AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.

Market 1.05

1975

UNIVERSITY OF CALIFORNIA
DAVIS
SEP 22 1975
Agricultural Economics Library

ANALYSIS OF MARKET STRUCTURE AND PERFORMANCE IN THE FARM SUPPLY INDUSTRY USING SIMULATION TECHNIQUES

E. M. Babb
Purdue University

and

L. A. Lumpkin
Land O'Lakes Cooperative

Abstract

The structure of the farm supply industry is projected to become more concentrated, but with about the current balance of cooperative and proprietary firms. Performance varied significantly among firms from different types of organizations and among different price levels. Farmers may face higher prices for inputs.

Paper presented at AAEA annual meeting, Columbus, Ohio, Aug. 10-13, 1975.

ANALYSIS OF MARKET STRUCTURE AND PERFORMANCE IN THE FARM SUPPLY INDUSTRY USING SIMULATION TECHNIQUES

The behavior of firms (observed as business decisions) is important because it directly affects their individual performance and economic performance in the aggregate. Many factors both internal and external to the firm may influence its behavior. Determining the impact of these factors on behavior and subsequently on performance from observation of real world events poses serious problems. In our dynamic economy it is impossible to hold many things constant or to measure all of the factors which are changing that influence behavior. To better understand business firm behavior and the consequences of this behavior, new research approaches which allow controlled observation and measurement are needed.

Previous research used experimental gaming in a laboratory setting to test hypotheses about business behavior of firm managers as subjects (Babb and Bohl, 1974). Subject managers were from the farm supply industry which distributes feeds, seeds, fertilizer and other inputs to farmers and purchases farm produced grains. The previous research[1/] assessed the effects of organizational affiliation, external environment and competitive environment on firm behavior and performance. Managers from various types of organizations made decisions in a management game under external and competitive environments imposed by the researchers. Their decisions and the results of decisions provided data for hypothesis testing.

This research builds on the work of Babb and Bohl and explores the implications of the behavior observed in their gaming experiments for future performance and industry organization. The management game used in the prior research was converted into a simulator which was used to develop response surfaces on performance variables for managers from different types of organizations and under different competitive environments. The objectives were: (1) to project which types of organizations are most likely to survive and grow in various competitive environments, and (2) to develop projected performance measures and the implications of these measures for firms in the industry and for farmers.

This research makes use of the same theoretical framework developed for the previous research. Economic theory, organizational theory and the previous research provided the basis for the following hypotheses which were tested:

(1) performance would be the same for managers from the seven types of organizations,

(2) performance would be the same under different competitive environments,

(3) performance would be the same for the three to five most viable types of organizations.[2/]

Procedures

This research focused on pricing decisions made in the farm supply industry. The means and standard deviation of price decisions made by managers from different types of organizations and under different

competitive environments in the previous gaming experiment were the basic inputs for the simulator used in this research. The simulator provided longer run implications of repeated price decisions observed in the gaming experiment.

Simulator Construction

The management game used in the previous research was converted into a simulator (Babb and Bohl, 1969). It contained the decision variables which were in the management game, but permitted determination of the distribution of performance variables for firms from a particular type of organization based on repeated decisions made during experimental gaming. Since the focus was on pricing decisions, decision rules were developed to handle some non-price decisions made by managers in the previous research, such as orders, facility expansion, investment of excess cash and the like. These decision rules applied uniformly in all experiments which had the effect of holding non-price decisions constant. The game was made interactive so that the joint decisions of managers affected total market potential, rather than just their share of a fixed market potential. The model was made stochastic by incorporating a random number generator to develop distributions of prices for repeated trials, given the means and standard deviations of prices in the previous research. Procedures were incorporated in the model to handle a random walk experiment. Subroutines were developed to store performance data and to perform specific analyses of the data.

Experiments Performed

This research analyzed consequences of organizational affiliation and competitive environment factors as defined in the previous research. The specific treatments follow.

A. Type of Organization. Farm supply firms doing business in the Midwest were classified into seven categories based on size, type of ownership and number of retail outlets as follows:

1. independent proprietorship with single retail outlet and annual sales less than $600,000,
2. independent proprietorship with single retail outlet and annual sales of $600,000 to $1,400,000,
3. independent proprietorship with single retail outlet and annual sales over $1,400,000,
4. independent proprietorship with multiple retail outlets and annual sales over $1,000,000,
5. cooperative with multiple retail outlets and annual sales of $700,000 to $2,500,000,
6. cooperative with multiple retail outlets and annual sales over $2,500,000,
7. cooperative with single retail outlet and annual sales of $1,000,000 to $3,500,000.

B. Degree of Price Competition. In the prior study the researchers set the cost of goods sold and the average price of products sold by subjects' competitors, i.e., the researchers acted as competitors so that all subjects faced the same competitive environment during a

particular decision period. Three levels of price competition were imposed by the researchers representing situations of low, normal and high gross margins. These margin levels were used in experiments with the simulator.

The following experiments were conducted:

1. fifty independent replications[3] for managers from seven types of organizations under normal margins, under low margins, under high margins and under the combination of margin situations used in the prior study,[4]
2. fifty independent replications of the three to five most viable types of organizations under normal margins,[5]
3. twenty independent replications of a random walk situation covering ten decision periods by all seven types of organizations and by the most viable types of organizations, under normal margins.[6]

Statistical Analysis

The performance variables (simulator output) used in subsequent statistical analyses included return on investment, profit, profit as a percent of sales, total sales, operating expenses as a percent of sales and gross margins for feed, fertilizer and grain merchandizing. A one- or two-way analysis of variance (ANOV) was used to analyze performance variables, depending upon the design of the specific experiment. If the ANOV revealed significant differences[7] in performance variables among types of organizations, the Student-Newman-Keuls multiple range test was used to rank these categories.

Results

The means of performance variables, F values and rankings of managers from different types of organizations are presented for the experiments performed. Where the Student-Newman-Keuls multiple range test results are shown, the types of organizations have been ranked in descending order based on the performance variable mean. When lines are drawn below the ranks of two or more types of organization, the means of the performance variable for these types are not significantly different at the five percent level of probability.

Levels of Margins

The first three experiments included all types of organizations under low, normal and high margin environments. In these experiments prices of 26 products (feeds, fertilizers and grains), four services, quantity discounts, grain discounts and hog and layer contracting were randomly generated.

Differences in all performance variables among types of organizations were highly significant in each of the three experiments (tables 1, 2 and 3). In general, firms in organizational classes 3, 4, 5 and 7 were most profitable and had the highest gross margins for feeds and fertilizers. In the case of grain margins, the rankings were different from those for feeds and fertilizers. This was largely due to cooperative organizations taking a lower margin on grain and higher margins on feed and fertilizer, compared to proprietary organizations. Firms in organization classes 1 and 2 generally had higher expenses as a percent of sales which partly accounted for their lower profitability. The most profitable groups did not necessarily experience the highest sales.

From an economic standpoint, the results show important differences among types of organizations with respect to profitability measures. Differences of one to two percent in return on investment over time may affect survival. As expected, the level of margins in the three experiments had an important influence on profitability.

Combination of Margin Situations

The particular combinations of margin levels used for the six decision periods in the previous research were used as input to the simulator to obtain response surfaces for both types of organization and competitive environment. Both of these factors were highly significant (table 4). The interaction term for these factors was not significant, indicating that the relative performance of managers from different types of organizations was stable among different competitive environments. Ordinal rankings of types of organization on the basis of performance variables were essentially the same as in the experiments with low, normal and high margins. This indicates consistency in performance among types of organization with variation in level of margins and with combinations of margin levels.

Most Viable Types of Organizations

On the basis of the previous experiments, organizational classes 3, 4, 5 and 7 were selected as the most viable and the experiment with normal margins was repeated using only these four groups. There were still significant differences in performance variables among these four groups, but most of the rankings were not in completely separated groups

(means which were the basis for ranking not significantly different) as in the earlier experiments (table 5). Further, the economic impact of differences in performance among these four types of organization is probably not important in terms of their relative success or survival.

Random Walk

The ten-period random walk experiment for all types of organizations under an environment of normal margins was replicated 20 times. Because of auto-correlation in performance measures among the ten time periods, ending net worth (sum of profits over ten periods) for each of the 20 trials was used as the performance variable to be analyzed. There were significant differences among types of organization in ending net worth and the same types of organizations (3, 4, 5 and 7) that were most profitable in earlier experiments had the highest net worth (table 6). There was a tendency for prices to decline during the ten-period random walk as a number of managers in the previous study adopted a policy of pricing slightly below their competitors. This behavior was reflected in the results of the simulator. The ending net worths of the four most viable types of organizations were not significantly different in the experiment including only those groups.

Conclusions

The null hypothesis that performance would be the same for managers from the seven types of organizations was rejected in all experiments for all measures of performance. The experiment using combinations of margins was the basis for rejecting the null hypothesis that performance would be the same under different competitive environments.

This was further supported by important differences in performance among the experiments with low, normal and high margin levels. The null hypothesis that performance would be the same for the three to five most viable types of organizations was rejected, but the economic importance of these differences is probably not important to their survival. In fact, there were not significant differences in the ending net worth of the most viable groups in the random walk experiment. If the behavior observed in the laboratory experiment is representative of behavior in actual business settings, this study suggests that the outlook for some types of organizations is not very bright.[8/] Further, the price levels jointly determined by competitors will have a major impact on the performance of firms from all types of organization.

Implications

1. If the types of organizations which survive and grow are those identified as the most viable in this research, the future organization and structure of the farm supply industry will change. Type of ownership does not appear important as two of the most viable groups were cooperative and two were proprietary. But, types of organizations projected as the most viable had either large single retail outlets or had medium or large size multiple retail outlets. This implies that retail outlets in the industry will become more concentrated over time. The results are consistent with the rapid decline in the number of smaller firms which is taking place. The results do not imply the complete disappearance of firms in a particular type of organization. There

was at least one firm in the poorest performing group that performed at least as well as the average performance in the most viable group.

2. Part of the poor performance of smaller firms could be attributed to their lack of control over operating expenses. Beyond this, managers from the smaller firms did not understand how their customers responded to price differences and the impact of prices established by competitors. They thus established inappropriate price policies in the gaming experiment. Educational efforts with smaller firms may improve their performance and viability.

3. Fewer and larger firms will increase the distance farmers travel to purchase inputs and to market grain. Farmers may pay higher prices for purchased inputs. In the case of feeds and fertilizers, firms in the most viable group charged higher prices, but there was an erosion of prices even among these firms in the random walk experiment. Further, in the real world there may be economies of size for the larger firms or those with multiple retail outlets which were not built into the game and could temper some of their higher prices. Differences in prices of feeds, fertilizers and grains among different types of organizations suggest it is advisable for farmers to compare prices.

4. Price policies, which have a major influence on measures of profitability, varied among different types of organization and can be expected to produce variability in price levels over time. Firms in weak financial condition are especially vulnerable during periods of low margins.

5. In general, the decisions made by managers did not generate returns on investment that would attract large amounts of capital to the industry. Improved decision-making may be necessary to attract capital if industry expansion or renovation is needed.

Table 1. Performance Results and Statistical Tests for Seven Types of Farm Supply Organizations under Conditions of Low Margins.

Performance Variables	Average Performance Type of Organization[1/] (1)	(2)	(3)	(4)	(5)	(6)	(7)	ANOV F Value	Student-Newman-Keuls Ranking
Return on investment (%)	0.52	-0.37	1.72	1.77	1.38	-0.12	2.51	29.2**	7 4 3 5 1 6 2
Profit as a % of sales	0.17	-0.11	0.53	0.59	0.44	-0.04	0.77	29.7**	7 4 3 5 1 6 2
Profit ($)	2,556.	-2,017.	8,926.	9,074.	7,074.	-622.	12,993.	28.3**	7 4 3 5 1 6 2
Total sales ($) (000) omitted	1,600.	1,675.	1,703.	1,562.	1,655.	1,798.	1,694.	15.3**	6 3 7 2 5 1 4
% Gross Margin Feed	14.99	14.89	15.45	15.71	15.66	14.98	15.80	34.6**	7 4 5 3 1 6 2
% Gross Margin Fertilizer	13.16	13.16	13.26	13.71	13.62	13.15	13.56	6.8**	4 5 7 3 2 1 6
% Gross Margin Grain	2.19	1.97	1.90	2.10	1.87	1.65	1.89	10.4**	1 4 2 3 7 5 6
Operating expenses as a % of sales	13.62	13.10	12.59	12.76	12.46	12.41	12.38	19.1**	1 2 4 3 5 6 7

**Differences among group means significantly different at the .01 level of probability. Lines below the ranks of types of organization indicate that the means for these types are not significantly different at the five percent level of probability.

1/ Types of organizations are identified as (1) through (7) as in text and as below: (1) proprietorship, single outlet, sales <$600,000, (2) proprietorship, single outlet, sales $600,000 to $1,400,000, (3) proprietorship, single outlet, sales >$1,400,000, (4) proprietorship, multiple outlets, sales >$1,000,000, (5) cooperative, multiple outlets, sales $700,000 to $2,500,000, (6) cooperative, multiple outlets, sales >$2,500,000, (7) cooperative, single outlet, sales >$1,000,000.

Table 2. Performance Results and Statistical Tests for Seven Types of Farm Supply Organizations under Conditions of Normal Margins.

Performance Variables	Average Performance Type of Organization[1/] (1)	(2)	(3)	(4)	(5)	(6)	(7)	ANOV F Value	Student-Newman-Keuls Ranking
Return on investment (%)	4.36	3.78	5.59	5.16	5.00	4.08	5.62	17.0**	7 3 4 5 1 6 2
Profit as a % of sales	1.41	1.17	1.71	1.71	1.57	1.22	1.75	19.3**	7 3 4 5 1 6 2
Profit ($)	22,640.	19,660.	29,235.	26,787.	26,073.	21,372.	29,418.	16.5**	7 3 4 5 1 6 2
Total ($) sales (000) omitted	1,621.	1,689.	1,713.	1,570.	1,669.	1,752.	1,684.	10.0**	6 3 2 7 5 1 4
% Gross margin feed	16.22	16.11	16.50	16.80	16.77	16.23	16.93	22.6**	7 4 5 3 6 1 2
% Gross margin fertilizer	14.97	15.23	15.52	15.91	15.82	15.36	15.57	12.0**	4 5 7 3 6 2 1
% Gross margin grain	2.96	2.72	2.75	2.96	2.69	2.59	2.73	7.6**	1 4 3 7 2 5 6
Operating expenses as a % of sales	12.34	11.75	11.57	11.77	11.45	11.48	11.50	10.5**	1 4 2 3 7 6 5

**Differences among group means significantly different at the .01 level of probability. Lines below the ranks of types of organization indicate that the means for these types are not significantly different at the five percent level of probability.

[1/] Types of organizations are identified as (1) through (7) as in text and as below: (1) proprietorship, single outlet, sales <$600,000, (2) proprietorship, single outlet, sales $600,000 to $1,400,000, (3) proprietorship, single outlet, sales >$1,400,000, (4) proprietorship, multiple outlets, sales >$1,000,000, (5) cooperative, multiple outlets, sales $700,000 to $2,500,000, (6) cooperative, multiple outlets, sales >$2,500,000, (7) cooperative, single outlet, sales >$1,000,000.

Table 3. Performance Results and Statistical Tests for Seven Types of Farm Supply Organizations under Conditions of High Margins.

Performance Variables	Average Performance Type of Organization[1/] (1)	(2)	(3)	(4)	(5)	(6)	(7)	ANOV F Value	Student-Newman-Keuls Ranking
Return on investment (%)	7.30	6.13	7.33	7.01	7.40	6.42	8.15	15.8**	7 5 3 1 4 6 2
Profit as a % of sales	2.32	1.87	2.24	2.31	2.25	1.87	2.48	22.2**	7 1 4 5 3 2 6
Profit ($)	38,843.	32,402.	39,013.	37,113.	39,392.	34,162.	43,712.	15.5**	7 5 3 1 4 6 2
Total ($) sales (000) omitted	1,689.	1,729.	1,740.	1,611.	1,752.	1,842.	1,764.	11.0**	6 7 5 3 2 1 4
% Gross margin feed	17.07	16.70	17.25	17.62	17.58	16.95	17.65	33.6**	7 4 5 3 1 6 2
% Gross margin fertilizer	15.03	15.48	15.52	16.13	16.06	15.42	15.85	16.6**	4 5 7 3 2 6 1
% Gross margin grain	3.78	3.55	3.53	3.72	3.41	3.34	3.49	8.5**	1 4 2 3 7 5 6
Operating expenses as a % of sales	11.67	11.21	10.94	11.08	10.70	10.85	10.81	10.0**	1 2 4 3 6 7 5

**Differences among group means significantly different at the .01 level of probability. Lines below the ranks of types of organization indicate that the means for these types are not significantly different at the five percent level of probability.

[1/] Types of organizations are identified as (1) through (7) as in text and as below: (1) proprietorship, single outlet, sales <$600,000, (2) proprietorship, single outlet, sales $600,000 to $1,400,000, (3) proprietorship, single outlet, sales >$1,400,000, (4) proprietorship, multiple outlets, sales >$1,000,000, (5) cooperative, multiple outlets, sales $700,000 to $2,500,000, (6) cooperative, multiple outlets, sales >$2,500,000, (7) cooperative, single outlet, sales >$1,000,000.

Table 4. Analysis of Variance Results for Five Performance Variables using Treatments of Competitive Environments and Types of Organization.

Performance Variable	ANOV F Values		
	Competitive Environment Effect	Organizational Effect	Interaction Effect[1/]
Return on investment	174**	92**	1.45
Profit as a percent of sales	154**	107**	1.34
Profit	176**	90**	1.31
Total sales	96**	53**	1.16
Operating expenses as a percent of sales	528**	71**	1.10

**Differences among group means significantly different at the .01 level of probability.

1/ Interaction of competitive environment × type of organization.

Table 5. Performance Results and Statistical Tests for the Four "Most Viable" Types of Farm Supply Organizations under Conditions of Normal Margins.

Performance Variables	Average Performance Type of Organization[1/] (3)	(4)	(5)	(7)	ANOV F Value	Student-Newman-Keuls Ranking
Return on investment (%)	5.58	5.44	5.50	5.96	2.9*	7 3 5 4
Profit as a % of sales	1.69	1.78	1.68	1.84	3.1*	7 4 3 5
Profit ($)	29,227.	28,355.	28,839.	31,309.	3.2*	7 3 5 4
Total ($) sales (000) omitted	1,733.	1,599.	1,721.	1,708.	19.6**	3 5 7 4
Percent gross margin feed	16.61	16.85	16.95	16.81	4.3**	5 4 7 3
% Gross margin fertilizer	15.35	15.86	15.67	15.67	5.5**	4 7 5 3
Percent gross margin grain	2.72	2.94	2.65	2.74	7.6**	4 7 3 5
Operating expenses as a % of sales	11.59	11.80	11.35	11.58	5.2**	4 3 7 5

* Means significantly different at the .05 level of probability.

**Differences among group means significantly different at the .01 level of probability. Lines below the ranks of types of organization indicate that the means for these types are not significantly different at the five percent level of probability.

1/ Types of organizations are identified as (3), (4), (5) and (7) as in text and as: (3) proprietorship, single outlet, sales >$1,400,000, (4) proprietorship, multiple outlets, sales >$1,000,000, (5) cooperative, multiple outlets, sales $700,000 to $2,500,000, (7) cooperative, single outlet, sales >$1,000,000.

Table 6. Ending Net Worth and Statistical Tests for Seven Types of Farm Supply Organizations under Conditions of Normal Margins in a Random Walk Experiment.

Performance Variable	Average Performance — Type of Organization[1/] (1)	(2)	(3)	(4)	(5)	(6)	(7)	ANOV F Value	Student-Newman-Keuls Ranking
Ending Net Worth	226,412.	237,446.	282,381.	310,349.	290,174,	234,079,	322,657.	4.92**	7 4 5 3 2 6 1

**Differences among group means significantly different at the .01 level of probability. Lines below the ranks of types of organization indicate that the means for these types are not significantly different at the five percent level of probability.

1/ Types of organizations are identified as (1) through (7) as in test and as below: (1) proprietorship, single outlet, sales <$600,000, (2) proprietorship, single outlet, sales $600,000 to $1,400,000, (3) proprietorship, single outlet, sales >$1,400,000, (4) proprietorship, multiple outlets, sales >$1,000,000, (5) cooperative, multiple outlets, sales $700,000 to $2,500,000, (6) cooperative, multiple outlets, sales >$2,500,000, (7) cooperative, single outlet, sales >$1,000,000.

Footnotes

1/ The term previous or prior research here and elsewhere in this paper refers to Babb and Bohl, 1974.

2/ The selection of the most viable types of organizations was based on results of experiments which included all types of organizations.

3/ The sample size of 50 was selected prior to conducting experiments on the basis of standard deviations from the previous research, a confidence interval of 95 percent and desired interval lengths.

4/ Subjects in the previous research made six sets of decisions in sequence. For each set of decisions, they faced various combinations of low, normal or high margins which were balanced over the sequence of six decision periods. That is, subjects did not face low margins for all products in the game during one decision period. The experiment which refers to the combination of margins used in the previous study duplicated the combinations used earlier. The experiment referred to as low margin used the low margin from the previous study for all products at one time. Experiments referred to as high or normal margins likewise applied high or normal margins to all products at one time for that experiment.

5/ The most viable types of organizations were defined on the basis of highest profits and returns on investment in simulator experiments which included all classes of organization.

6/ For the random walk experiments, the starting prices were based on the average of prices established by managers from each of the seven types of organizations. Cost-of-goods sold was held throughout the random walk. Given the standard deviations from the previous study, the random number generator created the distribution of prices for that period. Prices for the second year were based on averages of prices in the first and the random number generator then created prices for the second year and so on through ten periods. Thus, prices for different products could drift up or down over time.

7/ The F value was significant at the five percent level of probability.

8/ The previous research did not detect significant differences between the behavior of managers in a laboratory setting and in real life.