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Regional Shrimp Market Responses to Domestic Landings and Imports

by

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Abstract

U.S. shrimp landings are divided into four geographic regional markets and may be further subdivided into species and size characteristics. Seemingly unrelated regressions were used to analyze regional price responses of variable annual landings of shrimp. The contemporaneous correlation of competing market supplies and demands accounted for an improvement in forecasting reliability in each area and for species and size relationships. Imports were shown to affect regional markets unevenly, having a significantly higher impact on South Atlantic shrimp prices than on Gulf of Mexico, West Coast, or New England markets. Real disposable personal income affected West Coast and South Atlantic prices much more dramatically than those of Gulf Coast markets. The composition of the catch by size and species in each season introduced variable responses by regional market. Also, South Atlantic appeared least price-sensitive to its own catch.

Introduction

U.S. shrimp landings originate from four reasonably distinct geographic market areas and, if further subdivided by product characteristics important to distribution and resale, may be classified by species and size. As some 70 to 80 percent of the U.S. shrimp supply is consumed away from home (Hu; Thompson, Roberts, and Pawlyk), price responses for shrimp at the first exchange level (ex-vessel) more readily affect the direct distribution to restaurants and other institutions than if a larger proportion were distributed through retail outlets. Regional price responses to variable annual landings of shrimp exhibit contemporaneous linkages in market supply and demand relationships.

Imports of shrimp and shrimp products may also affect regional markets differently, since the composition and variation of regional landings differ considerably by species and size characteristics in the four regions--the Gulf of Mexico, South Atlantic, West Coast, and New England (see Table 1, for example). The United States currently imports approxi-

**Table 1. Composition of Gulf Coast and South Atlantic Shrimp Landings
By Species and Size, 1958-1984**

Species Size	Gulf Coast				South Atlantic			
	Percentage of Species Landed		Percentage of Total Regional Landings		Percentage of Species Landed		Percentage of Total Regional Landings	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
----- percent -----								
<i>Browns</i>								
Small	38.7	17.5	21.8	9.8	15.9	11.5	5.7	4.1
Medium	29.4	8.2	16.6	4.6	56.3	18.1	20.1	6.5
Large	31.9	7.6	18.0	4.3	27.8	13.7	10.0	4.9
Total Browns	100.0		56.4		100.0		35.8	
<i>Whites</i>								
Small	38.9	14.5	11.3	4.2	16.7	11.1	9.6	6.4
Medium	26.0	8.1	7.6	2.4	41.9	17.2	24.2	9.9
Large	35.1	9.3	10.2	2.7	41.5	11.3	23.9	6.5
Total Whites	100.0		29.1		100.1		57.7	
<i>Pinks</i>								
Small	28.7	8.4	4.1	1.2	47.7	33.9	3.1	2.2
Medium	38.7	14.4	5.5	2.1	43.7	25.0	2.9	1.6
Large	32.5	12.9	4.7	1.9	8.6	9.1	0.6	0.6
Total Pinks	99.9		14.3		100.0		6.6	

Note: Totals may not sum to 100 due to rounding.

SD = standard deviation as a percentage of landings.

mately 70 percent of the shrimp consumed domestically, and the greatest proportion of these imports are of medium to larger sizes of *penaeus* shrimp (Prochaska and Keithly). Of the domestic landings, approximately 80 percent of the catch is from Gulf waters, with some 8 percent from the South Atlantic, 9 to 10 percent from the West Coast, and the remainder from New England fisheries.

The development of useful market information, as suggested by several researchers, can be accomplished through regional price analysis (Doll; Caillouet, Koi, and Jackson; Chui; Capps; Poffenberger). This work differs from those cited above in that the interactions of landings and prices among regions are considered in order to determine whether one large market significantly affects gains or losses from changes in industry landings in other regions. The objectives of this paper are to analyze regional shrimp market relationships, to evaluate Gulf Coast and South Atlantic price behavior as related to shrimp species and size characteristics, and to estimate the potential impacts on the distribution of fresh shrimp.

Theoretical Considerations

Regional conditions regarding shrimp populations and their biological cycles differ, but market-clearing price determination influences are similar. Thus, regional price responses are analyzed as a system, generally including factors that contribute to the demand of any product, i.e. own price, prices of substitute and complementary goods, and, as shown by Liao, income and socio-economic and demographic characteristics. Because shrimp are highly perishable and the taste qualities of most varieties are adversely affected by current preservation and/or storage processes, supplies on an annual basis are considered to be (nearly) fixed. This implies that a price-dependent function is more appropriate than a quantity-dependent function in modelling shrimp demand. Prices used in this study are annual averages and are represented as a continuous function of reduced form excess demand:

$$P = f(D - S) = f(E) \quad (1)$$

where D is quantity of shrimp demanded from a certain region (may be further disaggregated by species and size), S is annual supply of shrimp, E is excess demand (D - S), and P is price. In the shrimp market, by assuming overall equilibrium and transforming prices and income using the Consumer Price Index (CPI), it follows that:

$$\text{Deflated Price} = f(\text{Quantities of Landings, Quantity of Net Imports, Quantity of Stocks, Deflated Total Disposable Income}) \quad (2)$$

The competitive position of shrimp is developed within the framework of separate but interacting markets. Although the major domestic source of large species of shrimp is the Gulf, large volumes of shrimp are shipped to the more urban areas of the middle and northeastern Atlantic. All shrimp prices decrease when a relative excess supply in one region increases, but the downward effect of this excess supply, when shipped to other regions, cannot exceed that of its own regional price.

Data and Empirical Procedure

Three species of shrimp were studied in the Gulf and South Atlantic: brown (*Penaeus aztecus*), white (*Penaeus setiferus*), and pink (*Penaeus duorarum*). Northern pink or bay shrimp (*Pandalus borealis*) were the predominant species in the New England and West Coast regions, with Ocean pink (*Pandalus jordani*) also important in the West Coast fishery. Data on Gulf Coast and South Atlantic prices and landings from 1958 to 1984 were obtained from the National Marine Fisheries Service (NMFS), Washington, D.C., and from regional NMFS offices in Miami and North Carolina, respectively. The Long Island, California, NMFS furnished data for the West Coast, while data for New England and imports were from summaries of landings in *Basic Economic Indicators, Shrimp 1972* and *Fishery Statistics*. Total disposable personal incomes by region and nationally were obtained from annual issues of *Survey of Current Business*. Average ex-vessel prices and disposable incomes were adjusted to 1984 constant dollars.

In specifying the variables and functional relationships in the regional analyses, emphasis is placed on the importance of the harvest of shrimp in a single region relative to harvests from other regions. The four regions are analyzed as a system, specified:

$$P_i = f(Q_i, Q_j, NI, DPI_i) \quad (3)$$

where i is own region and j is U.S. landings outside region j . The relative effect of one region's supply on another region's prices is referred to as a cross-price flexibility coefficient, and captures the importance of landed quantities of all other regions on a particular region's price. Total disposable personal income, DPI_i , was specific to the region. Quantities of year-end stocks of fresh shrimp were minimal in relation to landings and net imports (NI), and, under the perishability assumptions stated earlier, stocks were excluded from regional models. Previous works have found no significant influence from non-shrimp products, neither substitutes nor complements (Thompson et al.).

Consideration of sizes and species of shrimp was based on the assumption that differences in growth cycles and appearance in their respective markets will affect price structures. If in fact there are differentiated markets for the three species considered, then price interactions would still be significant. Chui concluded that there indeed are separate markets for the different sizes of shrimp and that resources should be allocated to markets where profit would be maximized.

Landings and prices of different species in each region were used to analyze ex-vessel cross-price flexibilities of the different species and sizes. The three species--pink, white and brown--were divided into three size groups--large, medium and small. As in Chui, the large shrimp category was composed of sizes with fewer than 30 tails per pound (raw, headless), medium with 30 to 50 tails per pound, and small with more than 50 tails per pound. The regional models examined were specified:

$$P_{jk} = f(Q_{ijk}, QREST_j, NI, DPI_j) \quad (4)$$

where P_{jk} is average deflated ex-vessel price of 1000 pounds shrimp for each region j for species k , Q_{ijk} is quantity of total landings in 1000 pounds for each size i in each region j for each species k , $QREST_j$ is quantity of U.S. total landings in 1000 pounds other than in each region j , NI is quantity of net imports in 1000 pounds, and DPI_j is deflated total disposable personal income in billion dollars for each region j .

Estimating a number of relative price functions is likely to reflect some common unmeasurable or omitted factors, such as government policies, technology, and tastes. Thus, we would expect the regional prices to exhibit some correlation. Equations assumed to exhibit contemporaneous correlation are estimated as a system using seemingly unrelated regressions (SUR). SUR estimation is hypothesized to be superior to ordinary least squares because it allows for the correlation between the error vectors of each of the system equations and it uses information on explanatory variables that are included in the system but excluded from any one equation (Judge et al., pp. 245-51).

Results and Implications

Regional Prices of Shrimp

Regional price flexibility coefficients are summarized in Table 2. Flexibility coefficients, the percentage changes in price for a one percent change in quantity or income, were calculated from the price response parameter estimates at mean values of the variables. South Atlantic (SA) regional dependence on other sources of shrimp appeared to decrease the effect of its own landings on price. The quantity of U.S. landings outside SA was likewise not statistically significant in regional price determination. Imports, however, had a significant effect on SA prices, and a decrease of 5.7 percent in the average price per 1000 pounds could be expected for every 10 percent increase in net imports. Reduction of imports would be favorable to SA fisheries in the short run but would raise prices to other sectors of the industry and to regional consumers.

**Table 2. Estimated Regional Ex-Vessel Shrimp Price Flexibility Coefficients,^a
1958-1984**

Variable	South Atlantic	Gulf Coast	New England	West Coast
<i>Quantity Own Region</i>				
South Atlantic	-0.103			
Gulf Coast		-0.365***		
New England			-0.012	
West Coast				-0.405***
<i>Quantity Other U.S. Regions</i>				
South Atlantic	-0.122			
Gulf Coast		0.087**		
New England			0.008	
West Coast				-0.424*
Net Imports	-0.571***	-0.178	0.562	-0.204
Real Disposable Personal Income	1.196***	0.800***	-1.538	2.392***

^a Price flexibility coefficients, $\frac{\alpha_P Q}{\alpha_Q P}$ and $\frac{\alpha_P Y}{\alpha_Y P}$, calculated from SUR estimated parameters at mean values.

* Estimated coefficient was significant at the 0.10 level or better.

** Estimated coefficient was significant at the 0.05 level or better.

*** Estimated coefficient was significant at the 0.01 level or better.

In contrast to SA results, total Gulf Coast landings had a significant effect on the price of Gulf shrimp--an estimated 3.6 percent decrease in price would be observed when landings increased by 10 percent. Variation due to quantity of U.S. landings outside the Gulf was again significant but positive, the effect of the species and size composition of mostly smaller shrimp, less desirable for the dining-out trade.

Landings in other U.S. areas were not a significant influence on ex-vessel shrimp prices in the New England (NE) region. Domestic shrimp available outside of NE are not a close substitute for Bay shrimp. The whites, browns, pinks in the major domestic shrimp-producing regions and most imports are superior species, preferred for fresh consumption. This is further demonstrated by the disposable personal income effect, which was negative (but significant only at the 0.15 level), or inferior compared to species of other regions. The relatively small-sized NE shrimp are mostly processed. The effect of U.S. net imports was not significant and not competitive with NE shrimp.

The West Coast market was more responsive to changes in own supply than were other regions, having the highest absolute price flexibility estimate, -0.41. The quantity of the rest of the U.S. catch also affected the WC average value significantly, a 4.2 percent decrease estimated when quantities from other regions increased 10 percent. Net imports did not significantly influence prices in West Coast fisheries; regional markets were supplied mostly by domestic sources or did not compete directly with imported species. Regional personal disposable income was significant and had the highest estimated flexibility coefficient, 2.4.

Regional Prices by Species and Size

Price flexibility estimates for the Gulf Coast and South Atlantic areas are summarized in Table 3. The price of Gulf brown shrimp was not significantly affected by own landings, nor by other species landed within the region. Only landings of shrimp from other U.S. regions and from net imports significantly

affected prices of Gulf browns. The average price of whites was significantly affected by all sizes of own and other species' landings, but not by imports. The price flexibilities for whites with respect to small and medium sizes of browns are statistically significant, but the positive sign would suggest that an additional 10 percent of small browns adds 0.1 percent to the average price per pound of whites, a proportional composition effect on changing total values. Prices of whites would decrease by 0.38 percent when the quantity of medium browns increased by one percent.

Landed prices of pink Gulf shrimp were affected significantly by own landings of large sizes, but decreased by only 0.25 percent when landings increased by one percent. They were also influenced significantly by all sizes of whites and by small and medium sizes of browns. Note that landings of small browns have the same significant positive effect on pink shrimp average prices as they did on whites. The market for brown shrimp appeared to be a good indicator of expected prices for whites and pinks. Increases in shrimp landings in other regions increased average Gulf ex-vessel prices. This could be explained by the composition of landings effect--Gulf landings are of larger shrimp, more desirable for the fresh, away-from-home entree markets, whereas other regions have greater proportions of smaller species, more suitable for processed and/or complementary dishes such as soups or salads. Gulf shrimp compete mainly with pond-raised shrimp imports. Net imports had a significant negative effect only on the price of brown Gulf shrimp, which make up 54 percent of Gulf landings. Brown shrimp prices decrease 6.3 percent when imports are increased by 10 percent. Disposable personal income had a significant positive effect only on whites.

Price response flexibilities of brown, white, and pink shrimp in the South Atlantic were affected by the magnitude of their own catch but not by the quantity of other U.S. landings (Table 3). As in the regional system, net imports significantly affected the prices of browns and pinks, and personal disposable income flexibilities were strongly significant and positive--prices increasing by 1.28 to 1.37

**Table 3. Gulf Coast and South Atlantic Ex-Vessel Shrimp Price Flexibility Coefficients
By Species,^a 1958-1984**

Species Size	<u>Price of Brown</u>		<u>Price of White</u>		<u>Price of Pink</u>	
	Gulf Coast	South Atlantic	Gulf Coast	South Atlantic	Gulf Coast	South Atlantic
<i>Quantity - Brown</i>						
Small	0.41		0.01**		0.39*	
Medium	-0.97	-0.13***	-0.38***		-0.37**	-0.10**
Large		0.07		-0.05***		
<i>Quantity - White</i>						
Small			-0.55***		-0.38**	
Medium	-0.28	0.05*	0.22*	0.03	0.30**	
Large	-0.57		-0.36**	0.06**	-0.46**	-0.10*
<i>Quantity - Pink</i>						
Small	-0.25		0.01		-0.04	
Medium	0.40				0.08	
Large	-0.07	0.01	-0.26*	0.02	-0.25*	0.03
Quantity - Other U.S. Regions	0.23*	-0.28	0.15**	-0.31	0.17**	-0.20
Net Imports	-0.63*	-0.48**	-0.16	-0.36	-0.03	-0.41**
Real Disposable Personal Income (Region)	1.22	1.37***	0.57**	1.28***	0.28	1.28***

^a Calculated from estimated parameters at mean values of the variables.

* Estimated coefficient was significant at the 0.10 level or better.

** Estimated coefficient was significant at the 0.05 level or better.

*** Estimated coefficient was significant at the 0.01 level or better.

percent for every one percent increase in regional income.

Conclusions

Variable U.S. shrimp landings have resulted in uncertain regional ex-vessel, or first-handler, prices. However, the impacts of imports on annual average regional dockside prices were shown to be significant only in the South Atlantic region, where consumption of shrimp was high relative to regional landings. South Atlantic supply variation and increases in regional population and income in the 1958 to 1984 period are consistent with this significance of imports to the region. In contrast, Gulf Coast dockside shrimp prices reflected the relative local abundance by size of each species, or the composition effect of shrimp landings. Brown shrimp landings appeared to offer a better basis as a forecasting indicator of seasonal average prices of pink and white shrimp species in the Gulf Coast region than for own price effects.

Regional excess demand for shrimp was also found to be strongly influenced by real regional disposable income, especially in the South Atlantic and West Coast regions. These two regions have the highest per capita consumption of shrimp among the four regions studied. Price income flexibility coefficients of 1.2 and 2.4, respectively, indicate potential expansion in demand for shrimp, especially *Penaeus aztecus* or brown shrimp, as population and income are expected to continue to grow rapidly in these two regions. The trend to increased consumption outside-the-home will reinforce this expected demand, particularly for fish and seafood entrees such as shrimp. Most of this increased demand would appear likely to be met by greater imports of shrimp unless domestic suppliers were to develop pond-raising facilities to supplement the presently limited sustainable off-shore landings.

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