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MARKET PERFORMANCE IN THE UNITED STATES VEGETABLE OIL INDUSTRY: AN APPLICATION OF SIMULATION FOR MARKET ANALYSIS

by

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Studies of market performance in agriculture have traditionally concentrated on the farm and retailing aspects of the marketing process. This is because price and cost data are generally available for farm and retail markets. This is not usually the case for food processing industries, however. Firm cost data are seldom made available voluntarily by food processing companies, and even price lists are difficult to obtain. These constraints have limited the extent to which research studies have been able to adequately assess market performance in food processing industries.

The purpose of this paper is to discuss the use of simulation as a tool for market performance analysis. A specific application is made to the processing sector of the domestic vegetable oil industry, a highly concentrated sector for which price and cost data are not readily available. Using representative plant and firm models, returns on five products are estimated over time by simulating production and marketing functions at actual input and output prices by months for the period January 1974 through December 1975. The results indicate that market power in the vegetable oil industry was insufficient to generate excessively high returns over this period, and demonstrate the potential of the simulation approach for use in studies of market performance.

Foundations of the Analysis

Five measures or conceptual approaches have been applied to market performance analysis when price and cost data are not available. These are productivity measures, marketing bill measures, flow analysis, market structure measures, and the application of welfare economics (Marion and Handy). The measure of market performance used in this study, the market rate of return, is a consequence of recent efforts by the Economic Research Service to identify the cost and profit components of the marketing margin for different food products, and is an outgrowth of marketing bill measures. The market rate of return, considered in the proper framework, "lies at the heart" of the analysis of market performance (Caves, 101). In this respect the rate of return, when it can be determined, serves as a far better measure of market performance than any of the other measures or conceptual approaches that have been applied to market performance analysis.

Recently Griffin proposed the use of the process analysis approach for determining empirical industry cost curves on the basis of a representative industry firm. In this study simulation is substituted for process analysis in a similar procedure for determining empirical industry cost curves. Marshallian representative firms are taken as the basis of the analysis, with the estimated rates of return for the products of the representative firm being taken as approximations of the rates of return on the same industry products. The points of reference to which the rate of return applies in this study then are the product markets in which the representative firm participates, not the aggregate rate of return to the representative firm itself.

Three Marshallian representative firms and six representative plants were identified in the processing sector of the United States vegetable oil industry for this study. These six plants included a soybean processing plant, a vegetable oil refining plant, a cooking oil bottling plant, a margarine manufacturing plant, a shortening canning plant, and a mayonnaise manufacturing plant. Of the three Marshallian representative firms, the first was defined to include soybean processing as its primary function, the second to include vegetable oil refining, cooking oil bottling, margarine manufacturing, and shortening canning as its primary functions, and the third firm was defined to include mayonnaise manufacturing as its primary function.

The System Model

The six plant, three firm system simulation model of the processing sector of the domestic vegetable oil industry was constructed by specifying the technical parameters of representative stage, plant, and firm production functions item by item. Representative stages, plants, and firms were selected on the basis of plant visitations and communications with individuals knowledgeable on the industry structure. The traditional economic engineering approach (French, Sammet, Bressler) was used in the specification and actual measurement of linear non-substitutable production functions. Information for specifying the levels of the technical parameters for the production functions was obtained by collecting data during visits to over forty plants and firms in the industry, by utilizing census data on plant specifications, and by consulting with equipment manufacturers. The entire system model was constructed to be jointly interactive so that all model plants and firms could be operated simultaneously within the simulation framework. If all technical parameters of each plant and firm are specified correctly, then the complete system simulation model should be representative, since by definition it is composed of representative production stages, plants, and firms.

Each of the three firms included in the simulation model are assumed to be spatially separated. Hence transportation costs are incurred in shipping crude soybean oil from the soybean processing firm's plant to the second model firm's vegetable oil refining plant, and in the shipping of refined vegetable oil to the third model firm's mayonnaise manufacturing plant. The vegetable oil refining plant, the cooking oil bottling plant, the margarine manufacturing plant, and the shortening canning plant, all operated by the second model firm, are assumed to be located at the same site. All assumptions concerning spatial location reflect prevalent industry patterns.

The results of a simulation experiment cannot be considered valid unless the underlying model is verified as accurate. Two methods were used to verify the accuracy of the model constructed for this study. First, actual plant and firm input and output data were used to check for inconsistencies in the generated input and output levels of the model plants and firms. No gross inconsistencies were found between actual industry input and output statistics and those generated by the model using this method. Second, the system simulation model was used to generate average costs for producing different industry products using 1975 prices. These generated average costs were then compared with available industry accounting average costs to check for inconsistencies. This comparison yielded certain discrepancies between actual industry accounting costs and average costs generated by the model.

For the cost verification method, detailed accounting data were available from industry sources on firm costs for three types of products. These were crude soybean oil, refined vegetable oil, and pint jars of mayonnaise. With respect to crude soybean oil, the cost of producing one pound of oil was estimated by the model to be 1.5 cents, while an average of data for thirteen processing firms in the industry indicated an average cost of 1.8 cents per pound in 1975. To some degree the discrepancy between these figures is attributable to the inclusion of older, more labor intensive plants in the composition of the firm accounting data, however. With respect to vegetable oil products, the costs of producing a refined vegetable oil, a margarine base oil, and a shortening base oil were estimated by the simulation model to be 1.2, 2.3, and 2.8 cents per pound of oil, respectively. The corresponding figures for similar but not identical products, as reported by one firm in the industry, were 1.0, 1.7, and 2.4 cents. Again, the discrepancies can be accounted for by differences between the firm for which costs are reported and the simulated model firm--the industry firm's plant was considerably more modern than the model firm's plant. Finally, with respect to mayonnaise, the cost of producing pint jars of mayonnaise was estimated by the simulation model to be 23.6 cents. Data from one firm in the industry indicated the cost of producing mayonnaise as 22.5 cents per pint. Also, in this case the discrepancy is attributable to variations between the structure of the model firm and the industry firm.

The attempts to verify the accuracy of the simulation model indicate that, when allowances are made for discrepancies, the model cost estimates are not grossly inconsistent with available industry data. Although accounting data could not be obtained to verify the accuracy of simulated costs of production for all the products considered in this study, each of the simulation plant and firm models were constructed using the same technique. Hence any biases that exist in the estimation of costs for one product are likely to exist in similar degrees in the estimation of costs for other products.

A Multiple Period Simulation Experiment

To evaluate the economic properties of the model and to generate descriptive statistics to analyze market performance in the vegetable oil industry, a complete system simulation was performed on a month by month basis using data for the twenty-four month period January 1974 to December 1975. One hundred and four monthly prices for inputs and outputs were collected for each of the twenty-four months in an attempt to re-create the actual environment in which plants and firms in the industry were operating over the period. The stochastic variables in the model were adjusted to remain at their mean levels so that random variations in plant performance would not affect costs or rates of return in any one period.

The simulation was performed so that at the end of each monthly period complete production cost data were generated for five final products of the vegetable oil industry on a per unit basis. These five products were twenty-four ounce bottles of cooking oil, thirty-eight ounce bottles of cooking oil, pound packages of margarine, three pound cans of shortening, and pint jars of mayonnaise. Cost data were generated by components consistent with those used by the Economic Research Service. For each of the five products forty-two separate components were identified for each of twenty-four periods, giving estimates of more than five thousand separate cost elements.

In order to focus on the key results of the simulation, estimates of the rate of return for the five finished products considered are presented in Table 1. The rate of return is defined as the per unit profit after taxes divided by the per unit value of assets. The information presented in Table 1 reveals that the variation in profit over the twenty-four month period was substantial for all five products. In addition, it is apparent that, with the exception of margarine, profits were generally greater for each of the five final products in 1975 than in 1974. This result contrasts with the fact that soybean prices and rates of return to soybean processors were considerably higher in 1974 than in 1975. These findings indicate clearly that, with the exception of margarine, finished product manufacturers were able to maintain and improve their rates of return as raw materials prices declined in 1975.

Table 1. Profit as a Percent of Net Worth for Five Products of the Vegetable Oil Industry, January 1974 through December 1975

Year	Month	Twenty-four Ounce Bottles of Cooking Oil	Thirty-eight Ounce Bottles of Cooking Oil	Pound Packages of Margarine	Three Pound Cans of Shortening	Pint Jars of Mayonnaise
1974	January	.0494	.0504	.0461	.0524	.0184
	February	.0481	.0287	.0257	-.0601	-.0627
	March	.1005	.0869	.0294	.0436	.0067
	April	.1074	.0924	.1118	.0642	.0463
	May	.0752	.0712	.0800	.0482	.0439
	June	.0654	.0395	.0534	.0105	.0356
	July	.0735	.0363	.0137	-.0960	.0035
	August	.0726	.0421	.0647	.0180	-.0048
	September	.0779	.0827	.0286	.0266	.0443
	October	.0618	.0365	.0409	.0491	.0448
	November	.0749	.0653	.0476	.0333	.0512
	December	.0879	.0787	.0313	.0523	.0740
1975	January	.1288	.1208	.0552	.0994	.1127
	February	.1495	.1414	.0640	.1205	.1316
	March	.1336	.1250	.0561	.1012	.1182
	April	.1370	.1282	.0875	.1104	.1192
	May	.1467	.1369	.1142	.1323	.1377
	June	.1396	.1297	.1134	.1254	.1318
	July	.0861	.0749	.0391	.0455	.0742
	August	.0708	.0590	-.0417	.0333	.0625
	September	.0905	.0791	-.0361	.0607	.0807
	October	.1122	.1012	.0045	.0786	.1011
	November	.1365	.1260	.0112	.1053	.1126
	December	.1331	.1216	.0078	.0994	.1213
Mean		.0982	.0856	.0436	.0564	.0668
Standard Deviation		.0326	.0363	.0408	.0547	.0521

Market Power in the Vegetable Oil Industry

For every product market there is some socially optimal normal rate of return on equity which must prevail if resource allocation is to be efficient (Caves). Although there is a problem in ascertaining what exactly a normal rate of return on equity is, this does not constrain the comparison of relative rates of return for analytical purposes. In specific cases where a detailed study over a period of time indicates that the rate of return in one market is consistently greater than the rate of return in other similar markets and that the rate of return is substantially greater than any long term interest rate realized over the period, then there is evidence of market power.

Referring again to the information presented in Table 1, it is readily apparent that the rate of return on cooking oil is substantially greater than the rates of return on the other products considered in this study. The mean rates of return for each of the five products are .0982 for twenty-four ounce bottles of cooking oil, .0856 for thirty-eight ounce bottles of cooking oil, .0436 for pound packages of margarine, .0564 for three pound cans of shortening, and .0668 for pint jars of mayonnaise. The rate of return on twenty-four ounce bottles of cooking oil, the product with the highest rate of return, is more than twice the rate of return on margarine, the product with the lowest rate of return. Although a twenty-four month period is probably not in actuality a "long run," it is useful to compare alternative investment opportunities available to firms in the industry over this period with their actual rates of return. The rate of return on corporate triple A bonds averaged .0871 over the twenty-four months from January 1974 to December 1975. For purposes of argument, if this figure is taken as the opportunity cost of investment, then of the five product markets considered there were extra-normal rates of return over the period only for twenty-four ounce bottles of cooking oil. Clearly then there were apparent inefficiencies in capital equity distribution in the processing sector of the domestic vegetable oil industry over the two year period from January 1974 to December 1975. These findings imply the virtual absence of any large degree of market power in the domestic vegetable oil industry over the period from January 1974 to December 1975. Only in the case of twenty-four ounce bottles of cooking oil are there indications of some degree of market power.

Two arguments may be offered to explain the absence of a large degree of market power in the processing sector of the domestic vegetable oil industry, even though the sector is highly concentrated. First, and perhaps most important, is the fact that the vegetable oil industry is a non-durable goods industry. It is difficult if not impossible to establish the price stability necessary to sustain oligopoly within non-durable goods industries. Traditionally, oligopoly has been identified principally in durable products industries where prices can be maintained by varying inventories and order backlogs (Scherer). In the vegetable oil industry inventories must be limited because of the relatively short life of the product. Hence prices are difficult to maintain as raw materials costs vary. For this reason the development of a large degree of market power in a multi-firm food processing industry would not be expected *a priori*. Second, a number of potential competitors do not face large entry barriers. For example, in the cooking oil industry there are three major firms which dominate the market. But there are also several that produce private label cooking oil. These potential comeptitors would only have to place a different label on their product and overcome advertising barriers in order to enter. For the other products considered in this study the situation is similar--there are several potential competitors.

Within the vegetable oil industry the estimation of a mean rate of return for each product allows for a comparison of relative market power. A related measure of market power is the standard deviation of the rate of return. Since market power implies some degree of control over prices and profit by the firm, it follows that the temporal standard deviation of the rate of return is likely to be smaller the greater the degree of market power. The acceptance of this premise would imply the expectation of an inverse relationship between the mean rate of return and the standard deviation of the rate of return. A reference to Table 1 will indicate that, except for margarine, the results generated by the simulation are consistent with this hypothesis. Twenty-four ounce bottles of cooking oil have the highest mean rate of return and the lowest standard deviation. The implication then is that of the five product markets considered in this study, market power is greatest in the market for twenty-four ounce bottles of cooking oil, and the least in the market for three pound cans of shortening.

Conclusion

This paper has discussed the use of simulation in a market performance study of the processing sector of the domestic vegetable oil industry. The results indicate little evidence of market power in the industry, even though most of the product markets of the industry are highly concentrated. This finding implies that some caution is in order when antitrust activities are urged against food processing companies when only data on market structure are available (Dahl, Hoffman, and Walters). Each individual case should be considered with respect to the market rate of return and other relevant factors. In the processing sector of the domestic vegetable oil industry there is evidence to indicate that complete economies of scale have yet to be realized in some instances (Lamm, Lamm and Johnson). An arbitrary policy requiring more diversification in the vegetable oil industry might do more harm than good since the implementation of such a policy would prevent the attainment of full scale economies.

The use of simulation as suggested in this paper offers a viable and powerful method for evaluating market performance when industry accounting cost data are not readily available. The advantages of using the simulation approach are that it allows for the segregation of individual product markets from aggregates and it allows for the use of explicit measures of market performance, measures which are more precise than the vague and sometimes misleading market structure measures frequently used. The only alternative which also has similar advantages is the use of accounting data. Since accounting data are generally not available for food processing industries, and would present some classification and collection problems even if they were available, the simulation approach outlined here offers perhaps the best alternative available for detailed market performance analysis.

References

Caves, R. E. American Industry: Structure, Conduct, Performance. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1972.

Dahl, D. C. "Public Policy Changes Needed to Cope with Changing Structure." American Journal of Agricultural Economics 57 (1975), 206-213.

French, B. C., L. L. Sammet, and R. G. Bressler. "Economic Efficiency in Plant Operations with Special Reference to the Marketing of California Pears." Hilgardia 24 (1956).

Griffin, J. M. "The Process Analysis Alternative to Statistical Cost Functions: An Application to Petroleum Refining." American Economic Review 62 (1972) 46-56.

____________. "The Process Analysis Alternative to Statistical Cost Functions: Reply. American Economic Review 64 (1974), 777-779.

Hoffman, A. C. "Discussion." American Journal of Agricultural Economics, 57 (1975), 216-218.

Lamm, R. M. "The Cost Structure of the Soybean Processing Industry." Paper presented at the Twenty-Second Annual Joint Conference of Cooperative Soybean and Cottonseed Processors, Miami Beach, Florida, 1976.

Lamm, R. M. and J. M. Johnson. "A Representative and Deterministic Cost Component Model of the United States Vegetable Oil Industry." Research Bulletin 107, Virginia Polytechnic Institute and State University, 1975.

Marion, B. W. and C. R. Handy. "Market Performance: Concepts and Measures." Economic Research Service, U.S.D.A., Agricultural Economic Report No. 244, 1973.

Scherer, F. M. Industrial Market Structure and Economic Performance. Chicago: Rand McNally and Company, 1970.

Walters, F. E. "Impact of Changing Structure of the Food Industries on Food Supply and Price." American Journal of Agricultural Economics 57 (1975), 188-195.