

DUAL STRUCTURAL EQUILIBRIUM IN THE FLORIDA SHRIMP PROCESSING INDUSTRY

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ABSTRACT

Stability, entry, exit, and mobility patterns for six size categories of firms in Florida shrimp processing industry for the 1959-71 period were studied by utilizing Markov Chain analysis. Forecasts over time predict that a structural equilibrium in the industry will be achieved by 1985. The forecasted changes in firm distribution suggest that Florida shrimp industry sales will become increasingly concentrated due to expansion in number of both small and large firms. A dual equilibrium, resulting in fewer medium-sized firms and more small- and large-sized firms, can be explained by the tendency for small firms to develop a specialty product and/or services in order to differentiate their markets from those of the very large firms. Medium-sized firms, then, tend to expand in size, or decline and either move to specialty products and services or exit from the industry.

Structural characteristics and patterns of Florida shrimp processing firms over the 1959-71 period, and the forecasts reveal several important structural characteristics of the industry. Entry into the Florida shrimp processing industry is relatively easy for small firms and more difficult for large firms. All firms are likely to move up in size by one only step or size category per time period. Exit from the industry in one time period is less probable for small and large firms than for medium-sized firms. Large firms are most likely to maintain their size between any two time periods and also experience less probability of declining in size than do medium- and small-sized firms.

Shrimp are the most important seafood processed in Florida. Total value of the shrimp processed in Florida in 1972 was slightly over \$88 million. Processed shrimp products account for approximately 69% of Florida's total volume of nonindustrial seafood products and 70% of the value of seafood processed. In 1972, Florida's share of processed shrimp production in the southeast region was 28% (the southeast region representing about 75% of U.S. production). The growth of this industry was substantial during the last decade; both Florida's production and share of the U.S. market increased (Alvarez 1974).

Despite the growth in processing experienced by this industry, shrimp landings in the State declined significantly during the 1960-73 period. In 1960, 51 million pounds (23 million kg) of shrimp were landed; however, by 1973, landings declined to only 20 million pounds (13 million kg). Currently, the volume of shrimp processed in the State is three times as large as the volume of landings in the State, with the deficit being met by imports and non-Florida U.S. landings (Alvarez 1974). These comparisons indicate the basis of concern for the growth potential and nature of competition

within the Florida shrimp processing industry. In a recent study addressing this concern (Alvarez 1974), emphasis was placed on processor sales concentration since there was evidence of "market power" in raw product purchases. The present study corroborates the findings of that study and further explains the results.

Predictions regarding future economic relationships are important to this industry for current managerial and investment decisions by firms and for long-run planning in optimizing firm size, scale economies, and product lines. Knowledge of the estimated number and size distribution of firms in the future will also help predict the character and intensity of competition within the market. Markov Chain analysis, employed in this study, is a useful tool for making such predictions. The analysis is a discrete-time stochastic process for which the state of the process at any time k depends only on the state of the process at the immediately previous time $k - 1$. A Markov Chain is described by listing the states of the chain, the initial probabilities of being in various states, and the probabilities of transition from one state to another (Bishir and Drewes 1970).

The purpose of this paper is to analyze by size category the entry and exit patterns of firms in the Florida shrimp processing industry during the

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1959-71 period. The prevailing entry and exit patterns during the 1959-71 period are then used to forecast firm distribution over time and predict the equilibrium state of firms within the market. Results from a 1973 survey (Alvarez 1974) of the Florida shrimp processing industry are utilized in discussing the economic and managerial implications of entry and exit patterns identified in this analysis.

This study only considers shrimp processing firms and not handlers who deal exclusively with raw headless shrimp. Shrimp processors cook, peel and devein, and bread or prepare specialty shrimp products.

THEORETICAL CONSIDERATIONS

That market structure of an industry, according to Bain (1968), embodies the framework or conditioning environment within which specific enterprise behavioral characteristics evolve. This behavior encompasses both the market conduct and the market performance of firms. These conditions in turn influence the type of structural equilibrium achieved within an industry. The following brief paragraph discusses the market structure theory relevant to this paper.

Market structure is defined as "... those characteristics of the organization of a market which seem to influence strategically the nature of competition and pricing within the market" (Bain 1968). The number and size distribution of sellers, the conditions of entry, exit, and mobility within the industry are important aspects of market structure to be considered. The number of sellers specifies how many firms are competing for the buyer's dollar. Generally, an increase in the number of competing firms is indicative of a movement toward freer competition (Ward and Smoleny 1973). The size distribution of firms is generally measured by volume of sales or by the proportion of total output of the industry supplied by a firm or a group of firms. Conditions of entry are defined as the relative easy or difficulty with which new firms may enter the market, determined generally by the advantage or control which established firms exercise over potential entrants (Bain 1968). Mobility gives an indication of the ability for firms within an industry to make adjustments in their size and, therefore, is an indicator of the degree of structural rigidity within an industry (Ward and Smoleny 1973). Structural equilibrium is that point where net

changes are no longer shown in the market structure. The number and distribution of firms remain fixed. Firm entry and exit occur at offsetting rates (Ward and Smoleny 1973).

ENTRY AND EXIT PATTERNS DURING THE 1959-71 PERIOD

Lack of time series data for total sales by individual firms necessitated use of employment data during the 1959-71 period as a measure of firm size (Florida State Chamber of Commerce 1959-71). A comprehensive research project based on a 1973 survey conducted by the authors showed that firm size measured by employment compared favorably with sales or volume as a measure of firm size (Alvarez 1974). Productivity per worker for firms with similar product lines (95% of industry sales) is quite similar to further corroborate this conclusion. Thus, employment is a good proxy for firm size in the shrimp industry.

The Florida shrimp processing industry is composed of several firms, each of a given size. The measurement of size as well as size categories (states of nature) are defined in this study as follows:

State	Size of firm (employees)	Sales classification, 1972	
1	0	-	-
2	1- 10	small	<\$2 million
3	11- 30	small	<\$2 million
4	31-100	medium	\$2-12 million
5	101-300	medium	\$2-12 million
6	>300	large	>\$20 million

Thirty-one firms processed shrimp in Florida during the 1959-71 period. These firms and their respective states of nature throughout the entire period are presented in matrix form (Table 1) in 2-yr intervals because the data are only reported biannually. Rows in the matrix specify the different states of nature for each firm during the period under consideration. Firm number 2, e.g., with state 1 in 1959 and 1961 was not in business, then in 1963 entered the industry in state 6 (firm size of over 300 employees), maintained that size in 1965 and 1967, and exited from the industry in 1969. From the data contained in the matrix of Table 1, the transition matrix presented in Table 2 was calculated.

The probabilities on the transition matrix illustrate the stability (diagonal), entry (row one), exit (column one), and mobility (off diagonal) patterns

TABLE 1.—Total number of Florida shrimp processing firms and their respective states of nature¹ during the 1959-71 period.

Firm no.	1959	1961	1963	1965	1967	1969	1971
1	4	4	4	2	2	3	3
2	1	1	6	6	6	1	1
3	4	4	4	5	5	5	5
4	4	1	1	1	1	1	1
5	1	1	1	4	1	1	1
6	1	1	1	1	1	3	1
7	1	1	1	1	1	2	1
8	3	3	3	3	3	1	1
9	1	1	3	3	3	1	1
10	1	1	1	2	2	2	2
11	1	1	1	1	2	2	2
12	1	2	2	2	2	2	2
13	5	5	1	1	1	1	1
14	4	3	3	3	3	4	4
15	1	1	1	3	3	3	3
16	5	5	5	6	6	6	6
17	5	5	5	1	1	1	1
18	1	1	1	3	3	3	3
19	1	1	1	2	1	1	1
20	3	3	1	1	1	1	1
21	4	4	4	1	1	1	1
22	3	3	3	4	3	3	3
23	6	6	6	5	5	6	6
24	5	5	1	1	1	1	1
25	1	1	1	5	5	5	5
26	1	1	1	6	6	6	6
27	1	1	3	3	3	1	1
28	1	1	1	1	4	3	3
29	1	1	1	1	4	4	4
30	2	2	2	2	2	3	3
31	3	3	3	3	3	4	3

¹For a definition of state of nature utilized in this study see text.

TABLE 2.—Transition matrix of the Florida shrimp processing industry.

Employees (number)	States of nature						
	1	2	3	4	5	6	
0	1	0.8025	0.0617	0.0617	0.0370	0.0123	0.0247
1- 10	2	.1053	.7895	.1053	—	—	—
11- 30	3	.1351	—	.7838	.0811	—	—
31-100	4	.1667	.0556	.2222	.5000	.0556	—
101-300	5	.1667	—	—	—	.7222	.1111
>300	6	.0769	—	—	—	.0769	.8462

to delineate the structure of the Florida shrimp processing industry during the 1959-71 period. Each entry (P_{ij}) in Table 2 represents the probability of a firm moving from state i (row) to state j (column); e.g., P_{34} (0.0811) is the probability of a firm increasing in size from state 3 to state 4 in the next time period, and P_{42} (0.0556) is the probability of a firm decreasing in size from state 4 to state 2 in the following time period.

Industry stability, the probability of a firm maintaining the same size between any two successive time periods, is represented by numbers on the diagonal. The highest probabilities in the transition matrix are for shrimp processing firms to maintain the same size between any two time periods, suggesting that the industry is fairly stable. Firms of the largest size (state 6) are most

likely to maintain their size. Medium-sized firms in state 4 are least stable, illustrated by an equal probability of remaining in the same size category or changing between any two periods.

Firm entry, specified in row one, is most probable for the smaller sizes (0.0167 for sizes 2 and 3) while the probabilities decrease for larger sizes.

Firm exit probabilities, shown in column one, are lowest for the largest and smallest firms.

Firm mobility, measured by increases or decreases in firm size, is shown by the off-diagonal numbers in the transition matrix. Shrimp processing firms of any size have at least some probability of moving one state upward at a time but almost zero probability of increasing in size by more than one state at a time. Moving downward in size scale is somewhat different. The largest firms (state 6) have a small probability of going from state 6 to 5, and zero of moving more than one state at a time. The second largest firms (state 5) have zero probability of moving down possibly because state 4 is not stable for various economic reasons. There are probabilities of declines by one or two states for firms of size 4 but a zero probability of decline from state 3 to state 2.

CHARACTERISTICS OF THE DUAL EQUILIBRIUM

Several important implications for the structure of the Florida shrimp processing industry can be drawn from the above description of the transition matrix, for the 1959-71 period. A dual equilibrium, created by instability of medium-sized firms and greater stability of small and large firms, is evident in the industry. Medium-sized firms are least stable as shown by the highest probabilities for either exiting from the industry or increasing or decreasing in size, and the highest probabilities for moving down more than two states in any time period. The dual equilibrium, with most stability for firms with less than 30 and for firms with 300 or more employees, is the result of a special characteristic of the Florida shrimp processing industry.

The largest firms may be able to exert some "market power" for a number of reasons. To be competitive, firms desiring to sell a general line of shrimp products must be sufficiently large to achieve the economies of scale in purchasing and processing presently experienced by large firms. Even though entry into the largest size is difficult, exit from that size in one time period is very unlikely. Size characteristics along with the high

probability of remaining in the largest state for a long period of time permit large firms to be more secure and ultimately more stable than small firms. Thus, large firms develop greater access to raw supply sources which are currently scarce, and greater knowledge of the national market accompanied by stability in supplying their customers.

Small firms, being able to enter with relative ease, find it very difficult to advance in size but remain in their state without too much difficulty. These firms are more likely to succeed if they produce specialty products, sell in isolated markets, or develop forward integration from shrimp fishing operations.

Firms of medium size, neither displaying the characteristics of large nor small firms, either exit from the industry or make adjustments in their size and/or product lines. Medium-sized firms tend to be unstable initially because they apparently are not organized to successfully enter shrimp specialty markets yet are too small to compete in the national major line shrimp markets.

FORECASTING FIRM DISTRIBUTION AND PREDICTING A STRUCTURAL EQUILIBRIUM

A forecast² for the 1961-71 period of the number of shrimp processing firms in each state of nature was conducted and compared with the actual number of firms appearing in the data during the same period (Table 3). The purpose of this procedure was to evaluate the appropriateness of the transition matrix for forecasting firm distribution within the industry.³ When comparing actual firm numbers to predicted numbers in states 2 through 6 for 1961 through 1971, 17 of the 30 predictions were accurate and in state 4, which is least stable, 5 of the 6 predictions were accurate, giving confidence that the dual equilibrium structure remains intact with the predicted numbers.

²To forecast firm distribution in the Florida shrimp processing industry over time requires that the transition matrix be stationary; that is, the probabilities in the transition matrix do not change over time. Although, the chi-square "goodness-of-fit" test was conducted and the results show the transition matrix to be stationary, predictions should be considered tentative due to the small number of observations per cell caused by the low number of firms in the industry. Forecasted distribution, however, being very close to that found in the past, indicates that the transition matrix remains useful for prediction.

³Some of the differences may be due to the small number of observations or to rounding procedures.

Forecasting Firm Distribution Over Time

The biannual forecasted distribution of firm size for the Florida shrimp processing industry from 1973 to equilibrium appears in Table 3. Few changes in the number of firms in each state are observed. The smallest sizes (states 2 and 3) experienced an increase of one firm each while the remainder (states 4, 5, and 6) show no change. Thus, there is an increase of two in the total number of active firms. The number and size of firms in the industry will attain a structural equilibrium in a relatively short period of time.

Equilibrium State Within the Market

The equilibrium matrix for the Florida shrimp processing industry was calculated to show the final distribution of firms within the industry under the assumption of a stationary transition matrix (Derman et al. 1973). In equilibrium, firms may still enter and exit but neither the number of firms in each state of nature nor the total number of firms in the industry changes once the equilibrium is reached.

The distribution of firms in the equilibrium state compared with the distribution of firms

TABLE 3.—Actual number¹ of firms in each state of nature in the Florida shrimp processing industry, compared with the corresponding predicted numbers² using the transition matrix, 1959-71 and forecasting to 1985 and equilibrium.

Year	States of nature						Total no. active firms	
	1	2	3	4	5	6		
1959	16	1	4	5	4	1	15	
1961	a	16	2	5	3	4	1	15
	b	15	2	5	3	3	2	15
1963	a	16	2	6	3	2	2	15
	b	15	3	6	3	3	2	17
1965	a	11	5	7	2	3	3	20
	b	15	3	7	2	2	2	16
1967	a	10	5	8	2	3	3	21
	b	11	5	7	2	3	3	20
1969	a	12	4	7	3	2	3	19
	b	11	5	8	2	3	3	21
1971	a	14	3	7	2	2	3	17
	b	12	4	7	2	2	3	18
1973	b	13	3	7	2	2	3	17
1975	b	13	4	7	2	2	3	18
1977	b	13	4	7	2	2	3	18
1979	b	12	4	7	2	2	3	18
1981	b	12	4	7	2	2	3	18
1983	b	12	4	7	2	2	3	18
1985	b	12	4	8	2	2	3	19
Equilibrium ³	12	4	8	2	2	3	19	

¹Data from source (Florida State Chamber of Commerce).

²Computed using the transition matrix.

³The equilibrium probabilities of transition in column order for the six states of nature were one (0.3881), two (0.1319), three (0.2454), four (0.0685), five (0.0603), and six (0.1058) for each of the six respective columns.

during the 1959-71 period (Table 3) shows that firms of the smaller sizes (states 2 and 3) increase in number as the industry reaches the structural equilibrium, while firms in states 4 and 5 decrease and firms in the largest size increase in number. This is a consequence of the industry dual equilibrium conditions of entry and exit identified in the 1959-71 period.

At the structural equilibrium, and in support of the dual equilibrium, the probabilities for firm entry are highest for firms with less than 30 employees and for those with more than 300 employees. Thus, the least amount of entry activity will occur within the medium-sized firms.

Mean Lifetime for Each Size Category

Mean lifetime values for each size category were calculated (Table 4) and further support the prevalence of a dual equilibrium in the Florida shrimp industry. Mean lifetime represents the

TABLE 4.—Mean lifetime in years for each size category for the Florida shrimp processing industry¹

States of nature ²	Column 1 Average ³ (yr)	Column 2 Perfect ⁴ (yr)	Column 3 Ratio ⁵
2	9.500	2.304	0.243
3	9.250	2.650	.286
4	4.000	2.418	.604
5	7.200	2.128	.296
6	13.000	2.236	.172

¹Mean lifetime represents the number of years a firm tends to stay in a given size category. In this case, results were multiplied by 2 since each time period equals 2 (yr) in the data.

²State 1 is not included because it is an absorbing state.

³Calculated from the transition matrix with the formula $(1/1 - P_{ii})$.

⁴Time spent in each state for a perfectly mobile industry as calculated from the equilibrium size distribution.

⁵Column 2 ÷ Column 1.

number of years a firm tends to stay in a given state of nature. The largest firms tend to maintain their size for a greater number of years (13) than firms in any other size category. Firms of sizes 2 and 3 have mean lifetime values of 9 yr, while firms of size 4 and size 5 tend to remain for an average of 4 and 7 yr in their respective states. These findings are the result of the firms' probabilities of maintaining their size between any two time periods. Column 2 of Table 4 represents the number of years spent in each size for an equilibrium distribution (perfectly mobile industry); the values are very similar. The data in Column 3 indicate state rigidity where the smaller the ratio, the more rigid the state. State 6 is the most rigid state in the industry, followed by states 2, 3, 5, and 4, respectively.

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