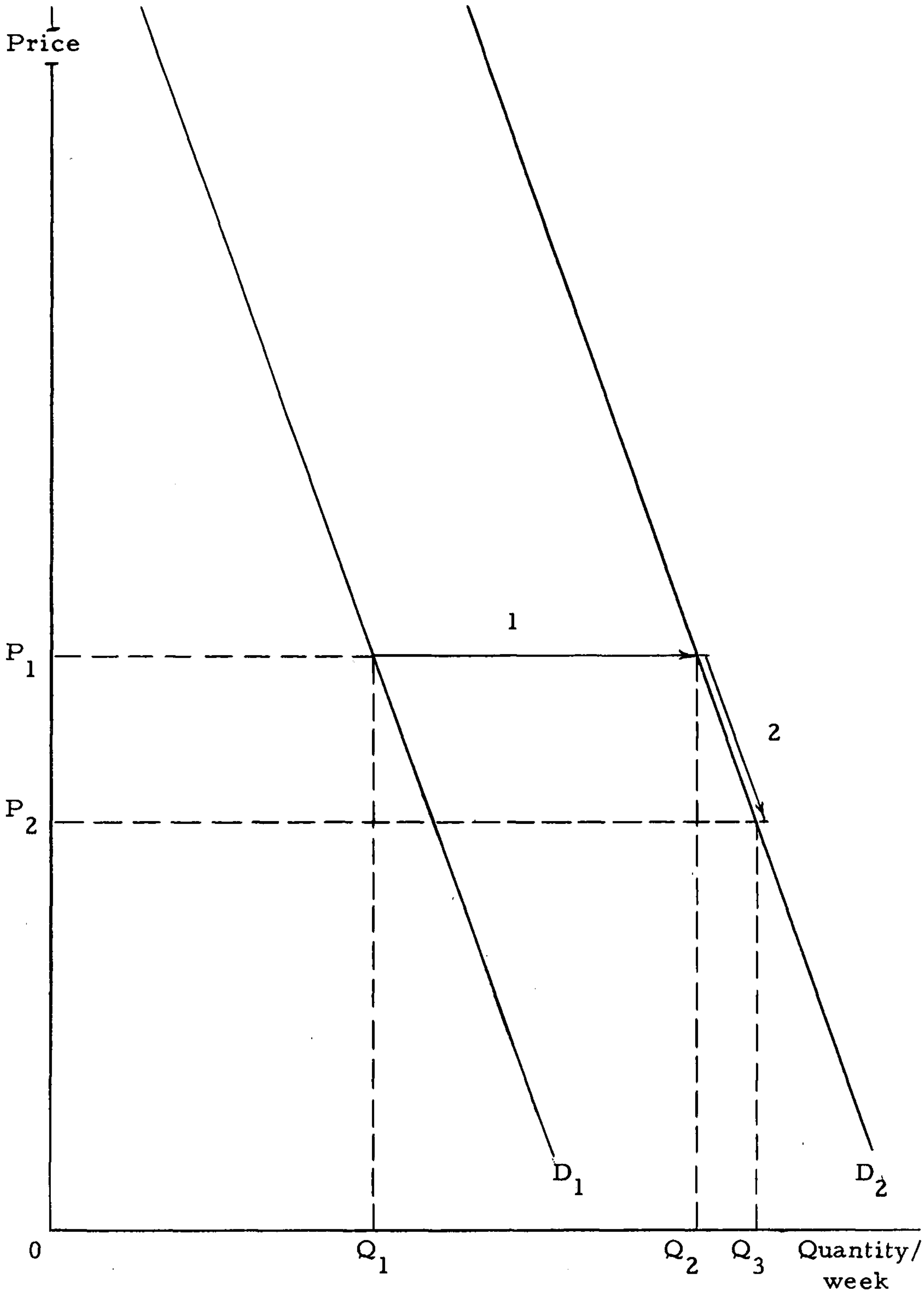

Figure 2. The advertising and price effect.

the demand curve for a fish item when no advertising is undertaken. Successful advertising will result in a shift of D_1 to, say, D_2. This shift is represented by vector 1 and implies that a larger quantity (Q_2) is being demanded after advertising than was demanded (Q_1) at the same price before advertising. This phenomenon was termed the advertising effect. If, in addition to simply advertising, a price reduction (P_1 to P_2) is offered on the fish item, there will be an additional increase in quantity demanded (Q_2 to Q_3) represented by vector 2 as a movement down D_2. This was the price effect. A measure of the price effect on total revenues of such a movement along curve D_2 would be <u>advertised-price</u> elasticity of demand. Whereas, the effect on revenue of a movement along curve D_1 would be measured by <u>price</u> elasticity of demand. The price elasticity of a movement from P_1 to P_2 on demand curve D_1 need not be equal to the advertised-price elasticity of demand of the same price change on curve D_2. For example, if advertising results in a parallel shift of the demand curve to the right, advertised-price elasticity will be less than price elasticity of demand; this can be demonstrated by examination of the formula for point price elasticity of demand: $\eta = -\frac{\partial Q}{\partial P} \cdot \frac{P}{Q}$. A parallel shift implies that the slope of the demand curve remains the same, i.e., $-\frac{\partial Q}{\partial P}$ equals a constant while P/Q changes. Thus, if one investigates the elasticities of the two curves at a given price, one finds the demand curve which results from advertising (D_2) will have the larger quantity response, and hence η' will be smaller for such a curve; that is, the demand curve resulting from advertising will be less elastic. (Figure 3)

If the original quantity was defined as, say, Q_1, at P=45¢ on the first curve (D_1), and this was compared with the response to an advertised price discount of 40¢ (Q_2) on the demand curve which results from advertising (D_2), one would conclude that advertising increases elasticity. In effect, the price elasticity measured is that of a third demand curve D_3. This curve D_3, however, fails to distinguish between price and advertising effects; it does not aid the decision-maker in deciding whether or not to advertise with a price discount.

Also, there is no a priori reason to assume such a demand curve shift will be parallel. A change in the shape of the demand curve will affect elasticity through a change in $-\frac{\partial Q}{\partial P}$, but the direction and magnitude is not known and must be determined empirically.

This study assumed that the decision to commit a certain level of resources to the advertising of fresh fish has been made (ex ante) and thus avoided some of the problems of determining the profitability of advertising programs. The investigation was concerned with whether or not total revenues will be increased by

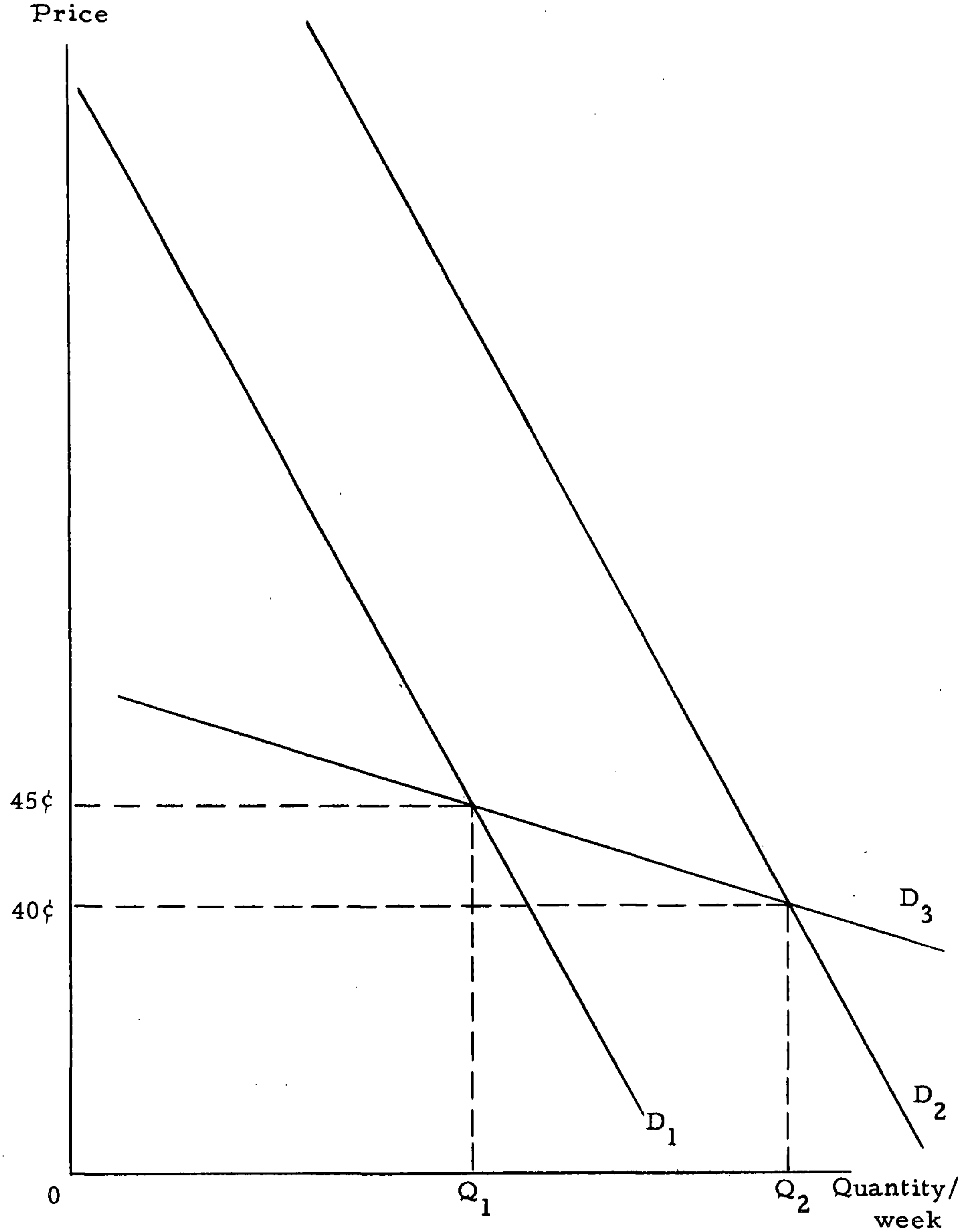

Figure 3. Advertising effects of price elasticity on demand.

advertising a fish item with a price discount, given that advertising will take place.

III. THE ECONOMIC MODEL AND PROCEDURES

Empirical Determination of Demand Relationships

In order to investigate the hypothesis "Advertisements of fresh fish which include a price discount increase gross receipts significantly more than identical advertisements without a price discount, *ceteris paribus*", it was necessary to estimate an advertising response function. The method employed was that of least-squares single equation multiple regression analysis.

Although the research was not attempting to determine a true demand function for fish, the determinants of demand had to be considered when constructing a model of the response to advertisements of fish. If variables are excluded from the analysis which have a significant correlation with the retained variables, biased coefficient estimates will result.

Other problems which beset an estimation of the true demand curve are also encountered when estimating the advertising response function. One such problem is known as the "identification problem" (Working, 1927). The identification problem arises when the simultaneous relationships (equations) are such that their separate effects cannot be determined from the data. These relationships are "unidentifiable". An example of this would be the case where neither the demand curve nor the supply curve shifts over the period of analysis. If this should happen the only point that would be observed would be the single equilibrium point; it would be impossible to determine the demand or the supply curve. Another example would be where both curves are shifting, but a regression on the observed points has no resemblance to either curve. Figure 4 is an example of such a result. If this were the case, an estimate of price elasticity obtained from the regressed line would be seriously biased.

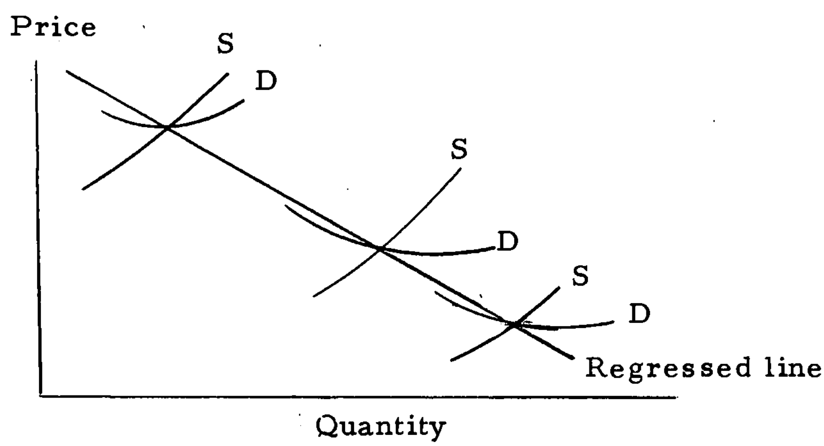

Figure 4. Biased linear regression estimate of the slope of a demand curve.

Such problems can also occur when an advertising function is estimated. The advertising function discussed here is an estimate of a short run demand curve, but differs from the same by the inclusion of advertising variables. The advertising response function derived relates quantity demand to a change in <u>advertised</u>

price, and hence differs from the usual demand curve which relates quantity demanded to various nonadvertised prices. Thus, the price elasticity obtained is not the "true" price elasticity of demand, but rather is an advertised-price elasticity. The advertised-price elasticity would approximate the "true" price elasticity of demand only to the degree that the determinants of demand, including advertising, remained constant over the period of analysis or were taken fully into account in the advertising response function. However, it is the estimates of advertised-price elasticities that will enable an investigation of the null hypothesis established for this study.

Since the investigation of the hypothesis required an unbiased estimate of advertised price elasticities, it is important to realize what assumptions must be met for the analysis to provide such an unbiased estimate. The assumptions are similar to those for estimating a true demand curve:

> Agricultural economists have justified the assumptions necessary to believe that the estimated elasticity is in fact reasonably accurate. If the demand curve is assumed to be stable, and the supply curve definitely not, and if independence is assumed, we are not in bad shape. And these may be very plausible assumptions. Stability of the demand curve is increased greatly by including income as a independent variable and thus removing its systematic effect on price-quantity relationship. And the supply curve may fluctuate a great deal due to the vagaries of weather, or to the cobweb cycle, or other factors. Another helpful assumption, that supply is inelastic, is also widely held. (Bolton, 1967, p. 40)

If these assumptions do not hold, then it is impossible to know how accurate the ordinary least-squares slope estimate is for the demand function, even when sample size is increased. This ignorance has been termed the identification problem.

Fortunately, for the problem at hand, such an identification problem is minimized. The supply curve for the advertised fish products is perfectly elastic for the firm to the consumer, and this is just as helpful an assumption for advertised-price elasticity estimation as if it were perfectly inelastic. That is, the slope of the supply curve is known. Also, the supply curve does fluctuate as normal prices and advertised prices are varied. Although this implies the supply curve has the desired lack of stability, it also implies some dependence between the shifts in the demand curve and the supply curve. However, since grocery stores do on occasion advertise fish without a reduction from the normal nonadvertised price, the correlation between shifts in the advertising response function and the supply curve is lessened. What dependence there is can be stated as a negative one: as the supply curve shifts down, the advertising response function tends to shift to the right and up. The advertising response function should be reasonably stable for a given level of advertising, and, as Bolton (1967) mentions, the inclusion of income as an independent variable can greatly aid in increasing the stability (and reducing the bias) of the estimated price coefficient.

The inclusion of income as a variable, however, frequently brings with it problems of multicollinearity. If the multicollinearity is severe, with price and income highly correlated, (r greater than .70 to .80) the estimates of the coefficients are unreliable. The researcher is then faced with the dilemma of removing one variable and introducing bias into the coefficient of the other, or including the variable and greatly reducing the significance levels for the slope estimators.

The use of the single equation least-squares multiple regression analysis also assumes that there is no serial correlation between the independent variable and the residuals. In this study, this would mean that in order to apply least-squares analysis, sales should be a function of advertising, but the converse would not be true. (Bass, 1963) Fortunately, grocery store advertisements usually meet this assumption.

The model that was selected was therefore of single-equation form.

$$Q = b_0 + b_1X_1 + b_2X_2 + \ldots + b_nX_n + e$$

with Q representing quantity sold in pounds per week and X_1, X_2, ..., X_n representing independent variables thought to significantly influence the variation in Q, the quantity sold. The error term is represented by an e.

The Data and the Assumptions

In order to secure values for the independent variables of the model (X_1, X_2, ..., X_n), it was necessary to collect time series data from retail grocery stores.

Information was obtained from a large food chain operating in the Portland, Oregon, metropolitan area of weekly inventories and normal prices of red snapper, sole, and silver salmon[3/] by store. Weekly inventories were used as an estimate of weekly sales; this proxy variable is not likely to introduce much bias (if any) since fish is extremely perishable and rarely frozen for future sales. The food chain has 20 retail outlets in the Portland area. Advertised prices were obtained by consulting the Oregonian and the Oregon Journal for the period of study, these being the two major newspapers in which advertisements for the food chain were carried. 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 fish purchases

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3/ 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).

would be atypical during these weeks).

The food chain does not pay for advertisements on a per advertisement basis; rather, it is on a 12-month contract rate determined by a minimum number of agate lines of advertisement used during those 12 months. The use of the single equation least-squares model was justified, since advertisements are not a function of either past or present sales. Also, because advertisement 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 = advertised first half of the week (Monday or Tuesday), A_2 = advertised last half of the week (Wednesday or Thursday). Advertising did not take place over the weekend.

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 model, since real price changes (36.41¢ to 73.43¢ (1956-59 = 100)) did not significantly (1% test level) influence the sales response when nominal prices were held constant.

Over the period of analysis, population increased 2.7% within the city limits (372,676 to 382,619) and 6.5% within Multnomah county (522,813 to 556,667) (1970 Oregon Population). Disposable per capita income rose from $2,118 to $2,847, while real disposable income rose from $1,985 to $2,349. (U.S.B.S.

Survey of Current Business) Income was included in the analysis as an independent variable. 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.

Position and size of the advertisement were judged to be insignificant. This is in agreement with other studies concerning newspaper advertisements:

> Little if any variance in advertising effectiveness seems to be the rule for most aspects of mechanical positioning in newspapers. (Position in Newspaper Advertising: 2, p. 76)

However,

> ... how much better or worse the grocery advertisements do may depend on size ... the two larger groups performed slightly better. (Position in Newspaper Advertising: 1, p. 55)

The food chain's food advertisements followed similar formats for ad size for the total advertisement from week to week; fish advertisements varied somewhat in size but were never truly prominent.

In addition, three somewhat heroic assumptions were made: 1) that advertisements of competing stores do not significantly affect the sales of the studied food chain; 2) that regular and advertised prices of substitute and complement goods do not affect the sales of "special" fish items in the studied food stores; and

3) that the individual butcher's attitude toward fish and store space for fish remained constant over the period of analysis. To the extent that these assumptions are invalid, there should be a larger amount of total variation in sales that remain "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.

A lagged response variable, A_{t-1}, was also added to the model, since it can be expected _a priori_ that if the fish item was advertised the week before, there might be a delayed response that would be seen during the present week.

The Red Snapper Model

Although economic theory can suggest what variables might logically be included in the model, theory gives few indications of the probable structural relationships the variables will have to one another. For this reason, it is frequently necessary to attempt to fit several functional forms to the data and to select the "best" regression for the purposes intended for the model. This selection is not always easy, nor is it completely objective, yet there are various criteria which aid in such a selection, such as F, t and R^2 (coefficient of determination) values. Five functional forms of the model were initially considered:

1. $Q = f(P, A_1, A_2, A_{t-1}, Y)$
2. $\ln Q = g(\ln P, A_1, A_2, A_{t-1}, \ln Y)$
3. $Q = h(\ln P, A_1, A_2, A_{t-1}, \ln Y)$
4. $\%\Delta Q = i(\%\Delta P, A_1, A_2, A_{t-1}, Y)$
5. $Q = j(\%\Delta P, A_1, A_2, A_{t-1}, Y)$.

where

Q = quantity sold

P = price

A_1 = advertised first half of the week (dummy variable)

A_2 = advertised second half of the week (dummy variable)

A_{t-1} = advertised any time the previous week (dummy variable)

Y = income.

The first, fourth and fifth forms of the model were considered since it was reasoned a priori that both the absolute difference in prices and the percentage change in prices may affect sales. (Katona, 1960) The two logarithmic functions were included since logarithmic transformations are one of the simpler functions which lend themselves well to estimates of concave (from above) demand curves, and many previous demand studies have had success with this type of transformation (Simon, 1969; Tolley, 1969).

The results of the estimation of the first three equations appear below:

(1)

$$Q = 1392.71 - \underset{(6.46)}{34.40\ P^{**}} + \underset{(63.30)}{421.47\ A_1^{**}} + \underset{(6.28)}{875.89\ A_2^{**}}$$

$$+ \underset{(44.39)}{161.65\ A_{t-1}^{**}} + \underset{(.277)}{.466\ Y} + e$$

$R^2 = 75.06\%$

$r_{p\,y} = .6298$

$F = 149.88$

(2)

$$\ln Q = -36.46 - \underset{(.294)}{1.34 \ln P^{**}} + \underset{(.0597)}{.42\ A_1^{**}} + \underset{(.0598)}{.63\ A_2^{**}} + \underset{(.0424)}{.23\ A_{t-1}^{**}}$$

$$+ \underset{(.658)}{1.56 \ln Y^{*}} + e$$

$R^2 = 66.85\%$

$r_{p\,y} = .6240$

$F = 100.07$

(3)

$$Q = -3752.58 - \underset{(301.76)}{1878.94 \ln P^{**}} + \underset{(61.24)}{399.93\ A_1^{**}} + \underset{(61.39)}{844.66\ A_2^{**}}$$

$$+ \underset{(43.55)}{159.67\ A_{t-1}^{**}} + \underset{(675.78)}{1525.75 \ln Y^{*}} + e$$

$R^2 = 75.95\%$

$r_{p\,y} = .6240$

$F = 156.63$

** Significant at 1% test level.
 * Significant at 5% test level.
Figures in parentheses = standard deviation.

The remaining two regressions, which concern percentage change relationships, were far less satisfactory, with adjusted R^2 = 47.51% and 43.39%. That is, only 47.51% (43.39%) of the variation in quantity sold is "explained" by the independent variables. Since the R^2 levels were considerably higher in the other three estimated equations, the percentage change regressions were discarded as unsatisfactory. Because the remaining three regressions have equally satisfactory coefficients and F levels, the one chosen for analysis was the one with the highest R^2, regression No. 3.

It should be noted that in all three regression equations, the three dummy variables (A_1, A_2, A_{t-1}), when tested as a unit, were significant at the 1% level. In two regressions (Nos. 2 and 3), income is significant at the 5% test level; price is significant at the 1% test level for all three regressions. All coefficient signs are the expected ones with increased advertising leading to increased sales, i.e., there is a positive "advertising effect". Advertising the second half of the week had a larger sales effect than advertising the first half of the week, as was expected.

All three regressions have a multicollinearity problem which fortunately is not severe. For estimated equations No. 2 and No. 3, the simple correlation coefficient, r, between the logarithm of income (Y) and the logarithm of price (P) is .6240; for equation No. 1

r is .6298. Although this r value is not ideal, it is not large enough to cause concern.

Examination of the residuals revealed a serial correlation of the error term as well; the autoregression coefficient, $\hat{\rho}$, ($e_t = \hat{\rho} e_{t-1} + u$) was equal to .329 ($\hat{\rho}$ may take on a value from zero to 1). When autocorrelation of the error term is present one or more assumptions of least-squares analysis is violated. It is difficult to identify the source of serial correlation, although it is necessarily one of the following four: specification error due to the influence of omitted variables, incorrect choice of the form of the relationship, measurement error, or the inherent nature of the model. (Hammonds, n. d.) Measures were taken to correct the data to compensate for the autocorrelation, and the procedure and results are discussed in the appendix. Fortunately, the autocorrelation was such that the conclusions obtained from the corrected data did not differ from those obtained from the original regression. Serial correlation of the error term implies that t tests of coefficient significance are no longer completely reliable, although the R^2 tests remain valid.

The Sole Model

The model, regression No. 3, which was formulated from red snapper data, was also applied to sole and silver salmon data.

Since the model was originally formulated from red snapper data, application of the model to new data was needed in order to test the model's validity. Sole and silver salmon were chosen for such a purpose.

It was assumed a priori that the model formulated from red snapper data would better explain the advertising response to the advertisement of another groundfish, sole, than to silver salmon. However, this was not the case.

Sole is a groundfish as is red snapper. Both are available all year and are usually marketed as fresh fillets. Sole retailed for 20¢ to 30¢ more per pound than red snapper throughout the period of study: mean price for red snapper was 49.48¢; mean price for sole was 77.61¢.

The model, when applied to sole, yielded the following estimated equation:

$$Q = -6039.95 - \underset{(168.03)}{161.47} \ln P + \underset{(32.52)}{234.38} A_1^{**} + \underset{(34.77)}{423.47} A_2^{**}$$

$$+ \underset{(18.04)}{37.77} A_{t-1}^{*} + \underset{(232.46)}{920.27} \ln Y^{**} + e$$

$$R^2 = 62.38\%$$

$$r_{py} = .4982$$

$$r_{pA_1} = -.6512$$

$$F = 82.24$$

* Significantly different from zero at 5% test level.
** Significantly different from zero at 1% test level.
Figures in parentheses = standard deviation.

The dummy variables (A_1, A_2, A_{t-1}) when tested as a unit were significant at the 1% test level. These dummy variables are "shift" variables representing the advertising effect. The multicollinearity problem between income and price was less in the sole regression than in the red snapper regression; however, there was a problem of serial correlation of the error term ($\hat{\rho} = .344$) in the sole estimated equation. When this correlation was removed, and the equation reestimated, the conclusions obtained were not different from those obtained from the uncorrected regression (see appendix). Hence, the original estimated equation was used throughout the study.

In the sole regression the coefficient of the logarithm of price is not significantly different from zero at the 1% test level. This is not a sufficient reason for removing the price variable and reestimating the equation. Indeed, price is an extremely important variable in any demand equation. The t test of significance is a measure of a significant relationship between variables for the particular data that are examined and not for the entire population of interest. Therefore, if there are strong theoretical reasons for including a variable, even though the t test is not significant for the particular sample data, the variable should be retained. Thus, the price variable appears in the regression.

The Silver Salmon Model

Silver salmon, in contrast to the two groundfish, is an anadromous fish most available in the fresh form during June through October. It is usually retailed drawn or as dressed steaks. The mean price for silver salmon over the period of analysis was 79.82¢. Since silver salmon is seasonally available in the fresh form, a new variable, S, was added to the model which was not present in the two groundfish estimated equations. This was a dummy variable which took a value of 1 when silver salmon was available in the fresh form (June through October) and a zero (0) value during other times of the year. The results are shown below:

$$Q = -2900.74 - \underset{(535.65)}{4814.52} \ln P^{**} + \underset{(101.80)}{200.50} A_1{}^{*} + \underset{(94.17)}{1310.30} A_2{}^{**}$$

$$+ \underset{(69.87)}{489.34} S^{**} + \underset{(995.12)}{3154.91} \ln Y^{**} + e$$

$$R^2 = 79.86\%$$

$$r_{py} = .5814$$

$$F = 188.75$$

* Significantly different from zero at 5% test level.
** Significantly different from zero at 1% test level.
Figures in parentheses = standard deviation.

The A_{t-1} variable (advertised any time previous week) was not a significant variable (1% test level); since there was no strong theoretical reason for retaining it, the A_{t-1} variable was not included. The dummy variables, when tested as a single unit, were significant at the 99% confidence level. Also, there was no significant (1% test level) serial correlation of the error term in the silver salmon regression.

IV. RESULTS AND CONCLUSIONS

Advertised-Price Elasticity

Table 1 contains the three final regressions for red snapper, sole, and silver salmon sales. From these equations an estimate of advertised price elasticity was derived in order to investigate the hypothesis: "Advertisements of fresh fish which include a price discount increase gross receipts significantly more than identical advertisements without a price discount, *ceteris paribus*." This hypothesis is identical to one which states "Advertised-price elasticity is greater than $|-1.00|$, *ceteris paribus*." (Advertised-price elasticity, it will be recalled, is equal to the percentage change in quantity sold divided by the percentage change in the *advertised* price.) That is, if the advertised-price elasticity is greater than $|-1.00|$ (elastic), then advertising that item with a price discount would be expected to increase gross revenues (see Chapter II). There is no reason to assume that the elasticity of an advertised fresh fish product will be the same as the elasticity for the identical but unadvertised product. Nor will elasticities necessarily be the same for different advertising levels.

In the three regressions in Table 1, the coefficient of the logarithm of price will give an estimate of elasticity. For reasons

Table 1. Regressions.

Red Snapper

$$Q = 3752.58 - \underset{(301.76)}{1878.94} \ln P^{**} + \underset{(61.24)}{399.93} A_1^{**} + \underset{(61.39)}{844.66} A_2^{**}$$

$$+ \underset{(43.55)}{159.67} A_{t-1}^{**} + \underset{(675.78)}{1525.75} \ln Y^{*} + e$$

$R^2 = 75.95\%$
$r_{p\,y} = .6240$
$F = 156.63$

Sole

$$Q = -6039.95 - \underset{(168.03)}{161.47} \ln P + \underset{(32.52)}{234.38} A_1^{**} + \underset{(34.77)}{423.47} A_2^{**}$$

$$+ \underset{(18.04)}{37.77} A_{t-1}^{*} + \underset{(232.46)}{920.27} \ln Y^{**} + e$$

$R^2 = 62.38\%$
$r_{p\,y} = .4982$
$F = 82.24$

Silver Salmon

$$Q = -2900.74 - \underset{(535.65)}{4814.52} \ln P^{**} + \underset{(101.80)}{200.50} A_1^{*} + \underset{(94.17)}{1310.30} A_2^{**}$$

$$+ \underset{(69.87)}{489.34} S^{**} + \underset{(995.12)}{3154.91} \ln Y^{**} + e$$

$R^2 = 79.86\%$
$r_{p\,y} = .5184$
$F = 188.75$

* Significantly different from zero at 5% test level.
** Significantly different from zero at 1% test level.
Figures in parentheses = standard deviation.

that will be discussed later, the regression equations are written in such a way that the shift in the estimated demand curve due to advertising is parallel (see Figure 5). The dummy variables allow only for a shift in the intercept value, but not a change in the slope of the estimated equation. Hence, as explained in Chapter II, since advertising without a price discount has a significant (1% test level) and positive effect on sales, the advertised-price elasticities will necessarily be more inelastic relative to nonadvertised price elasticities. The difference between the elasticities is larger the greater the shift from the "nonadvertised" to the "advertised" demand curves.

Advertised-price elasticity can be written as $\frac{\partial Q}{\partial P_a} \times \frac{P_a}{Q}$ ($\equiv \frac{\%\Delta Q}{\%\Delta P_a} \equiv \eta_{p_a}$). Differentiating the red snapper regression (Table 1) 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 $\frac{P_a}{Q}$:

$$\eta_p = \frac{\partial Q}{\partial P_a} \times \frac{P_a}{Q} = -1878.94 \ (1/P_a) \ (P_a/Q)$$

$$= -1878.94 \ (1/Q).$$

Using mean quantities as the divisors (Q), elasticities for the

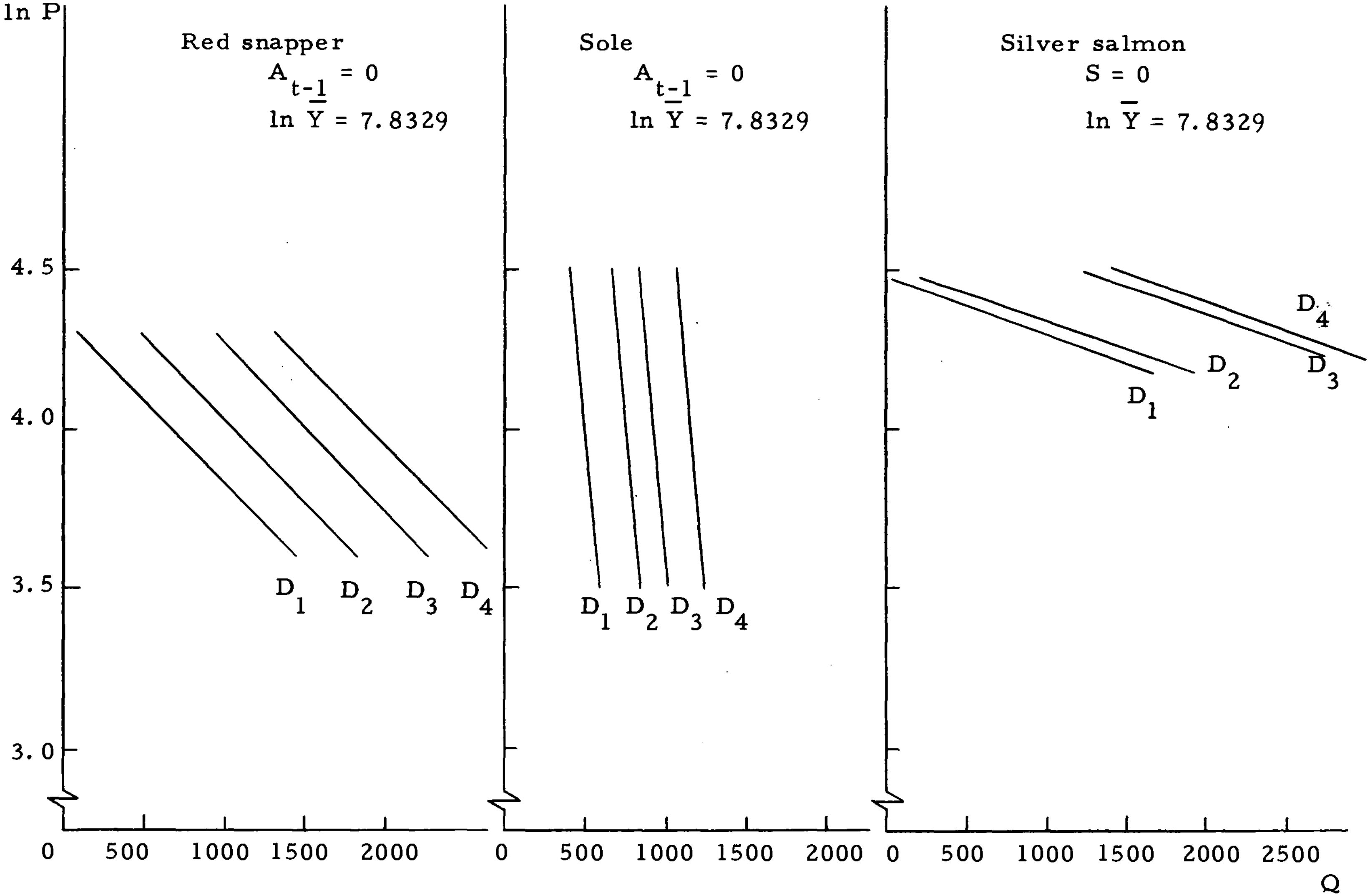

Figure 5. Shifts in the demand curves for fish: The advertising effect.

various advertising policies (for the mean price of 46.2¢) can thus be determined. The results are shown below.

Red Snapper

Table 2. Advertised-Price Elasticity Estimates for Red Snapper With a Mean Price of 46.2¢.

Policy and mean quantity	Elasticity
Not advertised Q_a = 820.41	-2.29**
Advertised 1st half of week Q_a = 1439.25	-1.305
Advertised 2nd half of week Q_a = 1979.94	- .949
Advertised all week Q_a = 2416.81	- .777
"Average" elasticity Q_a = 1346.83	-1.395

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

Only in the case of "nonadvertised" red snapper fillets sales was the price-elasticity figure significantly different from $|-1.00|$, i.e., significantly elastic as the 1% test level. When advertising took place, the resulting advertised-price elasticities were not significantly different from $|-1.00|$, and therefore advertisements with a price discount would not increase gross receipts significantly more than advertisements without a price discount. (An advertised-price elasticity of less than $|-1.00|$, implies that the quantity response to an advertised price discount will be such that gross receipts will decline relative to an identical situation 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 value of pounds of red snapper sold per week increased 195% when a policy of "advertised all week" was pursued compared to a policy of "nonadvertisement" (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 greater effect in increasing sales than did an advertised-price discount.

"Average" elasticity refers to the mean quantity sales response to price changes throughout the year taking into account all weeks' sales whether or not advertising took place.

A more comprehensive analysis of red snapper elasticities can be made showing the effect of differing price levels and the previous week's advertisement (income constant, ln Y = 7.83319 (mean value)).

Table 3. Advertised-Price Elasticities of Red Snapper Corresponding to Three Retail Prices, Annual Averages.

Advertising policy	Prices 39¢	49¢	59¢
Not advertised	-1.43	-2.12**	-3.50**
Advertised 1st half of week	-1.10	-1.46*	-2.00**
Advertised 2nd half of week	- .87	-1.09	-1.36
Advertised all week	- .73*	- .88	-1.05

** Significantly different from -1.00 at the 1% test level.
* Significantly different from -1.00 at the 5% test level.

As Table 3 indicates, very few of the advertised-price elasticities were significantly elastic. Theoretically, higher prices of fish should result in more elastic estimates; the results indicated that this was the case for red snapper. For example, with an "all-week" advertising policy, the advertised-price

price elasticity increased from -.73 to -1.05 as price increased from 39¢ to 59¢. Also, elasticities were increasingly smaller (more inelastic) with increased advertising, i.e., when price equalled 49¢, the elasticity decreased from -2.12 for "non-advertised" weeks to -.88 for "advertised all week". 4/

Table 4. Advertised-Price Elasticities of Red Snapper Corresponding to Three Retail Prices and Previous Week Advertising.

Advertisement policy	Price		
	39¢	49¢	59¢
Not advertised + advertised previous week	-1.27	-1.80**	-2.70**
Advertised 1st half of week + previous week	-1.00	-1.30	-1.71**
Advertised 2nd half of week + previous week	- .81	- .99	-1.22
Advertised all week + previous week	- .69**	- .82	- .97

** Significantly different from -1.00 at the 1% test level.
 * Significantly different from -1.00 at the 5% test level.

4/ It is well to emphasize a point made in Chapter II. Advertising of fresh fish results in a greater number of sales than does the same price without an advertisement. If the point of reference for the change in quantity is the demand curve for nonadvertisement weeks, this shift of the demand curve for fresh fish then implies <u>increased</u> elasticity. If the point of reference, however, is the demand curve for weeks with advertisements, then this shift implies <u>reduced</u> elasticity. For purposes of decision making about advertising with or without a discount, the reference point should be the curve for sales resulting from advertising.

Table 2 tabulates the effect of previous week advertising upon advertised-price elasticity of demand of red snapper. The effect of a previous week advertisement of red snapper was to increase the quantity response and to reduce advertised-price elasticity of demand. For example, when price equalled 39¢ and the advertising policy was "advertised all week", the advertised-price elasticity (without previous week advertising) was equal to -.73 (Table 3). However, with the additional effect of a previous week's advertisement, the advertised-price elasticity was reduced to -.69 (Table 4).

Since all but two (-1.46, -2.00) of the advertised-price elasticities from Table 3 were not significantly different from $|-1.00|$ at the 5% test level (and only -2.00 was significantly different from -1.00 at the 1% level), the null hypothesis was rejected for the range of prices considered. This implies that gross returns from advertising red snapper will be greater if the advertisement does not include a price discount from the unadvertised "normal" price than if it does. However, as the price approaches 59¢ a pound the estimates are elastic (-1.46, -2.00). If the *ceteris paribus* condition holds, higher prices imply greater advertised price elasticity.

This suggests that with higher prices the "best" advertising policy would be one which did indeed advertise with a price discount. However, it is not unreasonable to assume that as the absolute price of red snapper rises, the relative price of red snapper to substitute products' prices may remain fairly constant. If substitute products' prices are rising as well as red snapper prices (the *ceteris paribus* condition not holding), then it is possible for the original conclusion to apply, and advertising without a price discount would remain the best policy. This, however, is speculation beyond the research results; for the data analyzed, the null hypothesis established for this study would be rejected.

Sole

Since sole is a groundfish similar to red snapper but higher priced, it was hypothesized *a priori* that the model would apply well to sole but with more elastic advertised-price elasticities. This, however, was not the case. Indeed, the coefficient of the logarithm of the price variable in the sole model was not significantly different from zero at the 1% test level. It was, however, significantly different from $|-1.00|$ at the 99% confidence level for the advertised price elasticity estimates.

The original hypothesis is rejected in the case of sole, since the values were overwhelmingly inelastic at the 1% test level. This result was contrary to the expected and led to the formation of a new hypothesis to explain the differences between the sole and

Table 5. Advertised-Price Elasticity Estimates for Sole with a Mean Price of 77.3¢.

Policy and mean quantity	Elasticity
Not advertised Q_a = 468.93	-.344**
Advertised 1st half of week Q_a = 733.53	-.220**
Advertised 2nd half of week Q_a = 958.05	-.169**
Advertised all week Q_a = 940.00 (n = 3)	-.171**
"Average" elasticity Q_a = 564.05	-.286**

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

the red snapper elasticities: that 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 hypothesis 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 positive 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)

If this is the case in the Portland area, it would provide an explanation for the price inelastic demand for sole.

Silver Salmon

Surprisingly, the model performed even better (higher R^2) on salmon data than on sole data. The advertised-price elasticities derived from the silver salmon data are quite elastic (greater than $|-1.00|$) (Table 6). A more comprehensive analysis shows the effect of differing prices and seasonality (Table 7).

Every advertised price elasticity for silver salmon was significantly greater than $|-1.00|$, all but one of the 99% confidence level (-1.30). Higher prices corresponded with more elastic estimates, and increasing advertising resulted in lower advertised-price elasticity estimates.

In contrast to sole and red snapper, the null hypothesis was not rejected for silver salmon. Advertising silver salmon <u>with</u> a price discount would result in <u>greater</u> total revenues than advertising without a price discount.

Table 6. Advertised-Price Elasticity Estimates for Silver Salmon with a Mean Price of 76.3¢.

Policy and mean quantity	Elasticity
Not advertised Q_a = 690.00	-6.98**
Advertised 1st half of week Q_a = 1559.88	-3.086**
Advertised 2nd half of week Q_a = 2769.71	-1.738**
Advertised all week Q_a = 2824.62	-1.704**
"Average" elasticity Q_a = 1358.75	-3.54**

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

Table 7. Advertised-Price Elasticities of Silver Salmon Corresponding to Three Retail Prices, Nonseasonal Averages.

Advertising policy	Price		
	59¢	69¢	79¢
Not advertised	-2.21**	-3.38**	-6.22**
Advertised 1st half of week	-2.02**	-2.96**	-4.94**
Advertised 2nd half of week	-1.38**	-1.76**	-2.31**
Advertised all week	-1.30*	-1.64**	-2.11**

** Significantly different from -1.00 at the 1% test level.
 * Significantly different from -1.00 at the 5% test level.

Table 8. Advertised-Price Elasticities of Silver Salmon Corresponding to Three Retail Prices, Seasonal Supply.

Advertising policy	Price		
	59¢	69¢	79¢
Not advertised	-1.80**	-2.51**	3.81**
Advertised 1st half of week	-1.68**	-2.28**	-3.29**
Advertised 2nd half of week	-1.21	-1.49**	-1.87**
Advertised all week	-1.15	-1.41*	-1.74**

** Significantly different from -1.00 at the 1% test level.
 * Significantly different from -1.00 at the 5% test level.

When fresh silver salmon was most available (June through October), quantity response to a given advertisement was greater than during the other months of the year. (The quantity response is estimated by the positive coefficient of 489.34 pounds on the dummy variable S.) This positive increase in sales during the summer months implies reduced advertised-price elasticity estimates in comparison with estimates for the rest of the year. For example, Table 7 lists -1.38 as the advertised price estimate for a promotional policy of advertising the second half of the week (price equal to 59¢) when silver salmon is not in season. When the same policy was pursued during the summer months, the elasticity estimate becomes -1.21. Season, however, does not have a large enough effect on advertised-price elasticity to invalidate the conclusion that the null hypothesis would not be rejected.

Income Elasticity

The estimates of income elasticity derived from the regressions are probably not as accurate as those for advertised-price elasticity since weekly deflated income estimates were formulated from yearly figures. Because the advertised-price elasticities were the prime interest of the study, it was felt that such estimation for the income variable was adequate. The income elasticity estimates are from deflated per capita income and hence are slightly higher estimates than if undeflated data were used. The estimates are positive and greater than 1.00, and, as such, are

Table 9. Income Elasticities Estimated from the Study.

Fish item	Income elasticities
Red snapper	1.13
Sole	1.63
Silver salmon	2.32

in agreement with other studies (Nash, 1967, 1969). The estimates are derived from mean quantity sold throughout the period of analysis, which would incorporate advertising effects. Therefore, the income elasticity estimates are probably overestimated, at least from "true" elasticities. And, certainly the data is not precise enough to allow conclusions concerning differences between low income group consumptions of fish and high income group consumption. Such an analysis would require a cross-sectional study.

Separate Advertising Policies Effects

An attempt was made to segregate the data not only by species, but also by advertising policy: not advertised, advertised first half of the week, advertised second half of the week, and advertised all week. This would allow an estimate to be made of the change of the slope of the estimated demand equation as a result of advertising. The results were disappointing. Upon separation of the data, the multicollinearity problem between price and income became severe, although the reasons for this remain unclear. Although for the aggregated red snapper data, correlation between the logarithm of price and the logarithm of income was .62, it was as high as .8921 for the segregated data. Although for the aggregated sole data, the simple correlation coefficient obtained a value of .49, it was as high as .7881 for data that was for "advertised second half of the week". The identical problem occurred with silver salmon. 5/

These high multicollinearities resulted in unreliable coefficients since it is impossible to untangle the effects on quantity that result from price changes from those that result from income changes. With the data on hand, there is no resolution of this problem, for removing income would not give an unbiased price coefficient. Thus, the advertised-price elasticities obtained from aggregated data were used for the study. 6/

Net Revenues

Elasticity is useful in evaluating the responsiveness of demand to price changes and advertising policies, but it does not determine the real profitability of advertising expenditures. Such a determination would involve evaluating the marginal revenue

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5/ An attempt was also made to include a slope dummy variable in the original model. Severe multicollinearity problems again developed.

6/ One study of similar nature which successfully included a slope estimate into the analysis was that of Leo Gray (1964) in "Effects of Price Specials on Volume of Sales of Frying Chickens." The slope estimate was insignificant, and Gray concluded the shift in the demand function was largely parallel with little change in slope. Hopefully, this is true of advertised fish-"specials" as well.

product of the promotional dollar and comparing it to the marginal revenue product of the dollar in the next best alternative. The problem is greatly complicated when there is an ever changing "product mix" of promotional activities. However, even though determination of the optimum allocation of advertising expenditures is beyond the scope of this study, it is a simple matter to obtain an approximation of the change in net revenues from fish sales as a result of advertising. The retail food chain usually advertised at the 210,000 agate line contract rate per year (West, 1970). There are 2,408 agate lines to a page, and the retail display advertising rate for the *Oregonian* ranged from 32¢ to 38¢ an agate line over the period of the study. For the *Oregon Journal* the rate was .295¢ over the period of the study. A fish advertisement occupied approximately 1/20th of a page.

Therefore:

1. To calculate the fish advertisement's share of the cost of advertising:

1/20 page x 2408 agate lines/page x 36¢/line = $43.34 (1966 data).

2. To calculate the average increase in total revenues for each advertising policy:

Mean quantity difference between quantity sold with an advertising policy and without advertising	X	Wholesale-retail spread per pound	=	Average increase in total revenues.

For example, in 1966, the wholesale-retail spread per pound of red snapper was as little as 4¢ and as much as 21¢ but averaged near 14¢ per pound. The difference between mean quantity sold on "nonadvertised" weeks and "advertised first half of week" was 619 pounds (1439-820 pounds); between "not advertised" and "advertised second half of week", the mean quantity difference was 1160 pounds (1980-820 pounds). The change in gross (of advertising costs) revenues as a result of advertising, assuming no price discount and a 14% retail-wholesale spread, then is:

Advertised 1st half of week

619 pounds x 14¢/pound = $86.66.

Advertised 2nd half of week

1160 pounds x 14¢/pound = $162.40.

3. Thus, if these are the only costs associated with advertising, profit can be determined by simple subtraction:

Increase in gross revenues due to advertising - cost of advertising = profit.

Or:

Advertised 1st half of week

$86.66 - $43.34 = $43.28.

Advertised 2nd half of week

$162.40 - $43.34 = $119.02.

A modest profit of either $43.28 or $119.02 was gained from the increased sales that resulted from advertising.

Computations such as these, then, can be used to estimate a change in net revenues due to advertising. The example chosen here is a typical one. 7/

These computations, however, are dependent on an advertising response to a certain size of advertisement as well as the _ceteris paribus_ conditions, and it is dangerous to assume that such a situation would always prevail. It is difficult, therefore, to make any statement concerning the profitability of advertising fish except to say that if a fish product's advertised-price elasticity is less than $|-1.00|$, then it will be more profitable to advertise the item without a price discount than with a price discount. 8/

7/ These computations allow an estimate of the increase in net revenues that result from increased fish sales as a result of advertising. It must be cautioned, however, that the firm's profits will increase only if the increase in net revenues from fish sales is not cancelled by a decrease in net revenues from the sale of substitute products. If consumers reduce purchases of other products in order to purchase more fish, this could well be the case.

8/ The situation is complicated, however, by a type of rebate procedure that is maintained in the retail-wholesale grocery market. That is whenever a retailer discounts a fish product, the wholesaler also discounts the price to the retailer. In the case of the retailer studied here, however, the wholesale discount was given whether or not the advertisement had a discounted price.

Consumers' Conception of Prices

It was mentioned in the introduction that some authors (Morris, 1967, Engel, 1968) have concluded that the majority of consumers have only a vague perception of price. It would seem that one necessary but not sufficient condition for this to be the case would be that the coefficient on the price variable be not significantly different from zero; that is, the variation in quantity sold is not explained, even in part, by price variations. In this study, only sole had a price coefficient that was not significantly different from zero. The red snapper and the silver salmon coefficients definitely do not meet this condition.

Furthermore, there is evidence that consumers do indeed have a perception of "normal" price or at least of a range of prices in which the "normal" price lies. The retail food chain which was used in this study once lowered the price of crab from the regular price of 59¢ a pound to an advertised price per pound of 32¢. Previous advertised prices were only as low as 49¢ per pound, and previous week's sales during advertised specials averaged 3, 470 pounds. The advertisement which included the 32¢ per pound offer was not noticeably different from other advertisements, however the quantity response was an astounding 31, 450 pounds.

A hypothesis seemingly more fruitful for further investigation than Morris' "shoppers in general have a poor grasp of normal prices" would be that consumers perceive a range of prices in which the "normal" price fluctuates. If a strict inverse relationship between prices and sales does not exist, this may imply only that nonprice variables are taking precedence and not that consumers have a vague perception of prices.

V. SUMMARY

The hypothesis that was tested was "Advertisements of fresh fish which include a price discount increase gross receipts significantly more than identical advertisements without a price discount, *ceteris paribus.*" Embodied in the hypothesis are two testable statements: (i) that newspaper advertisements (with or without price discounts) increase gross receipts from an individual product's sale and (ii) that advertised-price elasticity of demand for fresh fish is greater than $|-1.00|$.

The hypothesis was investigated for three species of fish: red snapper, sole, and silver salmon. The data was obtained for November, 1963, to December, 1968, from a large retail grocery food chain which operated 20 stores in the Portland, Oregon, metropolitan area. The data were analyzed with the aid of single equation least squares multiple regression. A model was formulated from red snapper data and took the form of

$$Q = B_0 + B_1 \ln P + B_2 A_1 + B_3 A_2 + B_4 A_{t-1} + B_5 \ln Y + e$$

where

Q = quantity

P = price

A_1 = dummy variable for advertised first half of week

A_2 = dummy variable for advertised second half of week

A_{t-1} = dummy variable for advertised any time of previous week

Y = income

e = error term.

This model was then applied to sole data and silver salmon data. The coefficient of determination (R^2) values for the estimated equations were 75.95% (red snapper), 62.37% (sole), and 79.86% (silver salmon).

The null hypothesis established for this study was then examined in reference to the findings for the three fish species. For all three types of fish (red snapper, sole, and silver salmon), it was determined that newspaper advertisements increase gross receipts for the sale of an individual product. The second testable statement of the null hypothesis, "advertised-price elasticity of demand for fresh fish is greater than $|-1.00|$", was not rejected in the case of silver salmon (for the range of prices considered (59¢ to 89¢)). However, it was rejected in the case of red snapper and sole for the range of prices considered (39¢ to 59¢; 59¢ to 89¢), since the advertised price elasticities of these groundfish were found to be not significantly different from $|-1.00|$ at the 1% test level.

This suggested that for the ground fish, red snapper and sole, an advertising strategy which did <u>not</u> include a price discount would result in greater gross returns than an advertising strategy with a price reduction. Conversely, for silver salmon, gross returns would be larger if the advertising strategy <u>did</u> include a price discount than if it did not.

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APPENDIX

APPENDIX

Serial Correlation of the Error Term: Red Snapper and Sole Regressions. 9/

Since autocorrelated residuals existed in both the red snapper and the sole regressions, steps were taken to correct for their influence. Fortunately, the regressions that resulted from the correction process did not invalidate the conclusions deduced from the uncorrected regressions. Therefore, the uncorrected regressions were used throughout the study.

Red Snapper

Examination of the residuals of the red snapper regression revealed a serial correlation of the error term; the autoregression coefficient, $\hat{\rho}_1$, ($e_t = \hat{\rho}_1 e_{t-1} + u$) was equal to .329. This coefficient then, was used to transform the original data to

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9/ The material in this appendix relies heavily on an unpublished paper by T. M. Hammonds (n. d.) entitled "The Elimination of Autocorrelated Disturbances in Regression Analysis: A Revised Estimator", in which the author demonstrates the errors which are intrinsic in some of the textbook recommended corrections for autocorrelation and provides a substitute procedure.

eliminate some of the effects of autocorrelation. The original data were transformed by subtracting from each variable $\hat{\rho}_1$ times that variable lagged one observation (e.g., $Q_t - \hat{\rho}_1 Q_{t-1}$). The transformed regression then became: (see Table 10 for original regressions)

$$Q = -811.92 - \underset{(208.68)}{1073.99} \ln P^{**} + \underset{(58.68)}{386.35} A_1^{**} + \underset{(56.78)}{824.10} A_2^{**}$$

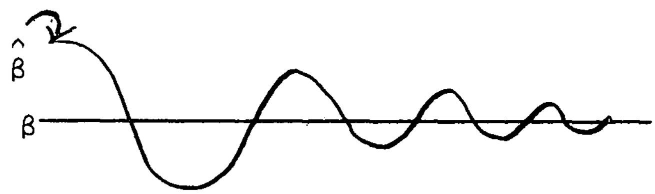
$$+ \underset{(40.41)}{111.89} A_{t-1}^{**} + \underset{(548.84)}{696.16} \ln Y + e$$

$$R^2 = 77.14$$

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

The iterative process was discontinued after this step, since the effect upon the coefficient of the logarithm of price was to reduce the estimate of elasticity to a more inelastic value ("average" elasticity became -.7974 compared to the original -1.395). Had it been otherwise, a new autoregression coefficient, $\hat{\rho}_\Delta$, would have been estimated from the transformed regression's residuals. This $\hat{\rho}_\Delta$ would be an estimate of the difference between the true, but unknown, autoregression coefficient ρ, and the estimated autoregression coefficient $\hat{\rho}_1$. Therefore, if further iterations had been desired, the original data would have been transformed by the lag coefficient $\hat{\rho}_2$, where $\hat{\rho}_2 = \hat{\rho}_1 + \hat{\rho}_\Delta$, and a new transformed regression would have been run.

The process would have continued until the coefficient estimates stabilized. This iterative process can be visualized as an oscillation around the true parameter estimates:



With each iterative step, the coefficient estimate oscillates around as it approaches the true parameter value. However, in the case of red snapper, one iteration was sufficient. The transformed equation's implications concerning advertised-price elasticity were such that they reinforced the original conclusion, i.e., that advertised-price elasticity is not significantly different from $|-1.00|$.

Sole

Serial correlation of the error term was also encountered with the sole species regression; the autoregression coefficient was $\hat{\rho}_1 = .344$. The transformed equation became

$$Q = \underset{}{-4225.89} - \underset{(109.175)}{181.74 \ln P} + \underset{(32.053)}{205.50\, A_1^{**}} + \underset{(34.166)}{397.70\, A_2^{**}}$$

$$+ \underset{(17.191)}{20.76\, A_{t-1}} + \underset{(195.647)}{708.67 \ln Y^{**}} + e \qquad R^2 = 64.80\%$$

** Significantly different from zero at 1% level.

This indicated an increased elasticity estimate ("average" elasticity increased from -.286 to -.322), however, this was such a small increase that it did not alter the original conclusion that both "average" price and advertised-price elasticity of sole is less than $|-1.00|$. Consequently, the iterative process was discontinued at this step and the uncorrected regression was used in this study.

Table 10. Original Estimated Equations and Transformed Equations.

Red Snapper

Original Equation:

$$Q = -3752.58 \; -1878.94 \ln P^{**} + 399.93\, A_1^{**} + 844.66\, A_2^{**}$$
$$(301.75) \qquad (61.24) \qquad (61.39)$$

$$+ 159.67\, A_{t-1}^{**} + 1525.75 \ln Y^{*} + e$$
$$(43.55) \qquad (675.77)$$

$$R^2 = 75.95\%$$

Transformed Equation:

$$Q = -811.92 - 1073.99 \ln P^{**} + 386.35\, A_1^{**} + 824.10\, A_2^{**}$$
$$(208.68) \qquad (58.68) \qquad (56.78)$$

$$+111.89\, A_{t-1}^{**} + 696.16 \ln Y + e$$
$$(40.41) \qquad (548.84)$$

$$R^2 = 77.14\%$$

Sole:

Original Equation:

$$Q = -6039.95 - 161.47 \ln P + 234.38\, A_1^{**} + 423.47\, A_2^{**}$$
$$(168.02) \qquad (32.51) \qquad (34.77)$$

$$+ 37.77\, A_{t-1}^{**} + 920.20 \ln Y^{**} + e$$
$$(18.04) \qquad (232.45)$$

$$R^2 = 62.37\%$$

Continued

Table 10--Continued.

Sole:

Transformed Equation:

$$Q = -4225.89 - \underset{(109.175)}{181.74} \ln P + \underset{(32.053)}{205.50} A_1^{**} + \underset{(34.166)}{397.70} A_2^{**}$$

$$+ \underset{(17.191)}{20.76} A_{t-1} + \underset{(195.647)}{708.67} \ln Y^{**} + e$$

$R^2 = 64.80\%$

* Significantly different from zero at the 5% test level.
** Significantly different from zero at the 1% test level.