Non-Stationary Markov Process Analysis of the Size Distribution of Shrimp Processing Firms in the Southeast United States

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Abstract. The shrimp harvesting sector is the largest component of the Southeastern United States fishing industry, accounting for 57% of the total value of landings in the region in 1996. U.S. shrimp imports were valued at $2.6 billion in 1996. Together, domestic production and imports of raw products support a large shrimp processing sector, which provides several thousand jobs either directly or indirectly. In 1975 and 1984, the United States International Trade Commission investigated the shrimp industry to determine whether the volume of shrimp imports was high enough to threaten domestic firms which were producing articles similar to, or directly competitive with the imported products. In both studies, the commission concluded that no harm was done to the processing sector. However, an analysis of the shrimp processing sector revealed that imports did have a negative impact. The objective of this research is to examine the impact of shrimp processors performance (as measured by processor's margins) on industry structure (as measured by the number of processing firms in activity) using a non-stationary Markov model. Results indicated significant margins changes on industry structure and size distribution. Specifically, the narrowing of processors' margins due to increased shrimp imports impacted more the small size firms than the medium or large firms. Additionally, some shrimp processors (medium and large sizes) were able to remain in the industry by adjusting their input mixes.

Keywords: Shrimp, Markov, Structure, Performance, Southeast U.S., Processing.

BACKGROUND

The shrimp harvesting sector is the largest component of the southeastern United States fishing industry, accounting for 57% of the total value of landings in the region in 1996. During that same year, the United States shrimp imports were valued at $2.6 billion. Together, domestic production and imports of the raw shrimp products support a large shrimp processing sector, which provides several thousand jobs either directly or indirectly. In 1975, the National Shrimp Congress filed a petition with the U.S. International Trade Commission (USITC) for import relief pursuant to section 201 of the trade Act of 1974 (Gulf of Mexico Fishery Management Council, 1981). The USITC started an investigation to determine whether U.S. shrimp imports were of such increased quantities as to be a substantial cause of serious injury or threat to the domestic industry producing a product directly competitive with the imported product. The domestic industry was defined as two industries: shrimp harvesting and shrimp processing. Some of the USITC commissioners who participated in the investigation found that shrimp products were not imported

in such increased quantities as to be a substantial cause of serious injury or threat to the domestic processing industry. The other commissioners focused on the impact of increased imports on the domestic harvesting industry. The commissioners found that the shrimp harvesting sector was being injured by the increased shrimp imports. Adjustment assistance to the industry was recommended.

In 1984, the U.S. shrimp industry was the focus of another federal investigation conducted under 322(g) of the Tariff Act of 1930 (United States International Trade Commission, 1985). The purpose of the investigation was to evaluate competition affecting the harvesting sector of the U.S. Gulf and South Atlantic shrimp fishery industry. In explaining their situation to the trade commission, the U.S. Gulf of Mexico and South Atlantic harvesters claimed that the harvesting businesses were being injured by imports and that shrimp industry in foreign countries were benefitting from government assistance, artificially allowing their product prices to be more competitive in the U.S. market (Keithly et al., 1993a). In spite of their claims, the commission issued a report and no further actions were

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recommended. However, an analysis of the shrimp industry that focused on the processing sector revealed that imports did have a negative impact.

For example, domestic production of peeled shrimp increased by more than twofold from 25 million pounds in 1973 to 79 million pounds in 1996. During the same period, U.S. imports of peeled shrimp products expanded from 75 million pounds to 260 million pounds, an increase of more than 240%. Overall, the deflated price of peeled shrimp (converted on a headless-shell-on basis) of $2.59 per pound in 1996 reflects a 58% decline when compared with the 1973 price of $6.27 per pound. The deflated price of raw shrimp used in peeling activities also declined by more than 44% from $4.68 per pound in 1973 to $2.58 per pound in 1996. Lastly the, margin between the processed product and the raw product narrowed by 56% between 1973 and 1996.

Similar trends are evident in the production of breaded shrimp quantities. The processed quantities declined from 97 million pounds in 1973 to 76 million pounds in 1983. The processed quantities increased after that period to reach a record level of 112 million pounds in 1989. Following the 1989 peak of domestically produced shrimp, total quantities of breaded shrimp leveled off at approximately one hundred million pounds per year. Between 1973 and 1982, imported breaded shrimp also increased from 978 thousands pounds to 3.9 million pounds. After 1982, shrimp imported quantities declined steadily to reach a low of 472 thousand pounds in 1996. The number of firms also declined steadily from 50 active processors in 1973 to 20 processors in 1996. During the 24 year period, the average product per firm increased from 2 million pounds in 1973 to 5 million pounds in 1996, which represents an expansion of 60%.The margin between the processed product and the raw product also decreased by 39 percent during the period of study.

Similar trends are also observed in the production of headless-shell-on shrimp. In 1973, the domestic production of headless-shell-on shrimp represented 35 percent of the total southeast processing activities and about 60 percent of the total U.S. shrimp imports. By 1996, however, the headless-shell-on shrimp product had declined to 27 percent of the total of the southeast supplies and 55 percent of shrimp imports. Annual domestic production of headless-shell-on shrimp fluctuated between 70 and 120 million pounds from 1973 to 1996. During the same period, imports of headless shell-on shrimp quantities increased from about 120 million pounds in 1973 to more than 350 million pounds in 1989, and then declined to 300 million pounds in 1996. The nominal value of domestic production of headless-shell-on shrimp increased from $150 million in 1973 to more than $500 million in 1986. But, by 1996, this value has fallen to nearly $320 million, which is still an

increase of more than twofold when compared to the 1973 value. This increase can be explained by two factors: first, the drop in domestic production of 9 percent was more than compensated by a 150 percent increase in imports between 1973 and 1996. Second, the current price of headless-shell-on shrimp increased throughout much of the period of analysis from $1.97 per pound in 1973 to $4.59 per pound in 1996. When adjusted for inflation, the value of domestic production declined steadily after 1978 despite an increase in imports. This decline reflects a sharp fall in the real price of processed product since 1979. The deflated processed price per pound of $4.59 in 1996 represented about a 50 percent decline from the 1979 price of $9.15 per pound and about 34 percent decline when compared to the per pound deflated price of $6.96 in 1973. The margins between the processed product and the raw product also decreased during the period of study by 30 percent.

The narrowing of processor margins due to increased imports had significant effects on firm number and size distribution. The number of processors in the Southeastern region of the United States declined steadily from 181 in 1973 to 97 firms in 1996, or by more than 45% (Figure 1). From 1973 to 1988, the decline in the total number of firms in the shrimp processing industry was 15%. The decrease in the number of firms is more pronounced after 1988, with 37% drop when compared to the 1988 processing firm number of 153.
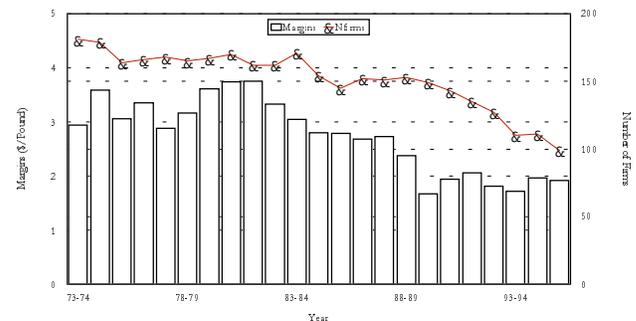

Figure 1: Number of Firms and Processors Margins for the Southeastern United States Shrimp Processing Industry, 1973-1996

These trends, however, do not show the variation in processor size distribution, nor the dominance of a specific type of firm. There was a growing domestic production per firm that arose from the declining number of shrimp processors. For example, the number of shrimp processors declined between 1973 and 1996, while domestic production fluctuated between 200 and 300 million pounds per year. During that same period, U.S. imports of shrimp increased from 200 million to 600 million pounds. Consequently, the average quantity of shrimp processed per firm increased from 1.18 million pounds per year to 2.60 million pounds. A closer look at the industry reveals that

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the annual processed shrimp production of 275 million pounds in 1988 (product weight basis) represented an increase of 28% when compared to 1973 annual production of 214 million pounds. Overall, 1988-1990 average annual production of 291 million pounds (product weight basis) represented an increase of 53 percent when compared to the 1973-75 average annual processing activities of 190 million pounds.

In summary, between 1973 and 1996, the shrimp processor margins declined by 56% for the peeled shrimp, 30% for the headless-shell-on shrimp and 39% for the breaded shrimp. Overall processor margins for the three products declined by 35%. The goal of this research is to examine the impact of shrimp processors performance (processor's margins) on industry structure (number of firms). Specifically, entry, exit and firm size distribution in the southeast United States shrimp processing industry will be evaluated using a Markov model. The rational associated with the objective is twofold. First, most econometric studies of the shrimp processing industry may no longer accurately reflect industry structure given the substantial changes within the industry during the last two decades. Second, entry/exit, size distribution and their impact on alternative management measures need to be quantified. Knowledge of the estimated number and size distribution of shrimp processing firms in the future will help predict the character and intensity of competition within the market. The empirical model from this study will allow estimation of entry/exit and identify and estimate the strength of their determinants. To accomplish the goal of this paper, first, a review of relevant literature is presented in the next section. Second, the Markov model is specified and data and estimation issues are discussed. Third, the empirical results are presented and lastly, the paper concludes with discussion pertaining to the findings.

LITERATURE REVIEW

The impact of increased imports on U.S. shrimp sector has been addressed by several studies. However, most of these studies were completed during the period of the 1970s and 1980s (Prochaska and Andrew (1974); Alvarez et al. (1976), Roberts et al. (1990), Keithly et al. (1993b)).

Prochaska and Andrew (1974) raised concerns about the impact that a growing dependence on imports would have on the structure of the shrimp processing industry in the Gulf states plus Georgia. The authors investigated entry and exit by examining trends in firm size and concentration within the Florida shrimp industry. They used data on employment within the industry for their analysis. The authors found that the average biannual entry rate for

handlers[4] was 9.6% and 15.3% for processors between 1959 and 1971. Exit rates were 16.1% for handlers and 14.2% for processors. Based on employment data, the authors estimated that 14.5% of the processing firms were growing and 11.8% were declining within the period of study. Thus, 26.3% of the processing firms were changing size while 8.4% of the handlers were expanding or decreasing. The authors also found that the Florida shrimp industry had became more concentrated since the late 1950s, and that all firms were not affected equally by the shrimp supply shortage. A few of the largest firms had informal binding agreements with local suppliers, and they controlled a portion of local supply and paid substantially less for raw products than the remaining processing firms. The small competitors paid both a high price for Florida supplies and for imports, domestic and foreign.

In a later study, Alvarez et al. (1976) again used data on employment during the 1959-71 period as a measure of firm size. In their study, the authors examined the Florida shrimp processing industry using a stationary Markov chain model. They analyzed the stability, entry/exit, and mobility patterns for six size categories of firms from 1959 to 1971. The measurement of size as well as size categories were defined as follows: 1) firms employing zero individuals and no shrimp sales represented the exit category; 2) firms employing between 1 and 10 individuals and realizing a yearly shrimp total sales less than $2 million were classified in the second category; 3) the third category included the firms employing between 11 and 30 workers and realizing less than $2 million per year of shrimp sales; 4) the fourth category encompassed the firms employing between 31 and 100 workers and making between $2 and $12 million a year; 5) the firms employing between 101 and 300 workers and making between $2 and $12 million a year were classified in the fifth category. All other firms were classified in the sixth category. Entry into the Florida shrimp-processing sector was more common for small firms than for large firms. Larger firms were more likely to maintain their size between any two time periods. They also experienced lower probabilities of declining in size than did medium- and small-sized firms. The authors predicted that structural equilibrium in the industry would be achieved by 1985, resulting in fewer medium-sized firms and more small and large-sized firms. Medium-sized firms were expected to grow in size, to decline in number, and either move to specialty products and services or exit the industry. The forecasted changes in firm distribution indicated that Florida shrimp industry could become increasingly concentrated due to expansion in the number of small and large firms. Alvarez et al (1976) also pointed out the reliance of the southeastern shrimp processing

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[4]Handlers are those who exclusively freeze and package the headless shell-on shrimp

industry on foreign supplies. The authors also found that domestic supplies were being replaced by imports. Most of these studies were conducted before the large growth in import supply observed in the mid-80s.

One study conducted in the 1990s (e.g. Roberts et al (1990)), found an uninterrupted shrimp import usage among Georgia and Florida processors. Their results showed that Alabama and Mississippi processors have imported shrimp regularly since 1982. The imported shrimp helped the processing industry increase its output to meet growing domestic demand.

Keithly et al (1993b) investigated the Southeastern U.S. shrimp processing industry for the 1973-90 period. The authors found a declining number of firms over the period of study, and an increase in the processed quantities. The authors examined shrimp processing activities on the basis of four product forms: (1) raw headless products; (2) peeled products; (3) breaded products, and (4) specialty products (including canned products). The increased processed quantities were mostly peeled products. The decline in the specialty products resulted from an increase in canned products. The authors found stability in terms of industry concentration as measured by market shares based on the value of processed shrimp. This research will differ from the above studies in that it will analyze the Southeastern U.S. region shrimp processing firms size distribution using a non-stationary Markov model.

MODEL DEVELOPMENT

Stavins and Stanton (1980) provided a good survey on the utilization of the Markov model to predict farm size distribution. A basic Markov model implies the following four critical assumptions about the size distribution of shrimp processing firms:1) shrimp processing firms can be grouped into size classes according to some criteria, such as total output, total sales or a combination of total output and total sales; 2) the evolution of the shrimp processing firm size classes can be regarded as a stochastic process. A stochastic process $\{X(t), t \in T\}$ is a collection of random variables (Ross, 1985). That is, for each $t \in T$, $X(t)$ is a random variable. The index t is often interpreted as time and, as a result, one refers to $X(t)$ as the state of the process at time t. For example $X(t)$ might equal the total number of firms that have entered the shrimp processing industry by time t; 3) the probability that a shrimp processing firm will move from one size class to another is a function of some basic stochastic process, and 4) transition probabilities remain constant over time. The assumption that the transition probabilities are constant means that once the process of change has been identified, the same process of change will continue indefinitely.

Since many size categories can be available to firms based on their performance, a multinomial logit model, that has been applied in many studies where more than two alternative choices were available, will be appropriate. The multinomial logit model guaranties the estimated probabilities to be non negative and to sum to one for each row of the transition matrix. It also requires a construction of a matrix of total processed shrimp quantity per firm, an identification of the size category to which each firm belongs in each period, an identification of the year to year movement of all firms over time and the computation of processors movement between different sizes.

For any given state *n-1* probabilities are estimated while the remaining probability is used for the normalization. The probabilities from the model can be represented as

$$P_{ijt} = \frac{e^{\left(\alpha_{ij} + \sum_{k=1}^{K} \beta_{ijk} X_k\right)}}{1 + \sum_{j=1}^{n-1} e^{\left(\alpha_{ij} + \sum_{k=1}^{K} \beta_{ijk} X_k\right)}} \quad (1)$$

where;

(i) i = size category of the specific shrimp processing firm in year *t*, $i = 1, 2, 3, ..., n$;

(ii) j = firm size category in year *t +1*, $j = 1, 2, 3, ..., n$;

(iii) p_{ijt} = transition probability of the firm moving from size category i in time t to size category j in time *t+1*; and

(iv) $\alpha_{ij} + \sum_{k=1}^{K} \beta_{ijk} X_k = U_{ij}$ represents the utility

that a shrimp processor in state i in time period t has from making the choice to move to state j in time period *t +1*.

Following Judge et al. (1985), first consider the effects on the odds of choosing alternative 1 rather than alternative 2 where the number of alternatives facing the individual are increased from *j* to *j**. The odds of alternative 1 being chosen rather than alternative 3 where *J* alternatives are available are:

$$\frac{P_{i1}}{P_{i2}} = \frac{e^{x'_{i1}} / \sum_{j=1}^{J} e^{x'_{i1} \beta}}{e^{x'_{i2}} / \sum_{j=1}^{J} e^{x'_{i2} \beta}} = \frac{e^{x'_{i1}}}{e^{x'_{i2}}} \quad (2)$$

In general, the odds of obtaining the kth alternative relative to the first are

$$\frac{P_{ik}}{P_{i1}} = \frac{e^{x_{ik}\beta'}}{e^{x_{i1}\beta}} = e^{\left(x_{ik}^{'} - x_{i1}\right)\beta} \quad \text{k=2,...,j} \quad (3)$$

If x_{ik} and x_{il} contain variables that are constant across alternatives, then $x_{ik} = x_{il} = x_i$, for k=2,..., J and (3) becomes

$$\frac{P_{ik}}{P_{i1}} = e^{\left[x_i^{'}(\beta_k - \beta_1)\right]} \quad (4)$$

Some normalization rule is clearly needed and a convenient one is to assume $\beta_1 = 0$ (Judge et al. 1985). This condition, together with the *(J-1)* equations (4) uniquely determines the selection probabilities and guarantees the sum to equal 1 for each *i*. The resulting selection probabilities are

$$P_{i1} = \frac{1}{1 + \sum_{j=2}^{J} e^{x_j^{'}\beta_j}} \quad (5)$$

$$P_{ij} = \frac{e^{x_i^{'}\beta}}{1 + \sum_{j=2}^{J} e^{x_i^{'}\beta}} \quad j = 2,...,J \quad (6)$$

Using maximum likelihood procedures, one can carry out the estimation of the parameters of the multinomial logit model.

A Markov chain is said to be stationary if the probability of moving from one sate to another state is independent of the time at which the step is being made (Isaacson and Madson, 1976). The Markov chain is said to be non-stationary if the condition for stationarity fails. To test the null hypothesis of stationarity, we first run the model with a constant as an independent variable and the transition probabilities as a dependent variables and obtain the log likelihood function estimate $\left(\ln\left(L_0\right)\right)$. Second, we run the model with the transition probability as the dependent variables and the economic variables in our case the margins as independent variables and obtain the log likelihood function $\left(\ln\left(L_1\right)\right)$. The stationarity test is

$$-2\ln(\lambda) = 2\left(\ln\left(L_1\right) - \ln\left(L_0\right)\right) \quad (7)$$

This test is distributed as χ_v^s, with $v = (k-1)$ degrees of freedom, with *K* being the number of restrictions. The null hypothesis is rejected when the estimated value of the Chi-square for the sample period is greater than its critical value. Consequently, one can conclude that the estimated probabilities change from one period to another.

DATA

The study is based on data provided by the National Marine Fisheries Service (NMFS). The data represents an annual voluntary end-of-the year survey of all processing / wholesaling firms. The data includes the total pounds and values of processed shrimp (peeled, breaded, headless-shell-on) per firm and other species in the Southeast region of the United States. Raw shrimp (input) price was determined based on work by Keithly and Roberts (1994). The data were all converted to a shrimp headless-shell-on basis. The prices were deflated using the 1996 consumer price index.

It is assumed that processing firms can be grouped into four categories according to their total yearly shrimp sales. The first group, size zero, is the "entry / exit" category. It includes firms that can potentially process shrimp or exit the processing activities at any given time period. Those firms are assumed to be making less than $20,000 a year in shrimp sale. The second group, size one, includes firms that average between $20,000 and $1 million a year in shrimp sales. The third group, size two, encompasses firms with yearly shrimp sales ranging between $1 million and $10 million. The last group, size three, includes firms that average an annual shrimp sale above $10 million. The impact of changes in processor margins (due to increasing imports) on the firm size distribution can be analyzed using a multinomial logit model. In other word, the multinomial logit will help to quantify the impact of shrimp processing sector performance on the shrimp industry structure. It is hypothesized that increasing shrimp import have reduced processor margins causing the size distribution to change.

The first step in the modeling involves the construction of transition matrices. From those transition matrices, transition probability matrices were obtained. The transition probability matrices represent the dependent variables in the multinomial logit model. The independent variable is the difference in processor gross margins between two consecutive periods. The gross margins is the difference between the average wholesale processed shrimp prices and the average dockside price.

RESULTS AND DISCUSSION

The log of the likelihood function of the unrestricted (nonstationary) model is -92.9402, while that of the restricted (stationary) model is -102.6048. The Chi-square statistic is 19.32. With four restrictions, the Chi-square, corresponding to the rejection region at alpha equals 5 percent is 7.81. Since the test value is greater than its critical value, one can reject the null hypothesis of stationarity and conclude that the transition probabilities vary over time.

The number of firms in different size categories is expected to decrease with a decrease in the margins. Table 1, which displays the results of the Markov model, indicates that the decrease in processor margins is significantly associated with a change in the industry transition probabilities. In the multinomial logit model, the relationship between the dependent and the independent variables is non-linear, therefore less straightforward.

Table 1: Multinomial Logit Estimates for the United States Southeastern Region Shrimp Processing Industry (1973-1996)

Label	Estimate	T-statistics	Probabilities
P(Y=1)	0.9681	4.104	0.0001
P(Y=2)	0.8786	3.696	0.0002
P(Y=3)	0.6879	2.822	0.0048

Consequently, care must be taken in interpreting the estimated coefficients of the transition probabilities, because they do not directly measure the impact of prices (margins in this case) on the transition probabilities and the number of firms (Zepeda, 1995). An alternative would be to examine the predicted probabilities from the model that are presented in the five first columns of Table 2 (see Appendix).

Results indicate that the chances of a firm exiting the industry P(Y=0) and the chances of a firm remaining in size category 1 (P(Y=1)) increase with time as processor margins decrease, the chances of firms staying in size category 2 (P(Y=2)) and the chances of firms staying in size category 3 (P(Y=3)) increase. We were expecting firm size to decline with the narrowing of the processor margins. The reason for those discrepancies can be explained by the fact that the different probabilities for one time period must be positive and sum to one. If two probabilities are increasing, one or both of the two remaining probabilities must decline or be equal to zero. Consequently, the sign of

the coefficients presented in table 1 and the results discussed above are not sufficient to determine the direction of change of the corresponding probabilities.

A more practical view of the behavior of the multinomial logit is one that focuses not on the probabilities themselves but rather on their ratios (Aldrich and Nelson, 1984), that is the odds of one event occurring relative to another. The odds of the event Y=1 occurring relative to the event Y=2, is given by

$$\frac{P(Y=1)}{P(Y=2)} = \frac{e^{\sum \beta_{1k} X_k}}{e^{\sum \beta_{2k} X_k}} = e^{\sum (\beta_{1k} - \beta_{2k}) X_k} \tag{8}$$

It is useful to examine these odds as the exogenous variable changes. Since the function exponential(.) increases as its argument ascends the difference in the two coefficients alone determines the direction of the changes (Aldrich and Nelson, 1984). Consider the alternative of firms moving from size 1 to size 2 given the changes in processor margins. If the difference in the two relevant coefficients, $\beta_{1k} - \beta_{2k}$, is positive, then increases in the margins will raise the likelihood of observing alternative 1 rather than 2. The different ratios are presented in columns 6 to 11 in Table 2. Between 1973 and 1983 , the ratios P0/P1, P0/P2 and P0/P3 are declining. This indicates that the odds of a firm entering the industry or staying in size category 1, 2 or 3 are higher than the odds of a firm exiting the industry. During that same period, the ratios P1/P2, and P1/P3 were increasing. This implies that the likelihood of firms moving from size category 2 and 3 to size category 1 is higher than the likelihood of firms moving from size category 1 to size category 2 or 3. The ratio P2/P3 also increased between 1973 and 1983 suggesting that the odds of a firm moving from a size category 2 to a size category 3 are higher than the odds of a firm moving form size category 3 to a size category 2. One explanation may be that between 1973 and 1983, processor margins were high enough to attract or maintain firms in the industry, resulting in higher competition among firms. Those margins were high because of the limited shrimp supply.

After 1983, because of the increased shrimp imports from South Asian and Latin American countries, shrimp became available to U.S. processors year round. Consequently, the domestic wholesale prices and ex-vessels prices for shrimp declined, leading to a narrowing of the processor margins. During that same period, the odds of observing P0/P1, P0/P2 and P0/P3 increased. This suggests that the chances of a firm exiting the industry are higher than the chances of a firm staying in size category 1, 2 or 3. Results also

indicated that P1/P2 and P1/P3 declined suggesting that the firms of size 2 and 3 have higher chances of staying in their categories than moving to size category 1. The ratio P2/P3 declined between 1983 and 1996 suggesting that the likelihood of a firm staying in size category 3 rather than moving to a size category 2 are higher than the odds of a firm moving from a size category 3 to a size category 2.

In summary, firm size distribution is affected by the changes in processor margins. The narrowing in the margins seems to impact more the small size firm than the medium or large firm. Between 1973 and 1996, the number of processors in size category 1 declined from 85 firms to 37 firms. During that same period, the number of processors in size category 2 declined from 58 to 35 while the number of processors in size category 3 declined from 38 to 25. Additional examination of the data can shed some light on what happened in the processing industry. Before 1983, small, medium and large sized firms averaged their production at about 32 thousand pounds, 536 thousand pounds and 3.6 million pounds. During that same period, the shrimp production per worker was 1 thousand pounds for the small firm, 15 thousand pounds for the medium sized firm and 24 thousand pounds for the large firms. After 1983, the total production per firm for different sizes increased. A small firm averaged 51 thousand pounds a year, while the medium and large firms averaged 910 thousand pounds and 5 million pounds a year. The production per worker increased also to 26 thousand pounds for size 2 and 32 thousand pounds for size 3. The production per firm didn't change significantly for the small size firms. In summary, some shrimp processors were able to remain in the industry by adjusting their input mixes.

CONCLUSION

A model was developed to examine the impact of narrowing processor margins on firm size distribution. Results showed that the effects are significant. Specifically, the odds of a firm being in the first category were higher in the period 1973-1983 than the odds of a firm being in the same size category in the period 1984-1996. However, the odds of a firm falling in the second size category in the period 1973-1983 are similar to those of a firm falling in the same size category during the period 1984-1996 while, for the last category, the odds of a firm being of size 3 in the period 1973-1993 are lower than the odds of a firm being of the same size during the period 1984-1996. Those odds may be explained by the fact that all size categories were competing against new entrants for the limited supply of raw shrimp between 1973 and 1983. After 1983, the increase in shrimp imports made raw shrimp available to processors year round. This caused processor margins to narrow rapidly when compared to the margins realized by

processors prior to 1983, thus greatly increasing the odds of firms exiting the industry. In 1973, 181 firms were actively processing shrimp in the southeastern region of the United States. During that year, 45 percent of the firms had total sales below $1 million a year, 38 percent between $1 million and $10 million a year, and 21 percent with sales greater than $10 million a year. By 1996, those percentages were 38, 36, and 32 for categories 1, 2 and 3, with a total of only 97 firms processing shrimp. The firms that remained in size category 2 and 3 increased their production per firm and production per worker. They also decreased their number of workers. Its is suspected that firms in size 2 and 3 are benefitting from substantial scale economies.

ACKNOWLEDGMENT

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APPENDIX

Table 2: Predicted Probabilities from the Markov Model of the United States Southeastern Region Shrimp Processing Industry (1973-1996)

Label	P0	P1	P2	P3	P0/P1	P0/P2	P0/P3	P1/P2	P1/P3	P2/P3
73-74	0.0235	0.4462	0.3398	0.1903	0.0527	0.0691	0.1235	1.3129	2.3442	1.7854
74-75	0.0187	0.4583	0.3410	0.1817	0.0409	0.0550	0.1033	1.3438	2.5213	1.8762
75-76	0.0227	0.4481	0.3401	0.1890	0.0507	0.0668	0.1201	1.3176	2.3706	1.7991
76-77	0.0153	0.4686	0.3416	0.1742	0.0327	0.0449	0.0881	1.3718	2.6892	1.9603
77-78	0.0104	0.4875	0.3416	0.1602	0.0214	0.0305	0.0651	1.4269	3.0422	2.1319
78-79	0.0162	0.4660	0.3415	0.1762	0.0347	0.0474	0.0919	1.3644	2.6444	1.9380
79-80	0.0155	0.4682	0.3416	0.1746	0.0331	0.0453	0.0888	1.3706	2.6817	1.9566
80-81	0.0162	0.4660	0.3415	0.1762	0.0347	0.0474	0.0919	1.3644	2.6444	1.9380
81-82	0.0127	0.4778	0.3418	0.1675	0.0267	0.0374	0.0763	1.3978	2.8522	2.0404
82-83	0.0169	0.4637	0.3414	0.1778	0.0364	0.0495	0.0951	1.3583	2.6076	1.9196
83-84	0.0183	0.4597	0.3411	0.1808	0.0398	0.0536	0.1012	1.3474	2.5426	1.8869
84-85	0.0254	0.4419	0.3393	0.1933	0.0575	0.0748	0.1314	1.3023	2.2858	1.7550
85-86	0.0247	0.4433	0.3395	0.1923	0.0558	0.0729	0.1287	1.3059	2.3051	1.7651
86-87	0.0293	0.4336	0.3380	0.1989	0.0677	0.0869	0.1477	1.2827	2.1794	1.6991

87-88	0.0366	0.4204	0.3354	0.2074	0.0871	0.1092	0.1766	1.2531	2.0263	1.6169
88-89	0.0419	0.4119	0.3334	0.2126	0.1017	0.1257	0.1972	1.2353	1.9374	1.5683
89-90	0.0542	0.3948	0.3286	0.2222	0.1374	0.1651	0.2441	1.2015	1.7762	1.4783
90-91	0.0520	0.3976	0.3294	0.2207	0.1309	0.1580	0.2358	1.2069	1.8013	1.4924
91-92	0.0565	0.3919	0.3276	0.2237	0.1442	0.1725	0.2526	1.1961	1.7515	1.4642
92-93	0.0715	0.3747	0.3215	0.2320	0.1909	0.2226	0.3084	1.1655	1.6148	1.3855
93-94	0.0813	0.3648	0.3175	0.2362	0.2229	0.2562	0.3443	1.1489	1.5440	1.3438
94-95	0.0757	0.3704	0.3198	0.2339	0.2043	0.2367	0.3236	1.1582	1.5834	1.3671
95-96	0.0639	0.3832	0.3247	0.2281	0.1667	0.1968	0.2801	1.1802	1.6794	1.4230