Estimated Impacts on Ex-Vessel Brown Shrimp Prices and Value as a Result of the Texas Closure Regulation

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Introduction

Changes in commodity prices may result from any regulatory process that disrupts historical marketing conditions. The Federal regulation prohibiting offshore shrimp fishing during the time the State of Texas closes the territorial sea is anticipated to affect shrimp landings in Texas and therefore could be expected to affect ex-vessel or dockside prices. This paper presents estimates of the effects on shrimp prices as a result of changes in offshore landings due to the Texas closure regulation. Also, the change in ex-vessel value (or gross revenue) to the brown shrimp fishery resulting from the closure regulation is calculated.

Changes in prices caused by variations in the supply of shrimp are measured empirically by means of price flexibilities. Empirical estimates of price flexibilities provide the relative or percentage change in prices given a 1 percent change in the amount of shrimp landed. The data and analytical methodologies used to estimate price flexibilities of brown shrimp prices reported at ports in Texas and Louisiana are described in the Data Description and Methodology section. The Results section contains the estimated price flexibilities and provides comparisons of several alternative statistical models. Finally, the estimated changes in brown shrimp prices and landings are used to calculate the effect on gross revenue to this fishery.

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Data Description and Methodology

Price and Landings

In most published literature, shrimp prices are aggregated using a weighted-average price per pound. In this average (total value of landings divided by total amount landed), price per pound is weighted by the amount of different-size shrimp landed. The weighted-average price will therefore be determined not only by the price per pound, but also by the amount of the various sizes of shrimp in the landed catch.

Such weighted-average price data should be considered carefully for several reasons. First, shrimp are graded or sorted by size (i.e., number per pound) into eight marketing categories and the price per pound increases with the size of shrimp. For example, in May 1981, the reported price per pound was \$5.63 for the largest-size category and \$0.88 for the smallest-size category. The price of a single large shrimp was about \$0.38 and that of a small one was slightly more than \$0.01. Second, large landings in a few categories may skew the weighted average and camouflage movements in prices of other size categories. Third, the Texas closure regulation was implemented to increase the availability of larger, more valuable shrimp to the fishery.

Thus, the weighted-average (weighted over all sizes of shrimp) price per pound has the implicit assumption that the effects of the closure regulation would be spread equally over all size categories. For these reasons, the eight marketing categories were analyzed separately to determine the effects of the closure regulation.

Three species of commercially important shrimp—brown, pink, and white—are caught in the Gulf of Mexico off the coast of Texas and Louisiana. Due to its temporal and spatial distribution, however, brown shrimp, *Penaeus aztecus,* was the primary species affected by the closure regulation. Therefore, the analyses in this paper are restricted to brown shrimp prices.

The price and landings data used in the subsequent analyses are limited to monthly observations. This constraint is due to the manner in which landings were estimated in the simulation analysis performed by Nichols (1982). The constraints and feasibilities of using weekly price and landings data are discussed more thoroughly by Poffenberger[1]. The monthly time-series used in the regression analyses begin in January 1971 and continue through December 1980.

Methodology

The analysis presented in this paper was prepared after the closure and subsequent reopening of the offshore fishing areas; therefore, reported price and landings data from the brown shrimp fishery were available from

[1]Poffenberger, J. R. 1981. An analysis of price and value for the brown shrimp fishery in the Gulf of Mexico. Unpubl. rep., NMFS Southeast Fisheries Center, Miami, Fla., 45 p.

May through August 1981. To estimate the change in gross revenue, it is necessary to estimate the amount of landings that the fishery would reasonably have been expected to make during this 4-month period if the closure regulation had not been implemented. A simulation analysis provided estimates of the difference in brown shrimp landings if the area off the coast of Texas had been open for fishing during the early part of the brown shrimp season (Nichols, 1982). Changes in ex-vessel prices are determined by calculating the percentage difference between the monthly reported landings and the simulated landings. The percentage changes in landings are multiplied by the estimated price flexibilities and these products are multiplied by the reported prices for May through August.

The analysis that estimates the price flexibilities attempts to isolate only the effects of variations in U.S. domestic landings on brown shrimp prices, with the effects of other factors (such as imports and inventories) held constant. The statistical relationships between shrimp prices and landings were estimated by log-linear regression models (equations (1) and (2)). Using log transformations, the coefficients of the landings variables (L) in equations (1) and (2) provide the price flexibility estimates directly[2].

Two approaches were considered for statistically isolating the effects of shrimp landings on prices. First, a simple regression model was specified as follows:

$$ln(P_i) = ln(a) + bln(L_i) + \varepsilon \quad (1)$$

where P_i = reported ex-vessel prices of the ith size category (i = 1, 2, . . ., 8);
L_i = the amount of brown shrimp landings at Texas and Louisiana ports for the same ith size category;
a = the intercept;
b = the estimated coefficient of the landings variable (in this model it is also the price flexibility estimate); and
ε = the random error.

[2]The model specifications of equations (1) and (2) assume that the price flexibility estimates are constant over the range of the landings data. That is, the price flexibility estimates are the same at all locations of quantity supplied on the supply curve.

The simple regression model in equation (1) was specified for two reasons. First, it was an attempt to estimate only the effects of landings on the respective prices. This model specification implies that the effects of all other factors would be captured in ε, the random error parameter. Second, this model was specified to help determine whether the effects of U.S. domestic landings on ex-vessel prices were dependent on the magnitude of the landed catches in different years. This hypothesis appears reasonable because of the large variations in catches which are affected by exogenous factors such as rainfall, salinity, and temperature. A more explicit description of this hypothesis is presented by Poffenberger (footnote 1).

The second approach was an attempt to statistically account for those factors that may dampen or reduce the effect of changes in landings on the price structure. For this case, a multiple regression model that includes the major influential variables was specified as follows:

$$ln(P_i) = b_1 ln(S) + b_2 ln(I) + b_3 ln(PPI) + b_4 ln(RCPS) + b_5 ln(L_i) + b_6 ln(OL_j) + \varepsilon \quad (2)$$

where P_i reported ex-vessel brown shrimp prices for the ith size category (i = 1, 2, . . ., 8),
S = the end-of-month cold storage holdings in total weight,
I = total pounds of foreign imports of fresh and frozen shrimp,
PPI = monthly producer price index for meat, poultry, and fish,
$RPCS$ = monthly per capita expenditures at eating and drinking establishments deflated by a subcomponent of the consumer price index,
L_i = the amount of brown shrimp landings for the ith size category,
OL_j = the amount of brown shrimp landings for the jth size category such that $j \neq i$,
a = the intercept,
b's = the estimated coefficients for the respective six independent variables, and
ε = the random error.

The specification for equation (2) is based largely on the model estimated by Chui (1980).

Results

When all 10 years of monthly data were used, the simple regression model as specified in equation (1) indicated a significant relationship between price and landings (i.e., $b \neq 0$) only for the <15 and >67 size categories (Table 1). Since these results did not provide the needed price flexibility estimates, simple regression models were estimated for individual years between 1971 and 1980. As suggested by the hypothesis that ex-vessel prices are more strongly influenced by domestic landings in years of large landings, the estimated coefficients were significantly different than zero for the models of 1972, 1976, and 1977. For brevity, only the regression results for these 3 years are presented in Table 1 (second, third, and fourth columns). Individual results for all 10 yearly models are provided by Poffenberger (footnote 1).

For the multiple regression model as specified in equation (2), data for the end-of-the-month cold storage holdings (S) and imports (I) are available only by total pounds in storage or imported, i.e., data on the amount of cold storage holdings or imports by size of shrimp are not available. Prices for the eight separate size categories of shrimp are regressed on the same data series for storage and imports, as well as on the producer price index (PPI) and real per capita spending ($RPCS$). Thus, only the landings data are different for the eight regressions (Table 2). The dominance of the producer price index (PPI) for all eight size categories suggests that the increasing pattern of shrimp prices over time may not allow the actual market (price-landings) relationships to be estimated. A comparison of historic monthly prices and landings also indicates that prices have a definite increasing trend, whereas monthly landings exhibit large fluctuations but do not appear to have either an increasing or decreasing trend. As examples, monthly price and landings data for the 21-25 and 41-50 size categories are graphed in Figures 1 and 2.

In an attempt to adjust for the effects of increasing trends in prices, the monthly ex-vessel prices were deflated by the producer price index for meat, poultry, and fish, and a multiple regression model similar to equation (2), but without the producer price index variable (PPI), was estimated using these data (Table 3). Comparing the results of the unadjusted model (Table 2) with the adjusted model (Table 3) indicates only two slight differences. First, the summary statistics of the adjusted model are lower than the statistics for the unadjusted model. This is due to the removal of the increasing trend in the price data and the strong relationship it had with the increasing nature of the PPI. Second, the magnitudes of the price flexibility estimates (the coefficients of the landings variables (L)) are slightly greater for the adjusted model relative to the unadjusted model.

The specifications of the adjusted

Table 1.—Estimated coefficients for simple regression models by size of shrimp[1].

Size class	1971-80			1972			1976			1977		
	ln(a)	*b*	R^2	*ln(a)*	*b*	R^2	*ln(a)*	*b*	R^2	*ln(a)*	*b*	R^2
<15	4.57	−0.30* (4.2)	0.13	1.05	−0.03 (0.3)	0.01	2.08	−0.06 (0.8)	0.05	0.84	−0.06 (1.1)	0.11
15-20	2.24	−0.09 (1.5)	0.02	1.66	−0.08 (1.4)	0.16	1.94	−0.05 (0.8)	0.07	3.56	−0.18* (3.4)	0.54
21-25	1.64	−0.05 (1.1)	0.01	1.66	−0.09* (5.2)	0.74	2.59	−0.10* (3.8)	0.59	2.96	−0.14* (10.3)	0.91
26-30	1.46	−0.04 (1.1)	0.01	1.45	−0.08* (4.7)	0.69	2.61	−0.11* (6.2)	0.79	2.45	−0.11* (5.0)	0.72
31-40	1.39	−0.05 (1.4)	0.02	0.88	−0.05* (7.0)	0.83	2.44	−0.11* (6.5)	0.81	2.23	−0.10* (4.9)	0.70
41-50	1.03	−0.04 (1.6)	0.02	0.49	−0.04* (3.2)	0.51	1.52	−0.07* (3.4)	0.53	1.29	−0.06* (6.2)	0.79
51-67	0.76	−0.04 (1.6)	0.02	0.52	−0.06* (3.9)	0.60	1.16	−0.05* (3.9)	0.45	1.15	−0.06* (7.6)	0.85
>67	0.13	−0.03* (2.2)	0.04	−0.32	−0.03 (1.5)	0.19	0.41	−0.04* (5.0)	0.71	0.42	−0.04* (3.1)	0.49

[1]The regression equation for the four models is specified in equation (1). In the first model, monthly data from January 1971 through December 1980 (120 observations) are used. In the other three models, monthly data for the respective years are used (12 observations for each model). R^2 is the coefficient of determination, and the respective values of the *t*-ratio are presented in parentheses below each coefficient. It should be noted that the value of the *F*-ratio for a simple regression equation is equal to the *t*-ratio squared. All price and landings data are from the Southeast Fisheries Center, National Marine Fisheries Service, NOAA, Miami, FL 33149.

*Indicates that the coefficient is significantly different from zero at α = 0.05.

Table 2.—Estimated coefficients for the unadjusted multiple regression model by size of shrimp, 1971-1980[1].

Size class	*ln*(a) constant	Independent variables[2]						R^2	*F*-ratio	*D-W*
		L	*S*	*I*	*PPI*	*RPCS*	*OL*			
<15	−8.96	0.02 (0.4)	−0.03 (0.4)	0.28 (2.9)	1.34 (14.6)	0.53 (2.0)	−0.05 (2.2)	0.787	69.6	0.26
15-20	−7.58	−0.03 (0.6)	−0.13 (1.5)	0.33 (3.5)	1.28 (14.7)	0.57 (2.2)	−0.06 (2.3)	0.802	76.4	0.35
21-25	−7.17	−0.10 (4.8)	−0.15 (1.9)	0.30 (3.5)	1.34 (16.5)	0.48 (2.1)	—	0.826	108.3	0.43
26-30	−8.00	−0.04 (1.2)	−0.12 (1.5)	0.30 (3.3)	1.46 (17.2)	0.44 (1.7)	−0.06 (1.5)	0.843	100.9	0.43
31-40	−5.56	0.06 (1.4)	−0.39 (4.8)	0.18 (2.4)	1.34 (15.1)	1.17 (4.3)	−0.14 (4.9)	0.881	139.3	0.52
41-50	−5.53	−0.09 (5.9)	−0.37 (4.5)	0.11 (1.4)	1.54 (16.3)	0.77 (2.6)	—	0.870	152.5	0.37
51-67	−4.87	−0.11 (3.7)	−0.39 (4.3)	0.11 (1.3)	1.50 (15.6)	0.65 (2.2)	0.02 (0.8)	0.858	114.0	0.52
>67	−11.22	−0.5 (4.3)	0.01 (0.1)	0.00 (0.0)	1.76 (11.8)	0.91 (1.9)	—	0.749	67.9	1.06

[1]The regression equation for this model is specified in equation (2). The dependent variables are ex-vessel brown shrimp prices for the respective size classes, January 1971-December 1980 (120 observations). These price data are in current dollars and are not adjusted by any price index. The summary statistics are: R^2 = the coefficient of determination and respective values of the *t*-ratio are presented in parentheses below each coefficient; *F*-ratio and *D-W* = the Durbin-Watson statistic which measures the presence of first-order serial correlation.

[2]Independent variables are as follows:

L = landings for each of the eight marketing categories;
S = end-of-month cold storage holdings as reported by the National Marine Fisheries Service, Washington, D.C.,
I = imports of fresh and frozen shrimp reported by the National Marine Fisheries Service, Washington, D.C.,
PPI = producer price index (U.S. Bureau of Economic Analysis, 1972-1981);
RPCS = per capita expenditure at eating and drinking establishments (U.S. Bureau of the Census, 1981) adjusted by a subcomponent of the consumer price index; and
OL = landings of the following sizes of shrimp—for the <15 to 26-30 categories, the 21-25 landings were used as the *OL* variables; for the 31-40 to 51-67 categories, the 41-50 landings were used.

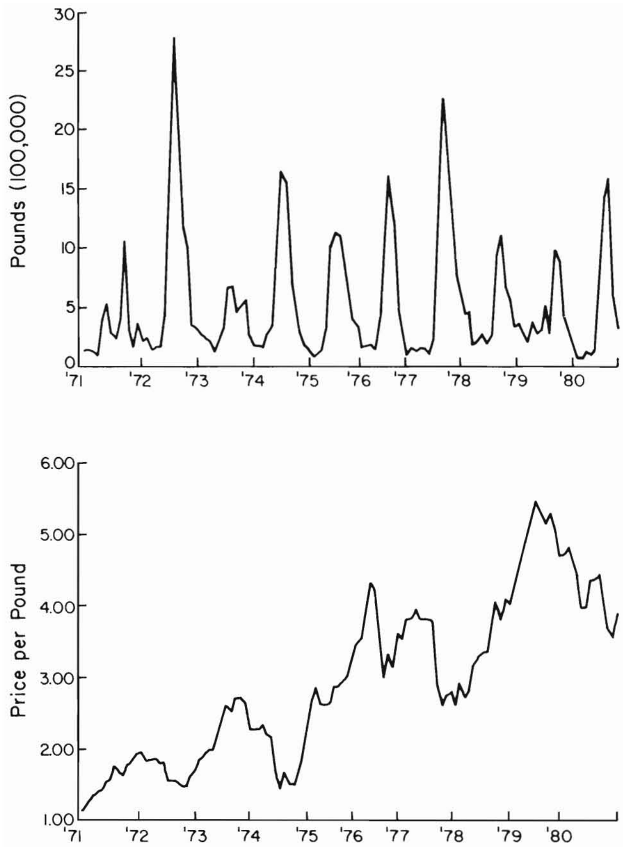

Figure 1.—Reported monthly landings (pounds) and ex-vessel prices of brown shrimp in the 21-25 size category landed at Texas and Louisiana ports, 1971-1980.

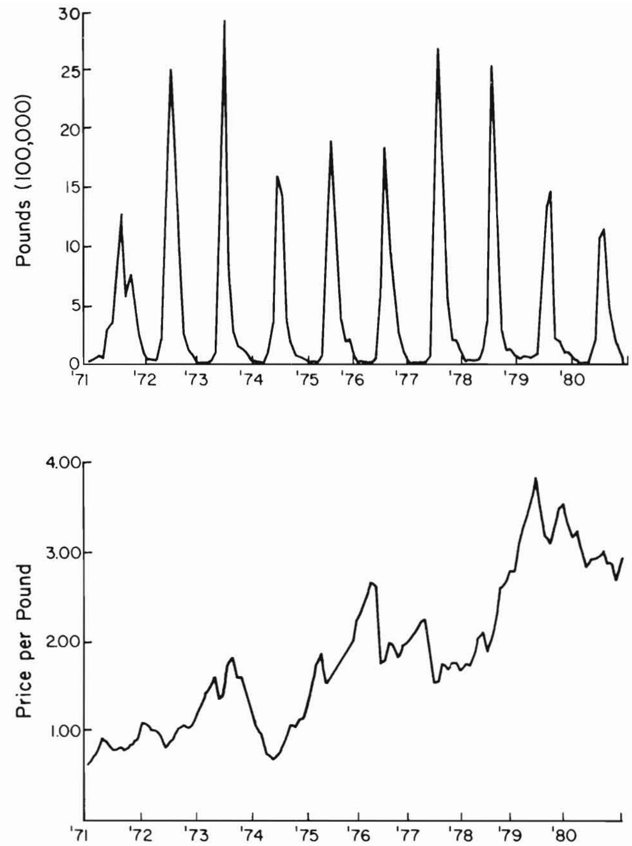

Figure 2.—Reported monthly landings (pounds) and ex-vessel prices of brown shrimp in the 41-50 size category landed at Texas and Louisiana ports, 1971-1980.

model also allow the hypothesis concerning the relationship between price and landings in good vs. average years to be tested. The 10 years of data were divided into two groups: Good years and average years. The data set for the good years contained the 36 observations of 1972, 1976, and 1977; whereas the data set for the 7 average years contained the remaining 84 observations. The estimated coefficients for the landings variable and their estimated standard errors were used to construct confidence intervals (at α = 0.05) around the estimated coefficients. For all eight size categories, the confidence intervals for the good and average years have substantial overlap, indicating that the hypothesis should be rejected and therefore a difference between good and average years does not exist.

Discussion

Indirect evidence from the multiple regression models suggests the nature of the relationship between ex-vessel prices, size of shrimp, landings, storage, and imports (Tables 2, 3). The relationships between prices and landings for the two largest size categories are not statistically different than zero; however, the relationships between prices of these two categories and imports (I) are significant. The statistical relationship between prices and imports remains significantly different than zero for the size categories of <15 through 31-40 (i.e., large shrimp). These relationships suggest that predominately large shrimp comprise foreign imports into the United States. It is interesting to note that the signs of the estimated coefficients for imports (I) are positive, therefore suggesting that the amount of shrimp being imported reacts to ex-vessel prices rather than to prices being influenced by the amount of imports[3].

[3] Although the t-statistic for the import parameter is significant (α = 0.05), two reasons strongly suggest that further research is required before a conclusion on the cause and effect between imports and ex-vessel prices can be accepted. First, the serial correlation present in these models may be causing the inappropriate significance of the import parameter. Second, these models may be misspecified as a single equation and a simultaneous model may be necessary to completely account for the interaction between imports and ex-vessel prices.

The other important variable, cold storage holdings (S), also provides an interesting interpretation. The estimated coefficient for this variable is significantly different than zero only for the 31-40, 41-50, and 51-67 size categories. Unfortunately, the aggregation of cold storage holdings data by total weight does not permit a more detailed analysis; however, the regression results do suggest that the very large and very small shrimp go directly to other processing and, for the most part, do not enter cold storage inventories. A final observation from the multiple regression models is that landings in the 21-25 and 41-50 size categories strongly influence the movement in prices of other sizes of shrimp.

The regression models estimated for this analysis have one major flaw—the presence of serial correlation in the residuals. The values of the Durbin-Watson statistic (D-W) are quite low and are not in the critical range for this statistic (Tables 2, 3). Furthermore, plots of the standardized residuals indicate that the residuals are highly correlated. The statistical consequence of serial correlation is the presence of a bias in the estimation of the variance of the stochastic disturbance term. Thus, while the estimated coefficients (least-squares estimators) are still consistent and unbiased, they no longer have a minimum variance, which means that the t-tests and F-tests are, in general, invalid. This problem raises some question regarding the validity of the statistical relationship between price and landings, but not necessarily the magnitude of the estimated coefficients.

Notwithstanding this problem, the estimated price flexibilities of landings for the eight size categories of shrimp are shown in Table 4. Asterisks indicate that the t-ratios for the respective coefficients are greater than the critical values for the t-distribution at an α = 0.05. The most important result of this comparison is the similarity in magnitude of the estimated price flexibilities irrespective of the model specification. Because absolute differences do exist in these estimates, however, the changes in prices calculated from the

Table 3.—Estimated coefficients for the adjusted multiple regression model by size of shrimp, 1971-1980[1].

Size class	$ln(a)$ constant	Independent variables[2]					R^2	F-ratio	D-W
		L	S	I	$RPCS$	OL			
< 15	−7.95	−0.02	−0.05	0.32	0.91	−0.05	0.260	8.0	0.31
		(0.5)	(0.6)	(3.3)	(3.5)	(2.0)			
15-20	−7.46	−0.00	−0.14	0.35	1.00	−0.08	0.348	12.2	0.40
		(0.1)	(1.5)	(3.6)	(4.3)	(2.6)			
21-25	−6.87	−0.10	−0.16	0.35	0.94	—	0.375	17.3	0.48
		(4.7)	(1.8)	(3.8)	(4.5)				
26-30	−7.30	−0.10	−0.15	0.32	1.19	−0.02	0.386	14.3	0.51
		(2.6)	(1.6)	(3.2)	(5.0)	(0.4)			
31-40	−4.96	0.08	−0.45	0.21	1.86	−0.19	0.600	34.2	0.73
		(2.3)	(5.4)	(2.7)	(8.5)	(6.7)			
41-50	−4.63	−0.13	−0.43	0.17	1.87	—	0.520	31.2	0.54
		(8.9)	(4.7)	(1.9)	(7.3)				
51-67	−3.91	−0.12	−0.47	0.16	1.68	0.00	0.489	21.8	0.62
		(4.0)	(4.7)	(1.7)	(6.6)	(0.1)			
> 67	−8.97	−0.07	−0.14	0.00	2.41	—	0.344	15.1	0.89
		(6.7)	(0.9)	(0.0)	(6.0)				

[1]The regression equation for this model is specified in equation (2). The dependent variables are ex-vessel brown shrimp prices for the respective size classes, January 1971-December 1980 (120 observations). These price data are adjusted for general price increases by dividing the monthly price per pound by the monthly producer price index for meat, poultry, and fish (U.S. Bureau of Economic Analysis, 1972-1981). Summary statistics are the same as those described for Table 2, and the respective values of the t-ratios are presented in parentheses below each coefficient.

[2]Independent variables are as follows:

L = landings for each of the eight marketing categories;

S = end-of-month cold storage holdings as reported by the National Marine Fisheries Service, Washington, D.C.,

I = imports of fresh and frozen shrimp reported by the National Marine Fisheries Service, Washington, D.C.,

$RPCS$ = per capita expenditure at eating and drinking establishments (U.S. Bureau of Census, 1981) adjusted by a subcomponent of the consumer price index; and

OL = landings of the following sizes of shrimp—for the < 15-20 categories, the 21-25 landings were used as the OL variables; for the 31-40 through 51-67 categories, the 41-50 landings were used.

price flexibilities would also be different depending on the model.

The remaining task is to use the price flexibility estimates to calculate the estimated effects on ex-vessel prices and then determine the change in gross revenue to the fishery. Both the reported and simulated (Nichols, 1982) landings for May through August 1981 are presented in Table 5, along with the reported brown shrimp prices. These data are combined with the price flexibility estimates presented in Table 4 to calculate the estimated prices during this 4-month period had the offshore area been open to fishing. The gross revenue (based on reported ex-vessel prices and landings) of the brown shrimp fishery for May through August 1981 was about $119 million. Had the Texas closure regulation not been in effect, the fishermen would have received slightly higher prices for the shrimp, but would have caught about 11.7 million pounds fewer shrimp (Nichols, 1982). The estimated gross revenue that the fishery would have received without the regulation is $97.6 million if the adjusted model is used or $97.4 million if the unadjusted model is used. Therefore, the difference or

Table 4.—Comparison of price flexibility estimates.

Size class	Single regression models		Unadjusted[2] model	Adjusted[2] model
	1971-80	Average[1]		
<15	−0.30*	N.S.	0.02	−0.02
15-20	−0.09	−0.18*	−0.03	−0.00
21-25	−0.05	−0.11*	−0.10*	−0.10*
26-30	−0.04	−0.10*	−0.04	−0.10*
31-40	−0.05	−0.09*	0.06	0.08*
41-50	−0.04	−0.06*	−0.09*	−0.13*
51-67	−0.04	−0.06*	−0.11*	−0.12*
>67	−0.03*	−0.04*	−0.05*	−0.07*

[1]Values in this column are the simple averages of the estimated coefficients from Table 1 that have a t-ratio greater than the critical value at α = 0.05.

[2]The unadjusted model includes price data in current dollars, whereas price data in the adjusted model are deflated by the producer price index for meat, poultry, and fish.

*Indicates t-ratios of these coefficients are greater than the critical value of a t-distribution for α = 0.05.

N.S. means none of the estimated coefficients were significantly greater than zero (α = 0.05).

Table 5.—Preliminary reported landings (in pounds), ex-vessel prices ($), and simulated landed catch (pounds) by size class for brown shrimp in the northwestern Gulf of Mexico, May-August 1981.

Item and month	Size class							
	< 15	15-20	21-25	26-30	31-40	41-50	51-67	>67
Landings[1]								
May	25,056	73,288	92,129	114,578	386,271	453,449	710,077	3,970,281
June	29,497	92,251	226,653	381,219	1,163,097	1,528,908	2,889,330	3,694,365
July	74,593	358,740	1,286,830	1,775,641	4,623,821	3,989,621	4,898,646	2,030,981
August	134,751	1,017,503	2,108,325	1,845,797	4,968,539	3,254,896	3,557,107	995,092
Prices[1]								
May	5.58	5.46	5.17	4.35	3.38	3.05	2.66	0.77
June	5.74	5.34	4.95	3.85	2.80	2.41	1.99	1.03
July	5.63	5.12	4.16	3.11	2.41	2.15	2.01	1.32
August	5.43	4 42	3.33	2.76	2.36	2.17	2.04	1.38
Simulated catch[2]								
May	74,636	155,560	175,196	188,282	380,915	332,831	467,315	2,288,193
June	34,609	121,709	242,777	531,426	1,113,768	1,416,483	2,457,639	2,492,539
July	28,427	182,832	699,639	1,181,032	3,392,978	3,210,926	4,047,937	1,644,817
August	72,445	810,562	1,597,439	1,589,093	4,288,949	2,650,516	2,549,840	720,592

[1]These NMFS data represent landed catch and ex-vessel prices reported at ports in Texas and Louisiana.
[2]Estimated by Nichols (1982) by a simulation cohort analysis model.

net benefit to the brown shrimp fishery resulting from the regulation is estimated to be $21.5 million.

Summary and Conclusion

In this paper, I have estimated the effects of the Texas closure regulation on shrimp prices and the concomitant effects on ex-vessel value of the Gulf of Mexico brown shrimp fishery. My methodology, described in the Data and Methodology section, was to estimate brown shrimp landings and prices under the assumption that the offshore area along the Texas coast was open to shrimp fishing as it has been historically. These estimates are compared with the actual reported landings and prices, and the difference represents a reasonable estimate of the closure regulation's effect on the gross revenue to shrimp producers. The use of brown shrimp landings caught in offshore areas limits the estimates of this analysis to the direct effects on this specific fishery. The analysis neither accounts for any impacts on the inshore fisheries in Texas and Louisiana nor does it account for any spillover effects on white or pink shrimp prices.

The Results section provided a detailed explanation of the two analytical approaches that were considered. In both approaches, the purpose was to estimate the statistical relationships between price and landings, with the influence of other factors being held constant. The hypothesis underlying the simple regression model, that assumed that ex-vessel prices were affected differently in good vs. average years of shrimp production, was rejected, and only the estimated price flexibilities from the adjusted and unadjusted multiple regression models were considered. Furthermore, when the estimated price flexibilities from the separate models are compared, the magnitudes of the empirical estimates are very close (Table 4) and the resulting estimates of ex-vessel value are essentially the same for either model. Therefore, the direct effect of the Texas closure regulation on the brown shrimp fishery during May through August 1981 was to increase the gross revenue of that fishery by about $21.5 million or slightly more than 18 percent of its reported ex-vessel value.

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