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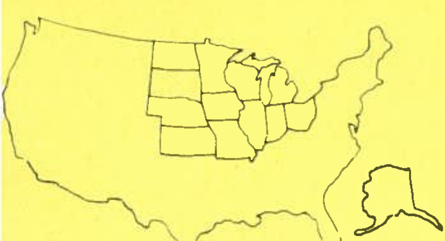
MARKET STRUCTURE AND TECHNOLOGICAL PERFORMANCE IN THE FOOD MANUFACTURING INDUSTRIES



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CHAPTER 3. DEFINITION AND CONSTRUCTION OF VARIABLES

The previous chapter examined a wide range of industrial-organization theories that establish a set of hypotheses relating firm and market structure to firm inventive activity. To test these hypotheses, we must first determine the correct measures for the dependent and independent variables, and then construct a data set measuring these variables. Finally, a model must be specified to give the functional relationship between the regressors and the regressand and to specify the distributions of random variables in the model.

DEPENDENT VARIABLES

In the early 1950s, only two measures of firm research-and-development activity were available: firm patents and firm employment in research-and-development laboratories. Beginning in 1972, data on firm research-and-development expenditures became publicly available. An analysis using structural data for 1950 will estimate separate models with patents and R & D employment. An analysis using 1967 structural data will estimate separate models with patents, R & D employment, and R & D expenditures.

Firm Patents

To qualify for a U.S. patent, an invention must: (1) be ". . . new and nonobvious"; (2) not have been ". . . commercialized or known to the public for more than a year before the date of application"; and (3) have . . . "practical utility."[1] Thus, insofar as the patent office is able to maintain these standards, patents are a measure of the output of firm research-and-development activities that have met certain minimum standards. Because of this and because U.S. patent data are available for many years, economists have used these data extensively in studies of firm research-and-development activity.

Firm patent data are not perfectly correlated with the value of firm inventive output for two reasons: The economic value of individual inventions varies widely, and not all inventions are patented. The economic value of an invention can be viewed as a random variable with an associated probability distribution. Scherer has suggested that the value of patented inventions has a Pareto distribution with the parameter less than 0.5.

> Fragmentary data on the profitability of patents—one indicator of economic significance—reveal a distribution highly skewed toward the low private value side, with a very long tail into the high high value side. A graphic test suggested the existence of a Pareto-type distribution of profits with an α coefficient of less than .5.[2]

Since the distribution of the profitability of *all* inventions presumably differs from that of *patented* inventions primarily by excluding inventions of low value, the distribution of the profitability of all inventions will also have a Pareto-type distribution but with smaller α coefficient.

Not only does the value of inventions vary, but so does the propensity to patent, i.e., the proportion of firms' inventions that are granted United States patents. The propensity to patent is jointly determined by the firm's evaluation of the benefits and costs of the patent and the patent office's decision to grant the patent. Like the economic value of an invention, the propensity to patent can be usefully considered a random variable with an associated probability distribution. An individual firm's propensity to patent may be viewed as a random drawing from this distribution.

Despite these problems, patent data have been used widely and successfully as an index of inventive activity. Comanor and Scherer have analyzed the extent to which these data problems will affect statistical analyses of patent data.

> The quality of patents might vary so widely that central tendencies would be literally drowned in variance. We must ask, therefore, whether a simple count of the number of patents reflects only statistical noise or whether there is a meaningful message in the results.[3]

To answer this question, they examined the correlation between firm patents, research personnel, and the introduction of new products in the pharmaceutical industry. This industry was chosen because, unlike virtually every other manufacturing industry, good data on new product sales are available. They conclude that both research personnel (variously defined) and United States patents assigned to the firm are sufficiently good indices of firm research-and-development output.

> Thus, it appears that the pharmaceutical firms which employ relatively more research personnel and introduce relatively more new products also apply for and are issued a higher number of patents. Furthermore, patents, together with a scale variable, appear to explain the variation in sales-weighted new products as effectively as an index of research personnel inputs together with the same scale variable.[4]

They further conclude that even though using patent data as a proxy for firm inventive output will increase the unexplained variance, this increase will not be so large as to swamp the systematic relationships in the model.

Firm patent statistics for the years 1950-1956 and 1968-1974 are the dependent variables in the regression models with 1950 and 1967 structural data, respectively. For the earlier (later) period, the structural data are assumed to be relatively stable over the years 1947-1953 (1964-1970), and the lag between the development of the invention and the grant of the patent is assumed to be three (four) years.[5] Given these assumptions, seven-year patent totals were used to minimize the effects of yearly variations in the granting of patents.

Research-and-Development Employees

Measures of firm labor inputs into firm inventive activity are available from the directory of *Industrial Research Laboratories in the United States.* These data on firm employees in research laboratories are broken down into three categories: scientists, technical support personnel, and other support personnel. The directory explains the components of each category:

> Decisions on what constitutes "research," and who is a "scientist," were left to the organizations, a broad interpretation probably being encouraged by the statement in the letter that "the term 'research,' for purposes of the directory, is considered to include industrial development work in processes, equipment, and production, as well as fundamental and applied research; it does not apply to laboratories concerned only with production control or commercial testing." In the case of the personnel, numbers were requested for "professionally trained members of the scientific research staff," "technical

personnel of the research staff not included above," and "administrative, clerical, maintenance, etc. personnel of the research laboratory staff."[6]

Given these data for three different categories of firm labor inputs, which one of the seven distinct combinations is the best measure of labor inputs into research and development? In their analysis of the dollar sales of new pharmaceuticals correlated with professional and total research labor inputs, Comanor and Scherer found that total research labor inputs had the highest simple correlation.[7] Therefore, for the 1950 structural data, 1950 total research employment will be used as the dependent variable; for the 1967 structural data, 1970 total research employment will be used. Between 1950 and 1970 the percentage of sample firms reporting R & D personnel remained fairly constant, with 64 percent of the firms in 1950 and 63 percent of the firms in 1970 reporting R & D personnel.

The number of firm research employees differs from total firm inventive inputs for several reasons. Firms may vary in their propensity to identify R & D employees as such and to identify nonresearch workers as R & D employees. Employees identified as working in research-and-development laboratories may be involved in some quality-control work, which may lead to shifts in the production function over time through a learning-by-doing process but is not directly related to the inventive output of firms. Research-and-development employees may be omitted, on the other hand, if they are not employed in a laboratory. Since some scientists and engineers may do research outside the laboratory and firms may have research scientists with no formal laboratory facilities, some research scientists will be omitted.[8] The propensity to identify a research employee as such will also be affected by the importance the firm attaches to secrecy in its research program. If it is important to the firm to disguise the extent of its research-and-development activities, the firm will not report data on the employment of scientists and supporting personnel. Further, the quality of research-and-development employees can vary widely within and across firms. Finally, the capital input per unit of labor may vary across firms.

Firm Research-and-Development Expenditures

Firm research-and-development expenditures have been available from the Securities and Exchange Commission since 1972. These data are in response to the 10-K reporting requirement for:

> The estimated dollar amount spent during each of the last two fiscal years on material activities relating to the development of the new products or services or the improvement of existing products or services, indicating those activities which were company-sponsored and/or those which were customer-sponsored.[9]

The 10-K data differ from the theoretically correct measure of the value of research-and-development inputs only in that they are estimated, not actual, magnitudes.

There are two situations in which the data for a firm were "constructed." First, if no data on R & D expenditures were available for a firm and that firm received zero patents between 1968 and 1974 and had no R & D employees in 1970, then the firm was assumed to have zero research-and-development expenditures. Second, if the firm did not report research-and-development expenditures in

1972, but did report them for a later year, then the 1972 R & D expenditures were constructed on the assumption that firms' research expenditures-to-sales ratios are constant. Eleven of the 61 firms in the sample were deleted because data on R & D expenditures were not available.[10] The remaining 51 firms comprised 68 percent of the total research-and-development expenditures of all food firms in 1972.

In summary, three indices of firm research-and-development activity are available: one measure each of firm inputs (R & D personnel) and outputs (patents) for the early 1950s and two measures of inputs (R & D personnel and R & D expenditures) and one measure of outputs (patents) for the late 1960s. Industrial-organization researchers have developed hypotheses relating firm and market structure to the dollar value of firm inventive activity. Our indices differ from the theoretically preferred variables. However, these are the only quantitative data available, and many other economists have employed these data to test the industrial-organization hypotheses.

INDEPENDENT VARIABLES

Data Source

The primary source of the 1950 structural data is the Federal Trade Commission, *Statistical Report Value of Shipments Data by Product Class for the 1,000 Largest Manufacturing Companies of 1950.* Using these data, Kelly[11] constructed four-firm concentration ratios, relative market shares, and industry advertising-to-sales ratios for the 97 largest public food-manufacturing corporations. The five firms (American Bakeries Co., Clinton Foods Inc., Godchaux Sugars, Inc., Griesedieck Western Brewery Co., and Russel Miller Milling Co.) acquired during the period 1950-1956 were dropped from our sample. City Products Corp., whose primary 5-digit industry is manufactured ice, was also deleted. Finally, four firms (International Milling Co., Peter Paul Inc., Planters Nut & Chocolate Co., and Welch Grape Juice Co.) were deleted because data necessary for a change in the firm sales variable, which was itself subsequently eliminated, were not available. One firm, Campbell Soup Co., was added to the sample since it became public in 1954 (its 5-digit value of shipments data were available from the FTC statistical report cited above) . Firm diversification, which is measured by the number of 5-digit products in which firms' value of a firm's shipments exceeds $1,000,000, was constructed from the FTC report.

The 1967 structural data were constructed from several sources. Data at the 5-digit SIC product basis for 33 firms were developed as part of a study prepared for the House Subcommittee on Monopolies and Commercial Law.[12] Additional firms were added from the data made available by Shepherd[13] and from a variety of public sources. Industry advertising expenditures at the 5-digit level were available from the work of the late Robert Bailey of the Federal Trade Commission.[14]

Market Power

Market power is represented in our econometric model by a combination of four-firm concentration, firm relative market share, and industry advertising intensity. The four-firm concentration ratio, (CR4) , which is the share of industry sales accounted for by the four largest firms, is a measure both of the extent to which firms in an industry recognize the interdependence of their pricing decisions and their ability to translate this recognition into business decisions that maximize their joint-preference function. In competitive markets, where four-firm concentration is low, individual firms cannot influence the selling price of their goods, and each determines its level of output at a given market price without regard for the output decisions of other firms. As four-firm concentration increases, the leading firms in the industry will recognize their ability to influence jointly the market price by restricting output.

Economic theory cannot uniquely specify the functional form of this relationship because there are several theories of oligopoly behavior. Since the existence of a critical point in this relationship is suggested by theory and is of interest for policy, linear and quadratic four-firm concentration will be used as regressors.

The industry advertising-to-sales ratio is the second industry measure of market power. In an industry where the advertising intensity is high, goods will be more highly differentiated in the mind of the consumer. The effect of this differentiation is to reduce the cross-elasticity of demand for goods in the same industry. Thus, firms in industries with high advertising intensity will be subject to weaker competitive pressure, *ceteris paribus.* As with four-firm concentration, a quadratic specification is preferred to allow for a critical value in the relationship.

Clearly, the conduct of a firm is influenced not only by the overall structure of the market in which the firm operates, but also by a firm's position relative to other firms in the industry. A natural measure of this relationship is firm market share: the proportion of industry sales accounted for by an individual firm. However, there are two problems with this measure, one statistical and one economic, that have led us to adopt *relative* firm market share as an index of a firm's position in its markets. First, firm market share has a significant, positive correlation with four-firm concentration.[15] Second, the conduct of the firm should be more closely related to its size relative to the industry leaders than its size relative to the industry. Relative firm market share, which is the quotient of firm market share and four-firm concentration, is superior to firm market share on both counts because it is less highly correlated with four-firm concentration and it explicitly measures the size of the firm relative to the four largest firms in the industry.

The concentration ratio is a weighted average of the national 5-digit concentration ratios for Census products with the proportion of the firm's value of shipments in that product as weights. For some products, however, the appropriate markets are regional. The Kelly study constructed regional concentration ratios for ice cream, fluid milk, prepared animal feeds, bread and related products, and beer.[16] Because the soft-drink companies are primarily manufacturers of soft-drink syrups, the national concentration ratios for soft-drink syrups were used rather than the local concentration ratios for soft-drink bottlers.[17] We constructed regional concentration ratios for fluid milk, ice cream, brewing, prepared feeds, and baking.[18] The national CR4 for soft-drink syrups was used in place of the CR4 for soft-drink bottling.

For 1950, industry advertising-to-sales ratios are available for IRS minor industries from the IRS *Sourcebook, Statistics of Income, Corporation Income Tax Returns.* These industries, which represent a level of aggregation between the 3- and 4-digit SIC industries, are broader than the theoretically preferred 5-digit SIC products. For 1967, industry advertising-to-sales ratios were available from the Federal Trade Commission at the 5-digit level.[19]

Firm Size

The overall size of the modern corporation can be represented by a variety of indices. Total firm sales, value added, assets, and labor force have all been used in econometric studies of the firm. Yet each of these presents a different measure of firm size, and each has a particular class of hypotheses for which it is the theoretically preferred measure of firm size.

Scherer, in his article "Size of Firm, Oligopoly, and Research: A Comment," has analyzed extensively the question of the theoretically preferred index of firm size in econometric studies of technology. His conclusion that firm value added is to be preferred rests heavily on the assumption that industrial research and development is largely oriented toward new products. Given this assumption, value added is preferred because it is not influenced by factor proportions.[20]

Research and development in the food-processing industries is heavily directed toward process inventions. Over 45 percent of new patents issued to these firms for the period 1971-1976 were for inventions used in the production process, and only 19 percent were patents on new products.[21] Thus, based on Scherer's analysis firm assets is the theoretically preferred measure of firm size.[22]

Hall and Weiss have argued that the appropriate functional form for the size variable in applied-econometric work in industrial organization is the natural logarithm of firm size rather than the firm-size variable itself.[23] Since, it is argued, the advantages to firm size increase less than proportionally with size, the untransformed size variable cannot be the correct specification. More importantly, a second degree polynomial in the logarithm of firm size, i.e., using the logarithm of firm size and the square of the logarithm of firm size as regressors, has an inflection point separating convex and concave portions of the function. Thus, this specification can model firm behavior of initially increasing returns to scale and then declining returns to scale for innovative activity. Since theory postulates this as one form of behavior, indeed the most interesting type for public policy, estimation of models with size specified in this fashion is of particular interest.

Firm Diversification

Determining the appropriate measure of firm diversification is often a difficult problem. Several different indices, which are not scalar transformations of each other, have been employed in the applied-econometric work in industrial organization. The percentage of firm sales outside the primary 2-digit (3-, 4-, or 5-digit) industry, a Herfindahl-type index, and a count of the number of 2-digit (3-, 4-, or 5-digit) industries in which the firm has nonzero value of shipments have all been used as indices of firm diversification in studies of firm behavior. Each presents a different picture of the nature of the firm's diversification, and the choice among competing indices is determined by the underlying theory.

Fortunately, the hypotheses relating firm inventive effort to firm diversification are reasonably explicit regarding the appropriate index of diversification. Diversification is posited to have a positive impact on research effort for two reasons: First, unanticipated research developments are more likely to fall into the firm's fields of production and marketing expertise if it operates in a large number of industries and, second, the firm that produces products in a large number of industries will have a lower-risk research portfolio.[24] Clearly, for both of these hypotheses, a simple count of the number of meaningful industries in which the firm operates is the theoretically preferred measure of firm diversification. Thus, only two questions remain: (1) what is a reasonable measure of "meaningful industries," and (2) is there a *de minimus* value of shipments below which firms should not be considered to be operating in an industry?

Defining "meaningful industries" for the purpose of constructing an index of firm diversification requires combining industries with similar production techniques. Examination of Census definitions suggests that 5-digit product classes are the best measure of meaningful industries. At the 4-digit level, products with widely different production techniques are often grouped together. For example, SIC 2023 includes the separate 5-digit products of concentrated, dried, canned, bulk evaporated and condensed milk; and ice cream; and ice-milk mix. At a level of discrimination finer than 5-digits, products with very similar production techniques are identified as distinct products.

Does a *de minimus* level of value of shipments in a 5-digit industry exist below which, for the purpose of constructing the diversification index, the firm should be considered to have a zero value of shipments in that industry? Returning to the theoretical hypotheses, a firm must have sufficient value of shipments to have "production and marketing expertise" in the industry. We assumed that a value of $1,000,000 in 1950 was required before the firm has this level of expertise. While this value is arbitrary, it was chosen because it corresponds to a natural breaking point in the 1950 data: value of shipments of less than $1,000,000 for a product tended to be substantially less. A value of $1,250,000 was selected for 1967 to reflect price inflation over the period.

While theory supports using the number of 5-digit SIC industries in which the firm has value of shipments exceeding $1,000,000 ($1,250,000) as a measure of firm diversification, we will test the sensitivity of our empirical results to the diversification variable chosen. Specialization ratios, defined as firm value of shipments in the primary industry divided by total value of shipments in the primary industry, will also be used in the hypotheses tests on the 1950 structural data. Since, as will be seen in Chapter 4, the specialization ratios do not perform better than the theoretically preferred diversification variable, they were not constructed for the 1967 data.

Technological Opportunity

In his article, "Firm Size, Market Structure, Opportunity, and the Output of Patented Inventions," Scherer introduced the concept of technological opportunity into the applied econometric analysis of firm inventive activity. As he put it:

> Technological opportunity in this context could relate partly to industry traditions or to demand conditions not manifested in mere sales volume, but it seems most likely to be associated with dynamic supply conditions dependent in turn upon the broad advance of scientific and technological knowledge.[25]

In our analysis, technological opportunity will be a control variable; while we will not be able to estimate it with sufficient precision to actually derive an index in which we have confidence, by controlling for technological opportunity we can obtain estimates of the other coefficients in the model.

No previous study has attempted to control for difference in technological opportunity within the food-processing industries. In Scherer's study, the food industries were combined with textiles, paper, miscellaneous chemicals, and primary metals in his "Unprogressive Group."[26] Imel, *et al.,* in estimating their models, assumed that technological opportunity is constant across the food industries.[27] By contrast, we have partitioned our collection of firms, for both 1950-56 and 1968-74, into high and low technological-opportunity classes. These industry groupings were developed by estimating models with separate intercept dummy variables for each of 11 food industries (dairy, meat-packing, brewing, baking, sugar-refining, canning, soft-drink, wet corn-milling, wheat-milling, distilling, and confectionery). Over a wide range of models, four industries—meat-packing, sugar-refining, wet corn-milling, and wheat-milling—had consistently higher estimated intercepts, placing them in the high technological-opportunity class.[28] The remaining seven were placed in the low-opportunity class.

MODEL OF FIRM RESEARCH AND DEVELOPMENT ACTIVITY

The hypotheses relating the structural variables to the indices of firm research-and-development activity are tested by estimating the following model by generalized least squares.

$$(1)\quad R\&D_i = B_{0,i}C + B_{1,i}\,CR4 + B_{2,i}\,SCR4 + B_{3,i}\,RMS + B_{4,i}\,SRMS + B_{5,i}\,AS + B_{6,i}\,SAS + B_{7,i}\,L + B_{8,i}\,LL + B_{9,i}\,DUM + B_{10,i}\,DIVERS + B_{11,i}\,NONFO + B_{12,i}\,FOREIGN + \varepsilon_i$$

Hypotheses: $B_{1,i} \gtrless 0$ $B_{2,i} \gtrless 0$ $B_{3,i} \gtrless 0$ $B_{4,i} \gtrless 0$

$B_{5,i} \gtrless 0$ $B_{6,i} \gtrless 0$ $B_{7,i} < 0$ $B_{8,i} > 0$

$B_{9,i} \gtrless 0$ $B_{10,i} > 0$ $B_{11,i} > 0$ $B_{12,i} > 0$

$i = 1, 2, 3$

where:

$R\&D_1$ = The total number of patents assigned to the firm for the years 1950-56 (1968-74).

$R\&D_2$ = The total number of firm research-and-development personnel in 1950 (1970).

$R\&D_3$ = Firm research-and-development expenditures in 1972.

CR4 = Four-firm concentration ratio.
SCR4 = $(CR4)^2$.
RMS = Relative firm market share.
SRMS = $(RMS)^2$.
AS = Industry advertising-to-sales ratio.
SAS = $(AS)^2$.
L = The natural logarithm of firm assets.
LL = $(L)^2$.
C = Vector of 1s.
DUM = Dummy variable (intercept) for technological-opportunity class.
DIVERS = DIVE1, D1, D2, or D3.
DIVE1 = The number of 5-digit products in which the firm has value-of-shipments greater than $1,000,000 in 1950 dollars ($1,250,000 in 1967 dollars).
D1 = The percentage of firm sales outside the firm's primary 5-digit product.
D2 = The percentage of firm sales outside the firm's primary 4-digit product.
D3 = The percentage of firm sales outside the firm's primary 3-digit industry.
NONFO = The percentage of firm value-of-shipments outside SIC 20.
FOREIGN = The percentage of firm sales outside the United States.
ε_i = Normally distributed random variable.

The generalized least squares estimator is based on the assumption that the variance-covariance matrix has the form:

$$V(\varepsilon) = \sigma^2 \begin{pmatrix} ASSETS_1^a & & & 0 \\ & ASSETS_2^a & & \\ & & \ddots & \\ 0 & & & ASSETS_n^a \end{pmatrix}$$

The values for "a" in each model for the time period examined were estimated by regressing the squared ordinary least squares residuals on the product of a constant term and firm assets to the "a" power. The estimate of the constant term controls for the variance, σ^2, and the point estimate of "a" is the estimate of the heteroscedastic pattern. The estimated "a" values are given in Table 3.1.

Table 3.1. Estimated "a" Values (Powers)

	1950 Structural Data	1967 Structural Data
Patents	.90	.42
R & D Employment	.68	.36
R & D Expenditures	—	.50

FOOTNOTES

[1] Scherer (1980), *op. cit.*. p. 439.

[2] Scherer (1965), *op. cit.*, p. 1098.

[3] W.S. Comanor and F.M. Scherer, "Patent Statistics as a Measure of Technical Change," *Journal of Political Economy,* May/June 1969, p. 393.

[4] *Ibid.*, pp. 397-398.

[5] Data on average pendency were taken from Jacob Schmookler, *Invention and Economic Growth* (Cambridge, Mass.: Harvard University Press, 1966). p. 36; and the Statement of Rene Tegtmeyer, Acting Commissioner of Patents, *Patent Law Revision,* Hearings on S. 1321 before the Subcommittee on Patents, Trademarks and Copyrights, Committee on the Judiciary, U.S. Senate, *93rd* Congress, *1st* Session (1973), p. 285.

[6] *Industrial Research Laboratories of the United States* (Ninth ed.; Washington: National Research Council, 1950), Preface.

[7] See Table 1, Comanor and Scherer *op. cit.*, p. 396.

[8] Smaller firms are more likely to have R & D employees without a R & D laboratory.

[9] Item 1. (6) (a) on the Securities and Exchange Commission's Form 10-K.

[10] These 11 firms are *not* firms that do no research. Rather, these are firms for which no R & D expenditures data are available but, based on R & D employment or patent data, there is good reason to believe that their R & D expenditures are not equal to zero.

[11] W.H. Kelly, *On the Influence of Market Structure on the Profit Performance of Food Manufacturing Companies,* Staff Report to the Federal Trade Commission (Washington: Superintendent of Documents, 1969).

[12] These data were obtained from the Federal Trade Commission by the Subcommittee on Monopoly and Commercial Law, Judiciary Committee, House of Representatives. See John D. Culbertson in W.F. Mueller, *The Celler-Kefauver Act: The First 27 Years,* Report prepared for the Subcommittee on Monopoly and Commercial Law, December 1978, pp. 189-192.

[13] W.G. Shepherd, "The Elements of Market Structure," *The Review of Economics and Statistics,* February 1972. Unpublished data appendix.

[14] For a more complete discription of these data see: W.F. Mueller and R.T. Rogers, "The Role of Advertising in Changing Concentration of Manufacturing Industries," *Review of Economics and Statistics,* February 1980, pp. 90-92.

[15] B.W. Marion, *et al.*, *The Profit and Price Performance of Leading Food Chains, 1970-1974* (Washington, D.C.: U.S. Government Printing Office, 1977), p. 41.

[16] W.H. Kelly, *op. cit.*, p. 9.

[17] *Ibid,* p. 9.

[18] The CR4s for brewing (CR4 = 80), fluid milk (CR4 = 55), and ice cream (CR4 = 55) were estimated by the authors. For baking (CR4 = 50) the 1968 CR4 for Interstate Bakeries from W.G. Shepherd

(1972) was used. The CR4 for prepared feeds (CR4 = 64) is the 1958 CR4 from the National Commission on Food Marketing, *The Structure of Food Manufacturing, Technical Study Number 8,* (1966), p. 37.

[19] For a more complete description of these data see: W.F. Mueller and R.T. Rogers, "The Role of Advertising in Changing Concentration of Manufacturing Industries," *Review of Economics and Statistics,* February 1980, pp. 90-92.

[20] F.M. Scherer, "Size of Firm, Oligopoly, and Research; A Comment," *Canadian Journal of Economics and Political Science,* May 1965, pp. 256-266.

[21] These figures are from Table 1.6.

[22] Scherer (1965), *op. cit.,* pp. 260-261.

[23] M. Hall and L. Weiss, "Firm Size and Profitability," *Review of Economics and Statistics,* August 1967, p. 322.

[24] If its R & D activities are spread among its product lines.

[25] Scherer, *op. cit.,* p. 1100.

[26] *Ibid.,* p. 1107.

[27] Imel, *et al., op. cit.,* p. 67.

[28] The opportunity-class variable by construction "dummies out" low-opportunity industries in 1950-1956 and high-opportunity industries in 1968-1974. Thus, in 1950-1956 the hypothesized sign is negative and in 1968-74 the hypothesized sign is positive.