# A Simultaneous Equation Analysis of Advertising, Concentration and Profitability*

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## I. Introduction

Nearly two decades of econometric research have been completed in testing relationships between industrial market structure and performance. Recently, a number of authors have reexamined these studies and cautioned on a number of conceptual difficulties which subject the results and interpretation of previous empirical work to question. One primary criticism of previous research has been the failure to account for the simultaneous nature of the interrelation among elements of industry structure, conduct and performance [2; 4; 5; 11; 22; 25; 30]. While the determinants of variables such as profits, advertising and concentration have been examined separately within the context of single equation models, the underlying theory suggests that these variables are more properly considered as jointly determined within a system of simultaneous equations.[1] Estimation of single equation models when a simultaneous system is appropriate leads to parameter estimates that are both biased and inconsistent.

Previous empirical studies of the structure-performance relationship have also suffered due to the omission of certain critical variables. First, the role of international trade as an element of market structure has yet to be generally incorporated into empirical studies, in spite of recent theoretical work that has demonstrated its potential importance [3; 20; 21]. Second, interindustry differentials in the price elasticity of demand have been neglected, even though theoretical analysis clearly underscores the necessity of explicity accounting for

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1. The simultaneity problem has been examined in a few recent articles. Strickland and Weiss [30] for example developed and estimated a three equation model of profits, concentration, and advertising. Their model has been extended by Martin [14] who points out that in its original form the model failed to meet identification criteria.

demand elasticities, before any systematic relationship between a key structure element such as concentration and performance can be inferred [6; 7; 16; 23; 24].

This paper examines the importance of the empirical questions raised above. A simultaneous equation model of three important structure, conduct, performance variables (concentration, advertising intensity, and profitability) is developed and estimated. The model is further designed to incorporate and evaluate the importance of international trade considerations and differentials in price elasticities of demand in influencing industrial organization relationships. The organization of the paper is as follows: in Section II the specification problems are discussed in detail. Section III describes the theoretical and empirical model. In Section IV the results of the estimation of the model, applied to the U.S. food processing sector, are presented. Finally, the general conclusion of the study are presented in Section V.

## II. Specification Problems in Previous Studies

### *Simultaneity in Industrial Organization Relationships*

A large literature has already been accumulated utilizing single equation techniques to test industrial organization hypotheses. This work was based on the notion of a unidirectional causality running from structure to conduct to performance, but more recent theoretical developments suggest not only that market structure may influence conduct and performance, but at the same time, market conduct and performance are likely to feedback and influence market structure.[2] For example, in most studies of the relationship between structure and profitability it has been customary to include some measure of advertising intensity as a structural variable. This follows the traditional hypothesis that some combination of brand loyalty induced by advertising and economies of scale in advertising, result in a product differentiation barrier to entry which allows established firms to achieve and maintain higher profit rates. The clear implication of this kind of model is that advertising intensity determines profitability [5; 9]. Yet, recent theoretical work concerning optimal advertising strategy suggest causation may run the other way [25; 30]. That is, higher profit rates induce greater advertising intensity, since, *ceteris paribus*, the higher profit rate per unit of sales, the more worthwhile it becomes to advertise in order to capture an additional unit of sales.

We are, therefore, confronted with two contrasting theoretical hypotheses: that advertising leads to higher profits and, in turn, high profits lead to more advertising. But once it is recognized that the direction of causation may run both ways then any correlation obtained between profits and advertising within a single equation model provides no information as to whether high advertising creates high profits, high profits lead to high advertising or both lines of causation occur simultaneously.

Similar problems of potential simultaneity exist in other industrial organization relationships such as that between advertising and industry concentration. One line of reasoning suggests that concentration stimulates advertising. This argument is based upon the presence of advertising externalities, where overall industry demand along with demand for an individual firm's product increase in response to advertising expenditures [5; 11; 30]. To the extent that these externalities exits, higher levels of concentration should generate higher levels

2. A comprehensive survey of profitability studies can be found in Weiss [37]. For summaries of studies concerning the determinants of advertising and concentration see: Ornstein [18; 19].

of advertising since the larger a firm's market share, the greater the proportion of the external industry effects and hence, the benefits of advertising, the firm is likely to be able to internalize.

A second view maintains that it is advertising which leads to increased concentration [9; 15]. This conclusion is based on the existence of potentially substantial economies of scale in advertising and the possibility that advertising activity creates barriers to entry. We are, therefore, confronted with the expectation that concentration and advertising may be casually interrelated, and the difficulty of interpreting single equation correlations between the two.

The above arguments lead to the conclusion that three variables of considerable interest within the traditional structure-conduct-performance paradigm (advertising, profits and concentration) should be viewed as mutually interdependent. This implies that all three should be considered as jointly determined endogenous variables within a system of simultaneous equations and that single equations models are inappropriate for hypotheses testing. For this reason we develop a three equation model in which profits, concentration, and advertising are considered jointly determined. The model which is specified in detail later takes the general form provided below:

$$PMG = f(CR, AD, X) \tag{1}$$

$$AD = f(CR, PMG, Y) \tag{2}$$

$$CR = f(AD, Z) \tag{3}$$

where $PMG$ is profitability, $AD$ is advertising intensity, $CR$ is seller concentration and $X$, $Y$, and $Z$ are vectors of exogoneous variables.

### *Price Elasticity of Demand*

In addition to the problems related to the simultaneity in structure, conduct, and performance relationships, a number of other specification improvements have recently been suggested. One of the most important of these is the accounting for inter-industry differentials in price elasticity of demand in structure-profit equations [5; 6; 7; 23; 24].

Virtually all prior empirical studies of the relationship between market structure and profits have neglected the existence of inter-industry differentials in price elasticity of demand and the role of demand elasticity as a structural variable.[3] This omission, however, is not justified by either the underlying theoretical models, or the available empirical evidence [1, 10]. The theoretical importance of price elasticity of demand can be clarified by reference to the familar profit maximizing price-marginal cost relationship

$$(P - MC)/P = 1/n_f \tag{4}$$

where $n_f$ is the price elasticity of demand for the firm's product. If, as is commonly assumed, concentration facilities collective action by firms and yields cartel-like pricing, then following Needham [16, 59] it is easy to show that the elasticity of demand for the $k$ largest firm $(n_k)$, and hence the profit maximizing price-marginal cost spread depends upon: the market price elasticity of demand $(n_m)$, the share of the market controlled by the $k$ largest firms $(S_k)$, and the expected output response of rivals to the $k$ largest firms pricing decisions $(E_r)$.

3. A notable exception is Commanor and Wilson [5].

Let, for example, $Q_k$, $Q_m$, and $Q_r$ represent the levels of the $k$ largest firms' output, market output, and rival output respectively. Then the elasticity of demand facing the $k$ largest firms is:[4]

$$\begin{aligned} n_k &= -(dQ_k/dP)(P/Q_k) = -((dQ_m - dQ_r)/dP)(P/Q_k) \\ &= -(dQ_m/dP)(P/Q_k) + (dQ_r/dP)(P/Q_k). \end{aligned} \tag{5}$$

If $S_k$ and $S_r$ represent the market shares of the $k$ leading firms and their rivals, and $E_r$ (the expected output response of rivals) is defined as $(dQ_r/dP)(P/Q_r)$ then (5) above can be expressed as:

$$n_k = n_m/S_k + E_r(S_r/S_k) = (n_m + E_r(1 - S_k))/S_k. \tag{6}$$

Substituting expression (6) into (4) we obtain the profit maximizing price-marginal cost relationship for the $k$ largest firms:[5]

$$(P - MC)/P = 1/n_k = S_k/(n_m + E_r(1 - S_k)). \tag{7}$$

Equation (7) illustrates the expected relationship between concentration ($S_k$), profitability, and market price elasticity of demand ($n_m$). If, for example, leading firms assume that rivals will not alter output in response to new pricing initiatives ($E_r = 0$) then price-cost margins should be directly related to the level of industry concentration and inversely related to the market price elasticity of demand. If, on the other hand, leading firms expect rivals to alter output in response to new pricing initiatives ($E_r \neq 0$), then rivals reactions will, in part, determine the price elasticity facing the leading firms. Nonetheless, given any expected rival output response, price-cost margins should be directly related to industry concentration and inversely related to market price elasticity of demand.

The above analysis suggests that an empirical relationship should be found to exist between concentration and profitability. However, it provides a warning that one may not be able to isolate a systematic cross section relationship between the two unless the market price elasticity of demand across all industries studied is identical. Since the available empirical evidence would indicate that this is not the case, the omission of price elasticity of demand variables in cross section profitability studies results in models with specification bias.

Even apart from the purely theoretical model presented above, price elasticity of demand should reinforce some of the non-competitive aspects of market structure as they are conventionally measured. For example, while it is true that any firm must consider the reaction of rivals to its price cuts, the potential risk associated with price experimentation is smaller in industries with price elastic demand, since overall industry sales would be expected to significantly increase even if rivals ultimately follow suit. Thus, given the level of concentration, the degree of firm interdependence and the ability to maintain tacit price agreements is likely to be higher in industries with relatively price inelastic demand. Finally, any entry barriers attributable to economies of scale become more critical at a lower percentage of industry output, as market demand becomes more inelastic. Thus, price elasticity of demand is a theoretically important structural variable and, particularly so, in studies of the relation between profits and concentration.

4. It is important to note that (5) is based upon the assumption that rivals always respond through quantity adjustments rather than price adjustments.

5. For a similar proof see: Saving [24] and Cowling [6; 7].

*Import Competition, Exporting and Industry Profitability*

Recent theoretical and empirical results [3; 20; 21] indicate that improvements in specification can be realized by explicity incorporating foreign trade variables in structure-profit models. For example, the market power usually associated with highly concentrated industries can be seriously overstated if firms in these industries face significant degrees of actual or potential import competition. In effect, import competition increases the number of firms within an industry and dilutes the degree of domestic seller concentration. Therefore, given any level of domestic concentration, prices and profits ought to be closer to competitive levels in industries facing close competition from foreign suppliers.

Exporting should also affect the performance of firms in the domestic market, but no unambiguous relationship can be theoreticaly derived. Caves [3] has shown that for a monopolist who is unable to price discriminate internationally, the existence of export markets can result in domestic pricing outcomes which are closer to competitive levels. He has further argued that this result is equally plausible in the context of oligopoly, since expansion into foreign markets may render sellers less conscious of their mutual interdependence in the domestic market. The implication of this argument is that given the conditions of domestic market structure such as the degree of seller concentration, those industries relying more heavily upon foreign markets for sales should experience lower profitability. This argument, however, needs modification if domestic firms are able to engage in international price discrimination. Under this condition, and assuming the likely case of a more elastic demand in the foreign market, then those industries which have expanded into export markets will experience higher rather than lower profits. Since industries differ in respect to the importance of import competition and the extent to which they export, any empirical analysis which includes only domestic elements of market structure provides an incomplete representation of market conditions within industries.

## III. The Model

In this section the simultaneous equation model presented earlier (equations (1), (2) and (3)) is specified in detail. The price elasticity of demand and international trade variables are included along with other theoretically relevant exogenous variables to explain concentration, profits, and advertising.

*The Concentration Equation*

Most explanations of concentration begin with the theoretical proposition that in a perfectly competitive industry in long run equilibrium, the number of firms is uniquely determined by the optimum size of the firm relative to the total size of the market. The number of firms and the level of industry concentration would then be inversely related to the size of the market, and directly related to optimum firm size. In actual non competitive industrial markets, however, no unique optimal firm size may exist. Indeed, most industrial markets exhibit an unequal size distribution of firms. Thus, the most prevalent theoretical hypotheses suggest that observed industry concentration is dependent upon a number of factors including: the size of the market, the shape of the long run average cost curve in terms of both its steepness and point of minimum efficient size, the growth rate in industry demand, and the height of barriers to entry.[6] The equation to explain differentials in the four-firm seller concentration ratios ($CR$) was therefore designed to reflect these factors.

The first step in developing the concentration equation was to devise variables which account for the influence of efficient firms size relative to the size of the market. In formulating such variables it is necessary to proceed with caution, since, as noted above, a tautological relationship exists between market size, efficient firm size, and the number of firms in an industry. That is, explaining concentration by a measure of the size of the market (say in value of shipments) and the size of an efficient firm (also in value of shipments) may be logically equivalent to explaining concentration simply in terms of the number of firms in the industry. The recognition of this problem led us to the construction of three variables to account for the influence of firm size vs market size in affecting the level of industry concentration.

The first was simply a measure of the size of the market ($SZ$) which was calculated as the log of 1967 value of shipments for each industry. The second was a capital requirements variable ($KR$) designed to provide an independent measure of minimum efficient plant size. The capital requirments variable was calculated as the dollar value of fixed assets required by a plant of minimum efficient size. The familiar Commanor and Wilson [5] measure of the average value of shipments per plant among the largest plants accounting for 50% of industry output was used to determine the minimum efficient plant size. The use of this combined variable to proxy efficient size allows us to avoid the problem of explaining concentration simply in terms of the number of plants and to reduce the potential spurious correlation which arises between the Commanor-Wilson measure and the level of industry concentration.[7] A third variable, the cost disadvantage ratio ($CDR$) was included to account for the cost penalities associated with operation of plants of less than minimum efficient size. It was calculated as the ratio of value added per employee in plants of less than minimum efficient size to that of plants of minimum efficient size or larger. The expectation is that the greater the cost disadvantage of small scale operation (i.e., the steeper the slope of the average cost curve) the higher would be the level of concentration.

Two additional variables were included to complete the concentration equation. The first was the growth rate in output ($GVS$) measured as the percentage change in nominal value of shipments between 1963–67. To the extent that growth in the size of the market acts as a deconcentration force via either new entry or internal growth of smaller firms, it would be expected to be inversely related to industry concentration. The second was the advertising to sales ratio ($Ad/S$). If high advertising intensity does create a barrier to entry then concentration should be directly related to the advertising variable.

The resulting concentration equation with the expected sign indicated below each independent variable is thus:[8]

$$CR = f_1\,(\underset{-}{SZ}, \underset{+}{KR}, \underset{-}{CDR}, \underset{+}{Ad/S}, \underset{-}{GVS}). \tag{8}$$

6. An excellent survey of the various theories of the determinants of concentration can be found in Ornstein, et al, [18].

7. The Commanor-Wilson measure of efficient plant size can be calculated as .5 times the reciprocal of the number of largest plants required to account for one half of industry output. It is thus highly correlated with levels of plant concentration. Since plant concentration is highly correlated with firm concentration, even in situations where little or no variations exist in relative scale economies, some spurious correlation occurs between concentration and minimum efficient plant size.

8. The data used to calculate concentration, size of the market, growth in demand, and the cost disadvantage ratio were obtained from the Census of Manufacturers [35]. Gross fixed value of capital was obtained from the Annual Survey of Manufacturers [33]. Finally, the advertising to sales ratio was obtained from Ornstein [19] which was calculated from the U.S. Input-Output tables at the four-digit level of aggregation.

*The Profit Equation*

The measure of profitability in the profit equation was the price-cost margin (*PMG*).[9] The choice of the margin as the profit variable was predicated upon a number of factors. First, since it approximates a rate of return on sales measure, it constitutes the profit concept which according to theory should be directly related to price elasticity of demand and advertising intensity. Moreover, it can be estimated directly from Census data at the four-digit level, thus avoiding a number of aggregation and accounting problems which arise when using either Internal Revenue Service or individual firm data.[10]

Since gross capital costs are included in the margin, it is necessary to include a variable which accounts and corrects for differences in capital intensity across industries. The capital output ratio ($K/S$), measured as the book value of depreciable assets divided by the value of shipments, was therefore included in the equation.

A second variable included in the profit equation was the industry's four-firm concentration ratio (*CR*). As was shown in equation (7) in an earlier section, profit margins should theoretically be directly related to the level of industry concentration given the market price elasticity of demand and expected reactions of rival sellers. Moreover, since higher levels of concentration should increase the degree of firm interdependence (i.e., knowledge of expected rivals reactions), and effectiveness of collusion (i.e., reducing the cost of establishing and monitoring agreements), the expectation is that concentration should exert a positive influence upon industry profit margins.

An implicit assumption regarding the published concentration ratios is that markets are national in scope. A number of industries, however, are more properly classified as regional or local in nature. In order to account for differences in the geographic dimensions of some industries in a sample, a dummy variable was constructed from information presented by Schwartzmen and Bodoff [28] and Siegfried and Grawe [29] to distinguish regional and local markets. The regional dummy (*RD*) was constructed to take the value of one if the industry were regional or local in nature, and zero otherwise.

Two market characteristics, price elasticity of demand (*EL*) and growth rate in output (*GVS*) were also included in the profit equation. Lower absolute values of demand elasticity (i.e., more inelastic demand) should result in higher margins. Unfortunately estimates of demand elasticity were not available. Nonetheless, within the food processing sector, sufficient data were available to make independent estimates of demand elasticity. A description of the procedures and data utilized for estimation of the elasticity values is provided in Appendix I. The absolute values of the estimated elasticities were introduced into the equation and are expected to be inversely related to margins.

Growth in output is expected to influence margins in a positive direction. Growth in output is reflective of increases in product demand, decreases in cost conditions, or some combination of the two. Reductions in cost conditions should lead directly to greater margins, while increase in demand should ultimately do likewise, via increases in product prices

9. The price-cost margin is calculated as: $\dfrac{\text{value added} - \text{payroll} - \text{rentals.}}{\text{value of shipments}}$

The data required for its calculation are available in the Census of Manufacturers [35] and the Annual Survey of Manufacturers [33].

10. The merits of the price-cost margin as opposed to other profit measures are more thoroughly discussed by Weiss [37]. The severity of the aggregation problem in regard to individual firm data is discussed by Imel and Helmberger [12].

or reductions in unit cost due to improved capacity utilization. The growth variable was measured as the percentage change in nominal value of shipments between 1963 and 1967.

Maintainable profit margins should also be higher in situations where barriers to entry due to either advertising intensity or scale requirements exist. To account for possible advertising barriers, the advertising to sales ratio ($Ad/S$) was entered into the equation. The economies of scale variable ($ESD$) was a dummy based upon the Commanor-Wilson measure of minimum efficient plant size taken as a percentage of total industry output. Industries with a value of this variable above the average for the sample were assigned a value of one, while those below were assigned a value of zero.

Finally, profit margins are expected to be influenced by international trade factors. To account for potential import competition and exporting activity the ratios of current imports and exports to domestic value of shipments ($M/S$, $X/S$) were included in the equation.[11]

Therefore, the resulting profit equation and expected signs are:

$$PMG = f_2\,(\underset{+}{CR}, \underset{+}{K/S}, \underset{+}{GVS}, \underset{+}{Ad/S}, \underset{-}{EL}, \underset{+}{RD}, \underset{+}{ESD}, \underset{\pm}{X/S}, \underset{-}{M/S}). \qquad (9)$$

*The Advertising Equation*

Following the work of Schmalensee [24] and Commanor and Wilson [5], the profit margin was included as a determinant of advertising intensity. If profits affect advertising in the manner the above models predict, it is expected higher margins would induce higher advertising intensity.

Seller concentration was also included in the advertising equation. It is expected that concentration should exert a positive influence upon advertising intensity because increases in market share allow firms to internalize a greater proportion of the industry-wide effects associated with advertising. Furthermore, in industries tending toward oligopoly, advertising may become the main instrument of rivalry as opposed to price competition.

The two market demand variables-growth in output and elasticity of demand were also included in the advertising equation. A positive association is expected between advertising and growth. First, rapid growth often implies the introduction of new products which, generally, are heavily advertised. Moreover, when demand is growing, profits are likely to be available to finance further marketing and advertising effort.

Since the early work of Dorfman and Steiner [2] it has been recognized that advertising should be influenced by price elasticity of demand. Their well known result for the monopoly case, implies that for any given relationship between advertising and its affect upon sales, the optimum advertising to sales ratio is inversely related to price elasticity of demand. It is difficult, however, to generalize this rule to market structures outside the pure monopoly model. For example, in cases other than monopoly, differences arise between an individual firm's elasticity of demand and the market price elasticity of demand. As equation (7) derived earlier indicates, the elasticity of demand facing the individual firm depends not only upon the market elasticity, but also upon market shares and expected reactions of rivals to pricing decisions. The implication of this is that low market elasticities may or may not imply low firm elasticities. This problem is compounded by the fact that the marginal returns to

11. The values for import and export shares were obtained from the U.S. Department of Commerce [34]. A more complete discussion of alternative measures of import competition and exporting intensity is provided by Pagoulatos and Sorensen [20; 21].

advertising may themselves depend upon market price elasticity of demand. If, for instance, market demand is already price inelastic, then the marginal returns to advertising may be low compared to cases where demand is elastic. Thus, while market price elasticity of demand may potentially have an important impact on advertising intensity, its direction of impact cannot be ascertained a priori.

A final variable in the advertising equation was a dummy designed to distinguish consumer goods from producer goods industries (*CPD*). Since consumer goods appear to be more differentiable through advertising, and because advertising, as opposed to direct sales, is likely to be a more effective means of reaching potential buyers in these industries, it is expected that advertising intensity would be higher in consumer goods industries. The dummy was constructed such that consumer goods industries were assigned a value of one and producer goods industries a value of zero. Delineation of consumer and producer goods was based upon Ornstein's calculations [8] of the percentage of industry output allocated to final demand as opposed to intermediate sales.[12]

Thus, the advertising equation and expected signs are:

$$Ad/S = f_3\,(\underset{+}{CR},\ \underset{+}{PMG},\ \underset{+}{GVS},\ \underset{\pm}{EL},\ \underset{+}{CPD}). \tag{10}$$

## IV. Model Estimation and Results

In the three equation model presented earlier, advertising appears in both the profit margin and concentration equations, concentration in the margin and advertising equation, and margins in the advertising equation. Thus it is necessary to treat all three variables as endogeneous whose values are jointly determined in the simultaneous equation system consisting of equations (8), (9), and (10). Each equation in the system is overidentified. Moreover, the accounting relationship between profit margins and advertising intensity results in contemporaneous correlation of errors across equations. Since the profit margin is measured gross of advertising, transitory variations in advertising are correlated with profit margins. Indeed, the correlation of errors across the two equations is $-.58$. The model therefore was estimated through the use of three-stage least squares (3SLS) which will provide consistent and asymptotically efficient parameter estimates.[13]

The industry sample utilized in the estimation of the model consisted of the 47 U.S. food processing industries defined by the Census at the four-digit level of aggregation.[14] The

12. Utilizing data from the U.S. Input-Output Table, Ornstein considers industries which allocate 50% or more of their output to final demand to constitute consumer goods, and those allocating less than 50% to be producer goods.

13. While two-stage least squares could provide consistent parameter estimates, the existence of contemporaneous correlation of errors across equations renders the two-stage estimated inefficient. Improvements in efficiency can be achieved under these circumstances with the three-stage procedure. For example, see Zellner [39] and Mandansky [13].

14. The industries included in this study (with the 1972 S.I.C. number in parenthesis) are: 1) Meatpacking (2011); 2) Meat processing plants (2013); 3) Poultry dressing (2016, 2017); 4) Creamery Butter (2021); 5) Cheese (2022); 6) Condensed and evaporated milk (2023); 7) Ice Cream and ices (2024); 8) Fluid milk (2026); 9) Canned specialities (2032); 10) Canned fruits and vegetables (2033); 11) Dried and dehydrated fruits and vegetables (2034); 12) Pickles, sauces and salad dressings (2035); 13) Frozen fruits, vegetables and juices (2037, 2038); 14) Flour and other grain mill products (2041); 15) Cereal breakfast foods (2043); 16) Milled rice and byproducts (2044); 17) Blended and prepared flour (2045); 18) Wet corn milling (2046); 19) Pet food (2047); 20) Prepared feeds (2048); 21) Bread and bakery products (2051); 22) Cookies and crackers (2052); 23) Raw can sugar (2061); 24) Sugar refining (2062, 2063); 25) Confectionery products (2065); 26) Chocolate and cocoa products (2066); 27) Chewing gum

time period studied was the year 1967. The food processing sector was chosen primarily due to the constraint of identifying an industry group with sufficient data to estimate price elasticities of demand. Nonetheless, the food processing sector distinguishes itself not only in its importance relative to total manufacturing activity, but also as an area of current public concern.

The 3SLS estimation results for 1967 are presented in Table I. The values in parentheses underneath each coefficient estimate are standard errors. It can be seen from Table I that most coefficients are substantially larger than their standard error and conform in sign to theoretical expectation.

The results from the estimated model given considerable support to the hypothesized interrelationships and feedback effects between margins, concentration and advertising. For example, the results indicate that advertising intensity does exert a significant affect upon profit margins, but at the same time higher margins are seen to feedback and exert a strong impact on advertising intensity. Similarly, concentration displays an important influence on both profit margins and advertising intensity, while higher advertising intensity results in significantly higher levels of concentration.

The value of the advertising coefficient in the margin equation is of particular interest. Since advertising expenditures are included in the gross margin, we would expect that the coefficient for the advertising to sales ratio should approach one, even if advertising yielded no barrier effect. The value of the advertising coefficient turns out to be 2.36 and is greater than one by almost two and one half standard errors. Taking this result in conjunction with the already noted important effect of advertising on concentration, suggests that high advertising intensity, at least within the food processing sector does act as a barrier to entry. Since, however, the model does not contain an explicit measure of risk or cost variability, we cannot dismiss the possibility as Sherman and Tollison [27; 28] have argued that the relationship between advertising and profitability actually reflects more fundamental technological forces at work. Nonetheless, the advertising results are in accordance with those found by the FIC [9] in an earlier study of the food sector, and do lend support to the importance of advertising and product differentiation in affecting concentration in consumer goods industries as suggested by Mueller and Hamm [15].

In the profit margin equation, the most striking finding is the significance of the market price elasticity of demand in affecting margins. Price elasticity is, therefore, found to be an important structural variable affecting interindustry differentials in price-cost margins. The value of the estimated coefficient for the elasticity variable implies that roughly a 10% decrease in demand elasticity is associated ceteris paribus, with a 1% increase in profit margins. The concentration ratio, growth in demand and capital intensity coefficient are also significant in the profit margin equation and display the expected signs.

The inclusion of the foreign trade variables, however, did not seem to add much in the profit equation. The coefficient for the import share variable is smaller than its standard error and displays an unexpected positive sign. Contrary to results obtained in other studies of

(2067); 28) Cottonseed oil mills (2074); 29) Soybean oil mills (2075); 30) Vegetable oil mills (2076); 31) Animal and marine fats and oils (2077); 32) Shortening, table oils and margarine (2079); 33) Malt beverages (2082); 34) Malt (2083); 35) Wines, brandy and brandy spirits (2084); 36) Distilled liquor (2085); 37) Soft drinks (2086); 38) Flavoring extracts and syrups (2087); 39) Canned and cured seafood (2091); 40) Fresh or frozen packaged fish (2092); 41) Roasted coffee (2095); 42) Manufactured ice (2097); 43) Macaroni products (2098); 44) Cigarettes (2111); 45) Cigars (2121); 46) Chewing and smoking tobacco and snuff (2131); 47) Tobacco stemming and redrying (2141).

**Table I.** Three-Stage Least Squares Regression Results (standard errors in parentheses)

| Dependent Variable | Con-stant | CR | K/S | KR | SZ | PMG | GVS | Ad/S | EL | RD | CPD | ESD | CDR | X/S | M/S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PMG | -2.41 | .214 | 6.15 | | | | .079 | 2.36 | -.111 | 3.22 | | 2.65 | | -.067 | .014 |
| | (9.41) | (.142) | (4.80) | | | | (.051) | (.557) | (.065) | (3.16) | | (3.22) | | (.094) | (.098) |
| Ad/S | -3.82 | .067 | | | | .134 | -.004 | | .022 | | 1.44 | | | | |
| | (2.53) | (.031) | | | | (.058) | (.017) | | (.022) | | (.787) | | | | |
| CR | 84.69 | | | 5.11 | -4.78 | | -.048 | 2.76 | | | | | -19.70 | | |
| | (19.14) | | | (1.97) | (2.07) | | (.096) | (.953) | | | | | (12.66) | | |

manufacturing industries, this suggests that import competition has had little impact in affecting profitability of domestic firms. The differing results found here probably reflect some special aspects of the U.S. food processing sector. Many industries within the sector, for instance, are highly protected via tariffs, quotas, and government inspection standards [38]. Thus, in many of the industries virtually no imports entered at all which apparently rendered import competition ineffectual in influencing domestic profits.[15] The results for the export share variable were not much better. The exporting variable coefficient displays a negative sign but is smaller in value than its standard error. Thus, our results are unable to support Caves' conjecture, that expansion into export markets results in more competitive outcomes in the domestic market.

With regard to the advertising equation, again most of the variables have coefficients with appropriate signs. Advertising intensity is seen to increase in response to higher profit margins as predicted by Schmalensee [25]. Since profit margins are measured gross of advertising, the coefficient on the margin variable should not be interpreted as suggesting that 13 cents on every dollar of net profits (profits minus advertising expenditures) is allocated to advertising. Rather, since the average advertising to sales ratio for the sample is approximately 2.9 percent, a more accurate interpretation would be that an increase in net profits of $1 is associated with an increase in advertising of about 10 cents.

The coefficient for the concentration ratio was positive and large relative to its standard error, suggesting that increases in industry concentration do result in greater advertising intensity. Also, as expected advertising intensity was found to be greater in consumer as opposed to producer goods industries. Finally, neither growth in demand, nor market price elasticity, had a significant influence upon advertising.

The last estimated relationship of the model was the concentration equation. All the estimated coefficients in the equation display the hypothesized signs, and all the coefficients with the exception of that for growth in demand are substantially larger in value than their standard errors. As expected concentration is found to be inversely related to the size of the market, and directly related to efficient plant size. In addition, concentration was found to be inversely related to the cost disadvantage ratio. Thus, the greater the penalties associated with small scale operation, the higher is the level of concentration. The coefficient for the growth variable is negative, but is smaller than its standard error. Finally, higher degrees of advertising intensity are seen to contribute to higher levels of concentration. Evaluated at mean values, the coefficient for the advertising variable suggests that a 10 percent increase in advertising intensity is associated with approximately a 1.9 percent increase in concentration.

## V. Conclusion

This paper has investigated the simultaneous nature of the relationship between structure, conduct, and performance, and the importance of demand elasticity as an element of market structure. Utilizing data for the U.S. food processing sector, values of price elasticity of demand for four-digit S.I.C. industry catagories were estimated and incorporated into a simul-

15. Our findings do, however, conform to the results of a number of studies done for specific industries within the food processing sector, such as Novakovic and Thompson [17].

taneous equation model depicting the inter-relationships between concentration, advertising, and profitability.

Estimation of the model yielded a number of interesting results. Confirming theoretical expectation, price elasticity of demand was found to play an important role in explaining inter-industry differentials in profitability. Advertising intensity was found to significantly influence both concentration and profits suggesting that within the food sector advertising does act as a barrier to entry. Industry concentration as well as profits were found to significantly influence advertising intensity in accordance with the feedback relationships hypothesized.

These results suggest that further effort in modeling industrial organization relationships within the framework of simultaneous equation systems is called for. Moreover, estimation and incorporation of demand elasticies within these models for more comprehensive industry samples would appear warranted.

## Appendix

The demand elasticity variable was obtained from regression estimates of demand equations for the industries in our sample. For each industry category a consumer demand equation was estimated using annual data for the 1952–75 period. The only exceptions were the chewing gum (1957–75) and soft drink (1960–75) industries where only these smaller samples were available. The general equation estimated was:

$$Q^i = a_0 + a_1 P^i + a_2 Y$$

where:

$Q^i$ is an index of per capita consumption of goods in industry $i$. (1967 = 100)
$P^i$ is an index of prices for goods in industry $i$ deflated by the retail food price index. (1967 = 100)
$Y$ is an index of disposable personal income per capita deflated by the implicit GNP deflator. (1967 = 100)

The estimated value of the price elasticity of demand was calculated as $EL^i = a_1(\bar{P}^i/\bar{Q}^i)$, where $\bar{P}^i$ and $\bar{Q}^i$ are the mean values of the two variables and $a_1$ is the coefficient from the estimated demand equations.

Data used for the estimation of the equations came from a variety of sources. The main consideration was to obtain a consistent time series for each industry. For a number of industries the price and output indicies were available from the Department of Labor's *Handbook of Labor Statistics* [36]. Data for the remaining industries were obtained from the U.S. Department of Agriculture's publications: *Food, Consumption, Prices and Expenditures* [31] and *Agricultural Statistics* [32]. The values of the estimated elasticities are available upon request.

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