# The Demand for Eastern Oysters, *Crassostrea virginica*, from the Gulf of Mexico in the Presence of *Vibrio vulnificus*

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## Introduction

The bacteria *Vibrio vulnificus* is a naturally occurring organism in estuarine waters and is found in an unknown proportion of eastern oysters, *Crassostrea virginica*, harvested from the Gulf of Mexico (hereafter, the Gulf). The presence of *Vibrio vulnificus* is highly correlated with water temperature, and virtually all Gulf-harvested oysters contain some concentration of it in the warmer summer months (McQuaid, 1997). As noted by Corcoran (1998) in the Nutrition Action Healthletter: "[e]very year, more than 50 people become ill and at least 10 die after eating uncooked Gulf Coast oysters that are contaminated with *Vibrio vulnificus* bacteria." Most of these illnesses and deaths occur between May and October.

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*ABSTRACT—California, in response to health concerns, initiated a program on 1 March 1991 which required anyone selling eastern oysters,* Crassostrea virginica*, from the Gulf of Mexico area to notify potential consumers that there was a risk in consuming them raw. This mandatory warning, followed shortly thereafter by a similar warning in other states, including Louisiana and Florida, received extensive press coverage throughout the country and particularly in the Gulf area. This paper examines the extent to which the demand for Gulf-area oysters has been reduced as a result of mandatory warning labels and negative publicity. In general, the results suggest that since 1991 the "summer" dockside price has been reduced by about 50% as a result of warning labels and associated negative publicity, while the "winter" dockside price has been reduced by about 30%.*

California, in response to this health concern, initiated a program on 1 March 1991 which required anyone selling Gulf oysters to notify potential consumers that the "consumption of raw oysters can cause illness and death among people with liver disease, chronic illnesses, or weakened immune systems" (Liddle, 1991). California's mandatory warning received extensive coverage in newspapers (and the trade literature) both there and across the country and particularly in the Gulf region.[1]

In a further step to promote public safety, the U.S. Food and Drug Administration (FDA) in 1994 proposed banning consumption of raw oysters from the Gulf from April through October when *Vibrio vulnificus* was most prevalent. After "heavy pressure from the Gulf oyster industry and members of Congress from Louisiana and other Gulf states," the FDA backed away from its initial proposal and instead opted for a "public awareness campaign" to notify and educate those people at risk (McQuaid, 1997).

The primary goal of this paper is to examine the extent to which the demand for Gulf oysters has been reduced as a result of the mandatory warning labels and associated media attention and to examine the impact on consumer welfare associated with further regulation of the harvesting sector. A secondary goal of the paper is to analyze the impacts of other factors, such as the quantity harvested and income, on the demand for Gulf oysters. To accomplish these goals, an overview of the oyster industry is presented here, followed by a review of relevant literature. Then, the model used for the analysis is specified, and the data and estimation issues are briefly examined. The empirical results are then presented, and the paper concludes with a discussion of the implications of the findings.

## Industry Overview

The U.S. oyster industry operates on both the U.S. east and west coasts. The primary oyster species harvested on the east coast (i.e. Atlantic and Gulf), the eastern oyster, produced average annual landings of about 31 million pounds during 1981–97 with an associated $77 million dockside value (NMFS[2]). Annual landings of Pacific oysters, *Crassostrea gigas*, the primary west coast species, averaged about 9 million pounds valued at $18 million (dockside) during 1981–97.

Gulf oyster production averaged 20 million pounds annually during 1981–97, or about 60% of the total eastern oyster production. Louisiana, the primary producer there, accounted for almost 60% of the Gulf output, while Texas accounted for an additional 20%.

Chesapeake Bay, once the nation's largest oyster source, has seen production fall sharply since the early 1980's

[1] Subsequently, other states—most notably Louisiana and Florida—have enacted mandatory warning label programs similar to that of California.

[2] NMFS Commercial Fisheries Landings data compiled by the Fisheries Statistics and Economics Division, Office of Science and Technology available at http://www.st.nmfs.gov/commercial.

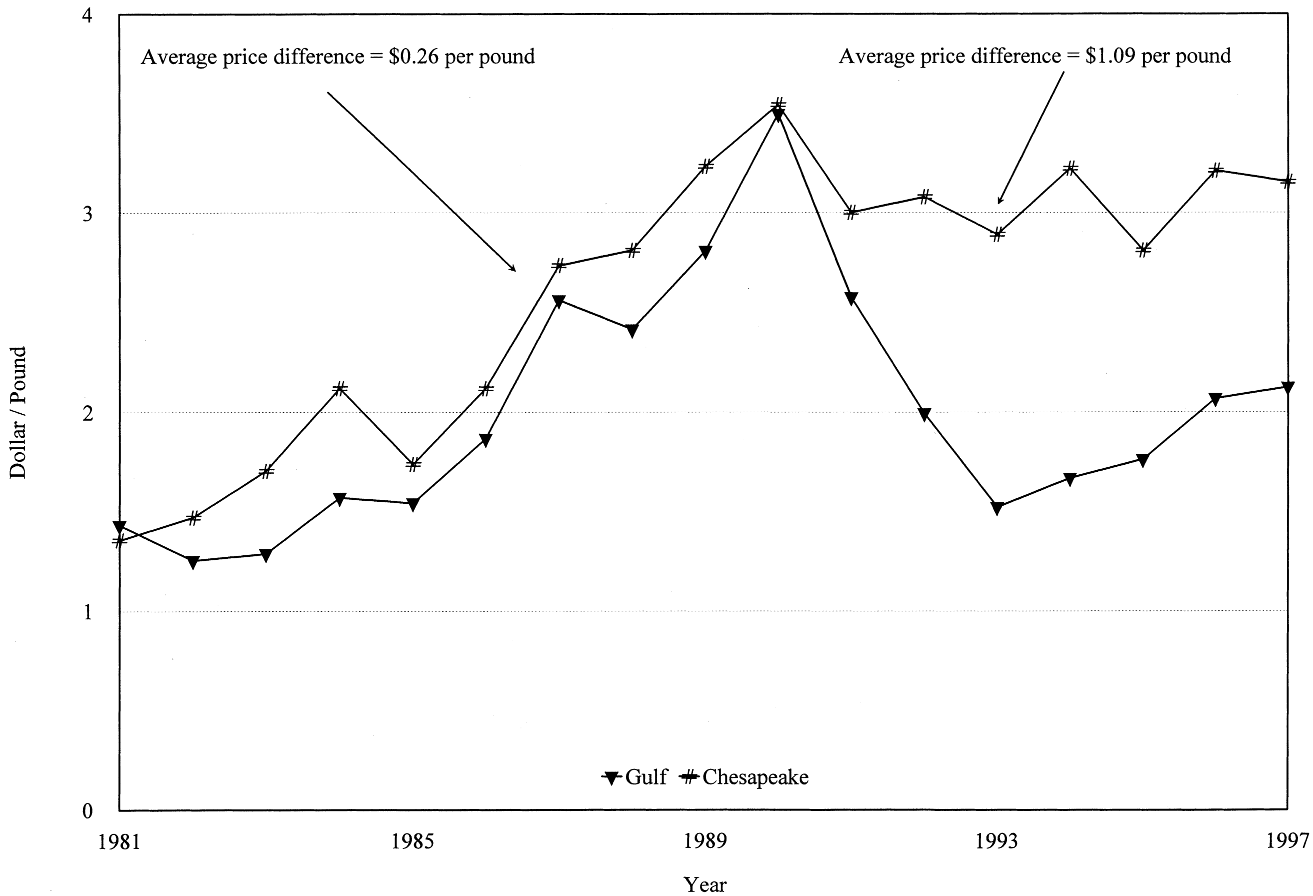


Figure 1.—Annual dockside oyster prices (current) in the Gulf and Chesapeake regions, 1981–97 (NMFS text footnote 2).

due to habitat degradation, overfishing, and disease (Rothschild et al., 1994). Then averaging close to 17 million pounds annually, the Chesapeake's output fell more than 90% to about 1.5 million pounds annually during 1995–97 (NMFS[2]).

Prior to 1991, annual dockside Gulf and Chesapeake oyster prices tended to "mirror" one another, with annual price differentials rarely exceeding $0.40 per pound (NMFS[2]) and an average price differential equal to only $0.26 per pound (Fig. 1). Since 1991, however, the prices in those regions have become decidedly more distinct, with the average annual price differential exceeding $1.00 per pound. The large price differential since 1991 provides some preliminary evidence that the mandatory warning labels and media attention may have impacted demand and, hence, price of the Gulf product.

## Theoretical Basis and Literature Review

Strand (1999) reviewed the literature pertaining to consumer behavior with respect to food-borne contamination events, concluding that the information related to an event, which is subjectively evaluated by consumers, is critical to perception formation. He further suggested that uncertainty contained in the information can also be critical in perception formation. Finally, Strand suggested that the credibility of the information depends on its source.

Perceptions, of course, can alter consumer choice. Strand (1999) further concluded that consumers react to negative news by reducing demand for the product and/or by taking defensive actions to lower the level of health risk. Furthermore, as a result of uncertainty (e.g. uncertainty of the marketing channels through which they obtain their consumables), consumers may reduce demand even though there is no scientifically supported risk to them from normal consumption. Finally, Strand (1999) suggested that changes in demand owing to reports of persistent toxic compounds (like DDT) appear to be a reaction to cumulative news reports, and while the effects associated with news will decay over time, the decay is slow.

Strand's synthesis of the literature provides several insights that are relevant to this study. First, one might hypothesize that consumers have reacted to the negative publicity concerning the consumption of raw Gulf oysters by reducing demand for the raw product and/ or taking defensive actions to lower the level of health risk. Such actions may include increasing demand for the processed product vis-a-vis the raw product or by reducing consumption only in the "summer" months when health risks (in terms of mortality) from the consumption of raw oysters are greatest.

Second, uncertainty is likely to be a major factor in determining the change in demand for Gulf oysters. The uncertainty is inherent in both the information presented to the consumer as well as uncertainty presented to the consumer as to whether he/she possesses the health characteristics (i.e. liver disease, chronic illness, or a weakened immune system) that would make the consumption of raw oysters "risky."

Third, one could argue that the change in demand for Gulf oysters is analogous to Strand's (1999) discussion regarding changes in demand for food products resulting from reports of persistent toxic compounds. Specifically, while *Vibrio vulnificus* is not a toxic compound, like some such compounds, it is persistent in nature and continues to receive adverse publicity several years after the initiation of warning labels.

### Model Specification

For purposes of analysis, the demand for Gulf oysters is specified as:

$$\begin{gathered} PG_t = \beta_0 + \beta_1 VUL_t + \\ \beta_2 SEAS_t + \beta_3 QG_t + \\ \beta_4 INC_t + \beta_5 (SEAS*VUL)_t + \\ \beta_6 (QG*SEAS)_t + \\ \beta_7 LATX_t + \beta_8 LPG_t + \in_t \end{gathered} \tag{1}$$

where $PG_t$ denotes the deflated Gulf oyster dockside price in quarter *t,* expressed in dollars per pound of meats (1997 Consumer Price Index equals base); $VUL_t$ is a binary variable used to "capture" the change in demand due to warning labels and associated media attention (equal to 0 before 1991 and 1 thereafter)[3]; $SEAS_t$ is a binary variable used to "capture" seasonality in the demand for Gulf oysters equal to 0 for the months April through September, (i.e. the 2nd and 3rd quarters) and 1 for all other months, (i.e. the 1st and 4th quarters); $QG_t$ denotes the Gulf oyster harvest, expressed in millions of pounds of meats, in quarter *t*; $INC_t$ denotes the U.S. real disposable income in quarter *t,* expressed in billions of dollars; $LATX_t$ denotes the share of Gulf oyster production accounted for by Louisiana and Texas in quarter *t*; $LPG_t$ denotes the deflated Gulf price lagged one quarter; and $\in_t$ denotes the error term. Parameters to be estimated range from $\beta_0$ to $\beta_8$.

The equation, as specified, is price dependent. This reflects the fact that production in the Gulf tends to be determined, to a large degree, by the availability of oysters which, in turn, is largely dictated by environmental influences, particularly in the short run.[4]

The variable $VUL_t$ was included to "capture" any decrease in demand associated with warning labels and media attention while the variable $SEAS_t$ was used to "capture" seasonal variation in demand. Since the incidence of *Vibrio* is temperature dependent and is higher in the warmer months of the year, it is further hypothesized that the impact of $VUL_t$ may vary by season with the impact on demand being greater in the "summer" months. To account for the possible variation in impact by season, an interaction term between $SEAS_t$ and $VUL_t$ is included in equation 1.

It is anticipated that price in quarter *t* responds inversely to changes in Gulf harvest ($QG_t$) and positively to changes in income ($INC_t$). Furthermore, given the interaction between harvest and season $(QG*SEAS)_t$, the response in price to a change in the quantity harvested is permitted to vary by season.

Louisiana and Texas, as noted, generally account for the majority of Gulf oyster production. There appears to be a premium attached to the price of oysters harvested from these two states, perhaps due to a larger average size. Hence, one would expect that the average Gulf price is positively related to the share of production derived from these two states. The variable $LATX_t$ is included in equation 1 to "capture" the price effect resulting from product heterogeneity across states.

The variable $LPG_t$ is used to model inertia in the change in dockside price ($PG_t$) to changes in exogenous variables. The value of $\beta_8$ is expected to fall between 0 and 1 with a value approaching 0 indicating instantaneous adjustment in price to changes in the value of exogenous variables, while a value approaching 1 suggests a high degree of inertia.

Finally, substitute products are often entered as exogenous variables in demand models of this nature. One would hypothesize that oysters produced in other regions of the country might constitute substitutes for the Gulf product. Chesapeake oysters, given the similarity in the type of oyster produced and the geographic relation, were considered a potential substitute product, a priori. Initial inclusion of Chesapeake production in the Gulf demand equation did not prove to be successful and, hence

[3] While many studies which evaluate the impact of information on consumer demand quantify the amount of information available at regular intervals (Swartz and Strand, 1981; Johnson, 1988) or the amount of cumulative information (Brown and Schrader, 1990), the use of such procedures were, for several reasons, impractical with respect to the current study. First, the information is received from both warning labels and the print media, and any attempt to isolate these two factors would be problematic. Second, a large percentage of raw oyster consumption occurs in the away-from-home market, and much of the information appears to occur in trade journals. Hence, one would need to isolate the impact related to information in trade journals from that of the more common news media. Finally, most studies that have evaluated the impact of negative information on demand are based on products for which the duration was of only a limited period of time. With respect to the impact of *Vibrio vulnificus* on the demand for Gulf product, the publicity is of longer or continuing duration.

[4] A reviewer suggested that, because of leasing activities in Louisiana and Texas, quantity harvested may not be exogenous to the system. To examine this issue, a vector autogressive model between Gulf price (PG) and quantity (QG) was estimated as follows:

$$QG_t = \alpha_0 + \alpha_1 QG_{t-1} + \alpha_2 PG_t + \alpha_3 PG_{t-1} + \xi_{1t}$$
$$PG_t = \beta_0 + \beta_1 PG_{t-1} + \beta_2 QG_t + \beta_3 QG_{t-1} + \xi_{2t}$$

where $QG_{t-1}$ represents the Gulf landings lagged one period and $PG_{t-1}$ is the Gulf price lagged one period. The Gulf oyster price is said to be block exogenous with respect to Gulf landings if the elements in Gulf price are of no help in improving the forecast of Gulf landings based only on lagged values of PG. The null hypothesis is "PG is not exogenous to QG" which is equivalent to $\alpha_2 = \alpha_3 = 0$. The test statistic follows a chi square distribution with one degree of freedom. The associated chi square statistic of 0.01 (significance level is 3.84) at the 5% significance level implies that PG is not exogenous to QG. In contrast, the test statistic of 12.56 (significance level is 3.84) implies that QG is exogenous to PG. These results agree with the hypothesis that current Gulf landings contribute significantly to the improvement of the forecasted price based only on lagged prices. However, current and lagged prices do not statistically improve the forecasted landings based only on lagged landing values.

the variable was not included in the final version of the model discussed in the following sections.[5]

## Data and Estimation Issues

### Data Issues

The Gulf dockside demand model developed in the previous section was estimated with quarterly data for the 1981–97 period. Where appropriate (i.e. prices and income), the data were deflated using the 1997 Consumer Price Index. Some summary statistics for the variables included in the model are presented in Table 1. The deflated Gulf oyster price averaged \$2.63 per pound, with the post 1990 price (\$2.13 per pound) being nearly 30% less than the pre 1991 price (\$2.98 per pound). The quantity harvested averaged 5.2 million pounds per quarter during the period of analysis, with the pre 1991 quarterly production (5.4 million pounds) averaging about 8% more than the post 1990 quarterly production (4.9 million pounds).[6]

In general, little price variation was evident during the 1981–97 period when examined on a seasonal basis, even though production during the "winter" season, which averaged 6.1 million pounds per quarter, exceeded the production during the "summer" season, which averaged 4.28 million pounds per quarter, by about 40%. Since 1991, "winter" season production has averaged 5.7 million pounds per quarter compared to 4.2 million pounds per quarter in the "summer" season.

### Estimation Issues

The lagged dockside price ($LPG_t$), as noted, was included in the analysis, based on the premise that the response in price to a change in an exogenous variable may not be completed in that quarter in which the change in the exogenous variable occurred (i.e. there exists some inertia in the change in price). Assuming a geometric lag structure, this inertia, can be expressed as :

$$Y_t = \alpha + \beta\,(X_t + wX_{t-1} + w^2X_{t-2} + ...) + \in_t \qquad (2)$$

where $w$ is the lagged weight ($0<w<1$) which declines at a geometric rate over time. As specified, equation 2 is difficult to estimate due to the infinite series of lagged regressors.

As shown by Madalla (1977) and Pindyck and Rubinfeld (1991), equation 2 can be rewritten as:

$$Y_t = \alpha(1-w) + wY_{t-1} + \beta X_t + (\in_t - w\in_{t-1}) \qquad (3)$$

Expressed in this manner, the geometric lag model can be easily estimated, given the finite series of the lagged variable (i.e. $Y_{t-1}$) .

The implications associated with equation 3 are twofold. First, all past values of the exogenous variable ($X_t$) are captured in the endogenous variable ($Y_t$) lagged one period with impact of a change in $X_t$ on $Y_t$ decaying at a geometric rate over time. Second, lagging the dependent variable results in the introduction of serial correlation of the error term, assuming $\in_t$ in equation 2 does not exhibit an autocorrelation pattern.

Several methods have been proposed for estimating the geometric lag structured model in the presence of serial correlation. The most popular technique, and the one that is used in the current analysis, is the instrumental variable approach whereby an estimate of the lagged dependent variable is generated by regressing its value against the lagged values of the exogenous variables in the model. Then, the model is estimated using a maximum likelihood procedure.

Given the structure of a geometric lag model, it is useful to identify the long-run impact associated with a permanent change in the level of an exogenous variable. Madalla (1977) shows that this impact is equal to $\beta/(1-w)$. Hence, as the value for $w$ increases ($0 < w < 1$), the greater will be the amount of time which expires before the full impact of a one-time change in an exogenous variable is recognized. This, in turn, implies that the difference between the immediate impact ($\beta$) and long-run impact ($\beta/(1-w)$) increases in relation to an increasing value of the lagged weight ($w$).

## Empirical Results

Table 2 summaries the regression results associated with the Gulf dockside demand model. The estimated parameters, in general, agreed with prior expectations and, with few exceptions, all estimated parameters were significant at the 90% confidence level. Furthermore, the estimated model explained almost 90% of the variation in the deflated Gulf dockside price (Table 2, Fig. 2).

Overall, increased information related to *Vibrio vulnificus* was found to significantly influence the demand (price) for Gulf oysters. Specifically,

**Table 1.—Summary statistics pertaining to the Gulf of Mexico oyster demand model.**

| Variable | Overall mean[1] | "Winter" mean | "Summer" mean |
|---|---|---|---|
| 1981–97 | | | |
| PG (\$/lb) | 2.63 (0.81) | 2.59 (0.83) | 2.66 (0.80) |
| QG (Mill lbs) | 5.20 (1.91) | 6.11 (2.08) | 4.28 (1.17) |
| INC (\$ bill) | 4,905.7 (588.0) | 4,908.6 (593.3) | 4,902.8 (591.6) |
| LATX (%) | 0.77 (0.10) | 0.74 (0.09) | 0.79 (0.10) |
| 1981–90 | | | |
| PG (\$/lb) | 2.98 (0.82) | 2.93 (0.87) | 3.02 (0.79) |
| QG (Mill lbs) | 5.38 (2.20) | 6.40 (2.48) | 4.36 (1.27) |
| INC (\$ bill) | 4,524.3 (442.2) | 4,527.1 (447.8) | 4,521.4 (448.1) |
| LATX (%) | 0.76 (0.11) | 0.73 (0.12) | 0.78 (0.11) |
| 1991–97 | | | |
| PG (\$/lb) | 2.13 (0.46) | 2.11 (0.44) | 2.15 (0.49) |
| QG (Mill lbs) | 4.94 (1.40) | 5.71 (1.31) | 4.16 (1.05) |
| INC (\$ bill) | 5,450.5 (228.6) | 5,453.5 (238.3) | 5,447.5 (227.5) |
| LATX (%) | 0.78 (0.08) | 0.75 (0.05) | 0.81 (0.10) |

[1] Standard errors of means are given in parentheses.

[5] For comparison purposes, the model that includes Chesapeake production as an explanatory variable is included in the table that provides empirical results (Table 2).

[6] Much of the difference in pre and post 1990 production can be attributed to abnormally low production in Louisiana in 1991 and 1992. Low production in those years reflects massive oyster mortalities from excessive rainfall and, hence, lower salinity.

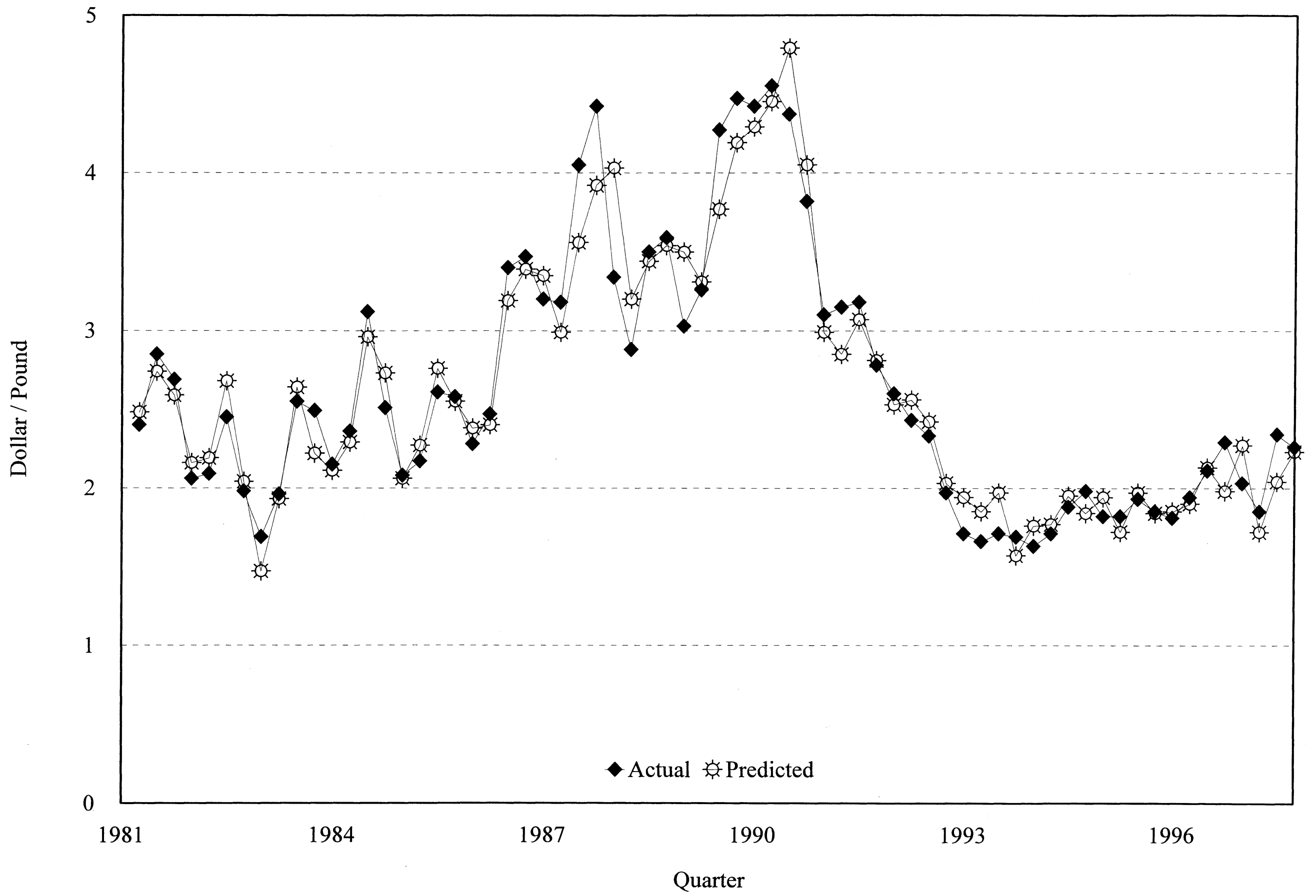


Figure 2.—Actual and predicted quarterly dockside Gulf oyster price (deflated), 1981–97.

the warning labels and associated media attention ($VUL_t$) resulted in an immediate reduction in the "summer" dockside price by $0.93 per pound compared to a reduction in the "winter" price of $0.72 per pound. These reductions, however, reflect only the initial impact. The fact that the estimate of $\beta_8$, equal to 0.553, falls between 0 and 1 implies that as one moves further away from the date that warning labels were initially mandated, the greater the absolute value of the magnitude of the policy variable.

In the long-run, the impact of warning labels was estimated to result in a decline in the "summer" dockside price equal to $2.07 per pound and a "winter" reduction in price equal to $1.60 per pound. The actual "summer" price in 1997 equaled $2.16 while the actual winter price equaled $2.22, suggesting that the "summer" price has been reduced nearly 50% as a result of the warning labels and negative publicity, while the "winter" price has been reduced by about 30%.[7]

**Table 2.—Estimated parameters and standard errors associated with the Gulf of Mexico oyster demand model.**

| Variable | Estimated[1, 2] parameter | Standard error | Estimated[1, 3] parameter | Standard error |
|---|---|---|---|---|
| Intercept | 0.669 | 0.537 | 0.349 | 0.606 |
| $VUL_t$ | –0.929* | 0.174 | –0.955* | 0.175 |
| $SEAS_t$ | –0.624* | 0.203 | –0.741* | 0.227 |
| $QG_t$ | –0.217* | 0.036 | –0.217* | 0.036 |
| $QC_t$ | | | 0.027 | 0.024 |
| $INC_t$ | 0.372E-3* | 0.134E-3 | 0.427E-3* | 0.142E-3 |
| $(SEAS * VUL)_t$ | 0.213** | 0.114 | 0.299* | 0.137 |
| $(QG * SEAS)_t$ | 0.109* | 0.036 | 0.111* | 0.036 |
| $LATX_t$ | 0.165 | 0.416 | 0.209 | 0.417 |
| $LPG_t$ | 0.553* | 0.076 | 0.557* | 0.076 |

1 * = statistically significant at the $\alpha = 0.05$ level; ** = statistically significant at the $\alpha = 0.10$ level.
2 Model estimated without Chesapeake landings ($QC_t$) as an exogenous variable; adj. $R^2$=0.88.
3 Model estimated with Chesapeake landings ($QC_t$) as an exogenous variable; adj. $R^2$ = 0.88.

7 One could hypothesize that the impact of warning labels and the associated negative publicity decays at some rate with the passage of time as consumers either forget about the negative publicity or overcome initial fears. To examine whether this was the case, the analysis was also conducted for the 1981–93 period. In general, the parameter estimates varied only marginally (e.g. $\beta_1 = -0.929$ and $\beta_5 = 0.265$), suggesting that the decay in the initial impact is, at most, minor.

With respect to the Gulf landings ($QG_t$), the results suggest that a 1,000,000 pound increase (decrease) in "summer" harvest results in an immediate $0.22 decrease (increase) in price. An equivalent change in the "winter" harvest, by comparison, results in an immediate inverse price response of only $0.11 per pound, or about half of that estimated for the "summer" season. In the long-run, a 1,000,000 pound increase (decrease) in "summer" harvest was found to result in a $0.48 decrease (increase) in the Gulf dockside price, while a 1,000,000 pound increase (decrease) in the "winter" harvest was estimated to result in a price decrease (increase) of $0.24 per pound.

With respect to seasonality, the results suggest that the demand for Gulf oysters in the "winter" season exceeds demand in the "summer" season, with the expected price differential equaling about $0.07 per pound ceteris paribus, prior to 1991.[8] After 1991, in association with the warning labels and media attention, the difference in demand between the "winter" and "summer" seasons resulted in an expected price differential of $0.21 per pound.

Income, as indicated in Table 2, was found to significantly influence the Gulf oyster dockside demand. Overall, the results suggest that a $100 billion dollar increase in real disposable income would result in an immediate $0.04 increase in price and a price increase equal to $0.08 increase in the long run.

## Discussion and Conclusion

A model was developed and analyzed to examine the impact of mandatory warning labels and the associated negative publicity on dockside price of Gulf oysters. Results suggest that the impact has been significant. Specifically, the results suggest that the "summer" price has been reduced by about 50% as a result of the warning labels and associated negative publicity, while the "winter" price has been reduced by about 30%.

The results developed in this paper can be used to assess the impacts of various policy measures. For example, the FDA, as noted in the introduction, proposed a restriction on sales of raw oysters for consumption from April to October when the *Vibrio vulnificus* bacteria is most prevalent in Gulf waters. From a welfare economics perspective, such a ban would lead to a net increase in the welfare of society if the benefits of taking action (i.e. prohibiting raw oyster consumption) exceed the costs. Benefits reflect, primarily, the reduction in premature deaths and illnesses. Costs, on the other hand, reflect the reduction in consumer and producer welfare (i.e. surplus) which would be incurred as a result of the ban.

As noted by Corcoran (1998), at least 10 people die annually from the consumption of raw Gulf oysters, while more than 50 become ill (an average of 17 individuals died annually during 1996–98). While assigning an economic value to a statistical life is problematic (Kuchler and Golan, 1999), recent empirical work, based on labor market analysis, suggests that the value of a statistical life, expressed in 1997 dollars, falls in the neighborhood of about $4–8 million (Viscusi, 1993, and Moore and Viscusi, 1988 provide details).[9] This suggests that the benefits from the proposed ban, excluding the reduction in illnesses, would approximate $40– 80 million annually.

An "upper bound" estimate of the loss in consumer welfare associated with such a ban can be generated under the assumption that production is equal to zero in those months that would be impacted by the proposed ban.[10] Based upon 1997 quarterly data and estimates, an "upper bound" estimate of the loss in consumer surplus in 1997 from the proposed ban would have been about $6,500,000 based on the 1997 dockside value of $21,200,000 (April through October).

While cost information on the Gulf oyster harvesting sector is insufficient to accurately estimate the loss in producer welfare associated with the proposed ban, it is obviously just a small fraction of the $21,200,000 in revenues generated during the April through October 1997 period. This fraction and the $6,500,000 loss in consumer welfare is considerably less than the $40–80 million annual benefits that would be forthcoming as a result of the ban. Hence, one could conclude that the welfare of society would be enhanced if the eating of raw Gulf oysters were seasonally restricted.

The FDA, as previously indicated, chose not to institute a ban on the consumption of raw Gulf oysters in the "summer" season, opting instead for a "public awareness campaign" to notify and educate those consumers at risk. As noted by Henson and Caswell (1999: 591), policy interventions by governments reflect an "...outcome of a complex trade-off between alternative demands that reflect the interests of the different groups that might be affected. In the case of food policy this will include consumers, food manufacturers, food retailers, and farmers, both at home and abroad, as well as government itself and taxpayers." Whether the alternative strategy (i.e. the awareness and education program), derived via this complex trade-off between alternative demands, proves to be as successful as a seasonal restriction would be has yet to be determined.

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[8] As indicated in Table 1, the observed 'summer" price exceeded the "winter" price by $0.05 per pound prior to 1991. Given the results of the current analysis, it appears as though the higher observed "summer" price reflects a lower level of production.

[9] The value of a life refers to the amount of money an individual is willing to trade for a small change in his or her probability of survival (Blomquist, 2001)

[10] Only an "upper bound" estimate of the loss in consumer welfare can be derived, because an unknown percentage of the "summer" season harvest is currently processed, which is not subject to the proposed ban. Furthermore, if the ban were to be implemented, the demand for processed product would likely increase resulting in a greater proportion of the harvested "summer" product being directed towards the processing sector.

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