AN EMPIRICAL INVESTIGATION OF THE IMPACTS OF MANDATORY WARNING LABELS ON THE DEMAND OF OYSTERS IN THE UNITED STATES

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ABSTRACT

In response to growing concerns about illness and deaths associated with Vibrio Vulnificus, California initiated a program in March 1991 that required anyone selling oysters to notify potential consumers that the "consumption of raw oysters can cause serious illness and death among people with liver disease, chronic illness, or weakened immune systems." This mandatory warning label, followed shortly thereafter by similar warnings in other states, received extensive media coverage. The primary objective of this study was to consider the impact of mandatory warning labels within the context of a complete demand system. The demand of Gulf, Pacific, Chesapeake, and imported oysters for the period 1985(1) to 2006(4) was estimated using an inverse almost ideal demand system (IAIDS). Results indicate that warning labels lowered the demand on Gulf and Chesapeake products and increased demand for Pacific and imported products. Elasticity estimates suggest that Gulf, Pacific, and imported oysters are gross substitute products. The estimated cross price flexibilities suggested that the Gulf and Chesapeake products have strong quantity-substitution effect on other products; implying that the prices of Chesapeake and the imported products are highly influenced by changes in harvests of the Gulf and Pacific products

Keywords: IAIDS, Oyster, Vibrio Vulnificus, Warning Labels, Food Safety

INTRODUCTION

Vibrio vulnificus is a naturally occurring bacterium found in the marine environment. The bacterium is particularly prevalent in the waters of the Gulf of Mexico and virtually all oysters harvested from these waters during the warmer summer months exhibit some concentration of it. While consumption of *Vibrio* laden oysters is relatively innocuous among healthy individuals, it can lead to serious illness and even death among individuals with immunocompromised systems (FAO, 2005). Since the Center for Disease Control began tracking *V. vulnificus* cases in 1995, 30 to 40 cases have been reported each year, nearly all linked to the consumption of raw oysters harvested from the Gulf. With an approximately 50% mortality rate, *V. vulnificus* exhibits the highest fatality to case ratio of any foodborne pathogen (FAO, 2005).

In response to several illnesses and deaths in the state linked to the consumption of raw Gulf oysters, California initiated a program in March, 1991 which required anyone selling raw Gulf product to notify potential consumers that the "consumption of raw oysters can cause serious illness and death among people with liver disease, chronic illness, or weakened immune systems." In the initial draft of the regulation, the sale of raw oysters from any region would have triggered the appropriate warning. After meetings involving state officials, West Coast oyster growers, and restaurant and retail representatives, the focus of the mandatory warnings was narrowed to only oysters harvested from the Gulf of Mexico. In general, some of the Gulf oyster producers harbored the impression that the "California warning labels were motivated by West Coast processors who wanted a bigger share of the Gulf-dominated oyster market" (Associated Press January 15, 1991). California's mandatory warning received considerable media coverage in both local papers and the trade literature.[i]

Because most consumers receive science knowledge from the media (Nelkin, 1987) and modify their opinions and behavior based on these reports (Kone and Mullet, 1994), media coverage of *Vibrio vulnificus* has probably affected demand for Gulf of Mexico product and, possibly, demand for products that are substitutes of Gulf oysters (i.e., oysters produced in other regions and imports).[ii] This is supported by anecdotal evidence. For example, the New York Times and the Daily News ran a number of front page stories about food safety for six months in 1998 which included issues related to Vibrio vulnificus. Bartholomew (1999) investigated the impacts of those media stories, with specific emphasis on the issues of food safety and perceived effects on sales in seafood restaurants in New York. Restaurateurs were asked if the Gulf oyster was safe and they overwhelmingly reported "no." In fact, most restaurants reported having stopped buying oysters harvested from the Gulf of Mexico several years prior to the media stories in the New York Times and Daily news. Similarly, Hardesty (2001) found that most West Coast wholesalers refused to handle Gulf oysters because of the reputed problems with *Vibrio vulnificus*. Assuming that Gulf product was a substitute for other oyster products prior to warning labels and that the warning labels reduced the demand for Gulf product, the demand for the substitute products likely changed.

The impacts of these warning labels and associated media coverage have not been well documented. In one of the few studies to examine the issue, Keithly and Diop (2001 a,b) found that the demand for both Gulf and Chesapeake oysters declined. The decline in the demand for the Gulf product is generally consistent with food safety event theory. Like the Gulf, the primary oyster produced in the Chesapeake is the Eastern oyster (*Crassostrea virginica*) and, as such, is generally considered to have a similar taste and texture. As such, the decline in demand for the Chesapeake product may reflect an unwarranted fear by consumers as a result of imperfect information. It is generally recognized, however, that there are significant differences in both texture and taste between the Pacific oyster (*Crassotrea gigas*) and the Eastern oyster which calls into question the degree of substitutability between these two products. Hence, one might posit that the negative publicity surrounding the California warning labels impacted the consumer demand relationship between the Gulf and Chesapeake products more than the relationship between the Gulf and Pacific products.

The primary goal of this analysis is to expand upon the work by Keithly and Diop by considering the impact of the food safety event (i.e., warning labels and associated media coverage) in a complete demand framework. To do so, a brief literature review of literature pertaining to the economics of food safety events is presented in the next section. Then, a brief review of the oyster industry is presented. This review is followed by the model considered for analysis. After briefly examining the data used in the analysis, empirical results and discussion are then presented.

LITERATURE REVIEW

While research on the economics of food safety events is limited, it can be traced back to 1960 (see Brown, 1969). One of the earliest economic analyses related to the economic costs associated with a food safety event was that by Shulstand and Stoevener (1978) who analyzed the welfare losses incurred by pheasant hunters in reaction to mercury contamination information. Since then, several studies have investigated the impacts of a food safety event on demand. The majority of these studies have examined the impact using a single equation approach. For example, Smith et al. (1988) used a media index to estimate the loss in sales following a1982 incident of milk contamination in Oahu, Hawaii. Brown and Schrader (1990) linked scientific literature to consumers' attitudes toward cholesterol and subsequent impact on the demand for eggs. Dahlgran and Fairchild (2002) examined the impact on chicken demand in the United States after wide news coverage of bacterial contamination of the product in the late 1980's. Studies of this nature, while "capturing" the effect on the product subject to the event, can fail to consider the effect of a food safety event on related products that are not the subject of the event (i.e., those products not separable in the utility function).

In an attempt to capture the effect of a food safety event on the demand for products not directly subject to the event, increased attention has been given to modeling the cross-substitution effects using a system-wise approach. One of the leading studies using this approach is that by Burton and Young (1996) who modified the Almost Ideal Demand System (AIDS), as originally proposed by Deaton and Muellbauer (1980), to account for the impact of Bovine Spongiform encephalopathy (BSE) on the demand for beef and other meat products in Great Britain. In a similar vein, Verbeke and Ward (2001) employed a modified version of the traditonal AIDS model to account for the impact of negative media on the demand of fresh meat products in Belgium. Piggott and Marsh (2004) investigate the impact of food safety information on the U.S meat consumption. Most recently, Mazzocchi *et al*. (2006) analyzed the demand for meat products following multiple food scares in Italy.

There are only handful studies that have attempted to evaluate the impact of food safety events on seafood demand. In 1975, the James River in Virginia was closed to all shellfish harvesting activities as a result traces of kepone being found in several species. The contamination was widely publicized and Swartz and Strand (1981), based on newspaper articles related to contamination of the James River, analyzed the impacts on the demand for oysters that (a) were harvested from a spatially separated area and (b) used in a product that was easily differentiated from product taken from the James River.[iii] The authors found that due to imperfect information, news of a contaminated product significantly impacted the demand for the alternative product (i.e., oysters harvested from other, isolated areas).

Employing firm-level data, Wessels et al (1995) examined the impact of information related to a 1987 toxic algae (domoic acid) contamination event in Montreal, Canada on mussel sales by a U.S firm whose product was not affected by domoic acid as well as the demand for that firm's product. The authors found that while mussel sales by the U.S. firm did not significantly decline as a result of the event, the demand for that firm's product did significantly decline.

Teisel *et al*. (2002) extended the AIDS model to account for the impacts of dolphin-safe labeling of canned tuna on the demand for tuna and other close meat products. Even though this study does not directly deal with the issue of food safety, it is still relevant because it investigates the changes in the demand of seafood product (canned tuna) as the consumers presented with new information about the quality of this product through labels. The main finding of this study is that dolphin-safe label has increased the market share of canned tuna product. To the best of our knowledge, this is the first study to look directly at the issue of seafood safety using complete demand framework.

INDUSTRY REVIEW

As previously noted, virtually all the Gulf and Chesapeake product is the Eastern oyster (*Crassostrea virginica)*. Gulf oyster production, as indicated in Figure 1, exceeded 25 million pounds in 1985 but thereafter declined to a low of about 12 million pounds in the early 1990s. Following this decline, production again increased, approaching the 1985 level by the late 1990s.[iv] Annual production from the Chesapeake Region declined from an annual average of more that 13 million pounds in 1985 and 1986 to as low half million pounds by 1993. This sharp decline in the Chesapeake production has been attributed to dermo (*Perkinses marinus*) and MSX (*Haplosporidiem nelsoni)*.

The Pacific oyster (*Crassostrea gigas)* represents the primary species harvested in the western region of the United States. Annual Pacific production averaged 8.6 million pounds prior to2000 (Figure 1). Since the turn of the decade, annual Pacific production has averaged more than 11 million pounds.

In addition to the domestic production, there is a significant quantity of imported product.[v] Oyster imports averaged about 5.7 million pounds during the period 1985-1999 but increased sharply thereafter, approaching 14 million pounds by 2006.

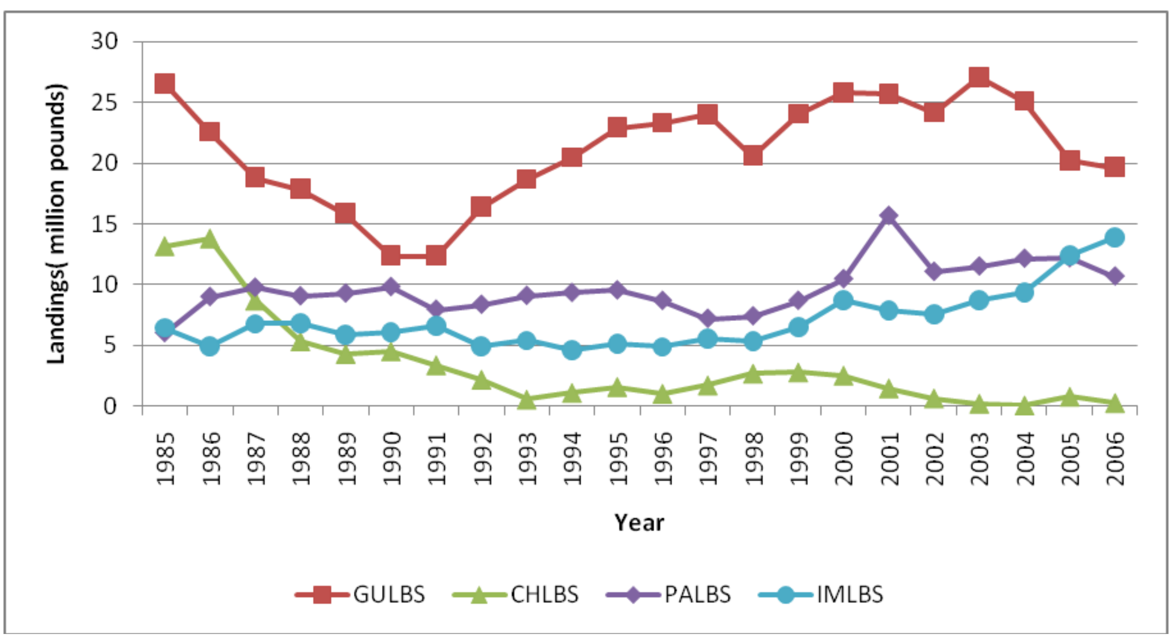

Figure 1: Annual U.S. oyster harvests by region and imports of oysters

As Gulf of Mexico oyster production declined between 1985 and 1990 (Figure 1), the deflated price increased (Figure 2). Despite production in 1991 that was equal to that of 1990, the regional dockside price fell by approximately 30%. After falling sharply, the Gulf deflated price then gradually increased despite increasing production during much of the period.

Like the Gulf, the Chesapeake deflated dockside price f tended to increase during the period1985 to 1990 and, in general, the Chesapeake price tended to "mirror" the Gulf price. Since 1991, however, the Gulf and Chesapeake dockside prices have become decidedly more distinct, with the annual Chesapeake price exceeding the Gulf price by a wide margin.[vi] There are at least two explanations for this post-1990 price differential. First, landings in the two regions have taken different paths since the early 1990s. Chesapeake production, as noted, fell sharply after the early 1990s while Gulf production generally increased after the early 1990s. Second, the impact of warning labels and associated media attention may have had a differential impact on ex-vessel prices in the two regions.

Prior to the early 1990s, the Pacific ex-vessel price tended to be significantly less than that for either the Gulf or Chesapeake product (Figure 2). Since the early 1990s, however, the Pacific price has generally exceeded the Gulf price (often in excess of 40 cents per pound) and even approached the Chesapeake price during some years in some years in the late 1990s.

The deflated import price, as indicated in Figure 2, generally increased rather slowly during the period 1985-95. Since the mid-1990s, however, the import price has gradually declined. This decline coincides with the increase in imports (Figure 1).

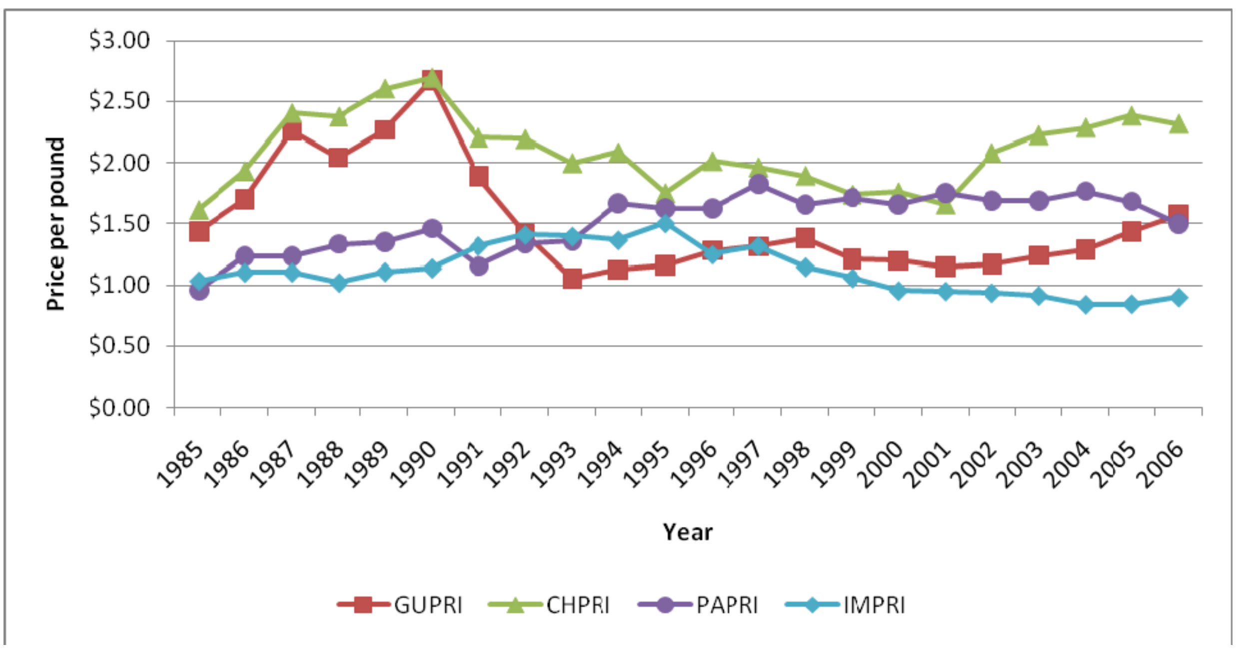

Figure 2: Annual deflated ex-vessel oyster prices by region and import price (1980-84 base year).

THEORETICAL MODEL

The oyster demand model is estimated using an inverse ideal demand system (IADS) developed by Moschina and Vissa (1992) and Eales and Unnevehr, (1994). The IAIDS model possesses the same properties as the

AIDS model initially proposed by Deaton and Muellbauer (1980) but is derived from the distance function rather than the cost function. The IAIDS model is generally considered to be appropriate when the quantities are considered to be predetermined and the prices are endogenous (Eales and Unnevehr, 1994). Because of the biological characteristics of the oyster fishery, the supply of the oyster is considered to be relatively fixed in the short run. This being the case, prices are expected to adjust for changes in production rather than vice versa.

The general linear version of the IAIDS model is given by:

$$w_{it} = \alpha_i^* + \sum_j \gamma_{ij} \log(q_{jt}) + \beta_i \log(Q_t) + \varepsilon_{it} \qquad i, j = 1, \ldots, 4 \qquad (1)$$

where w_{it} is the budget share for the i-th oyster product at time t, q is the quantity demanded of oyster product i at time t, and Q is the quantity index defined as:

$$\log Q_t = \sum_i w_i \log q_i \qquad (2)$$

To incorporate seasonality in demand and changes in the consumer tastes and preferences into the general IADS framework, the intercept in equation1 can be respecified as:

$$\alpha_{it} = \alpha_0 + \sum_{s=1}^{4} \delta_{is}\theta_{st} + \lambda * Trend + \varphi_i * Vib * (1 + \log[t^c])^s \qquad (3)$$

For notational purposes, θ_{ts} represents a quarterly discrete variable (θ_{ts} equal 1 when season is *s* and 0 otherwise) used to examine the influence of seasonality on the demand for oysters and *Trend* represents a time trend variable used to capture systematic changes in consumer tastes and preferences. Following Mazzocchi et al. (2004), the last term in equation 3 is included to permit a nonlinear shift in the intercept term which, in the current study, is used to evaluate the impact of warning labels and associated publicity on oyster demand.[vii] Included in this term are the following variables: (1) *Vib* which is a discrete in nature and is equal to zero prior to the second quarter of 1991 and one thereafter[viii], and (2) t^c which is a time trend that is equal 1 for the period prior to the third quarter of 1991. This functional form is appropriate because it allows for the impact of the warning label to be increasing over time (s>0) or decreasing over time (s<0). When the augmented parameter is equal zero, this functional form collapses back to the standard dummy variable case (0,1).

In order for the IAIDS model to meet demand theory requirements, the parameters of the demand system must satisfy the following restrictions:

Homogeneity: $\sum_{j=1}^{4} \gamma_{ij}$

Symmetry: $\gamma_{ij} = \gamma_{ji}$

Adding up : $\sum_{i=1}^{4} \alpha_i = 1$; $\sum_{i=1}^{4} \beta_i = 0$; $\sum_{i=1}^{4} \lambda_i = 0$; $\sum_{i=1}^{4} \gamma_{ij} = 0$; $\sum_{i=1}^{4} \delta_{is} = 0$; $\sum_{i=1}^{4} \varphi_i = 0$

The system of equations in (1) can be written in matrix notation as follows

$$w_t = \Pi Z_t + \varepsilon_t \quad \text{where } t = 1, \ldots, T \qquad (4)$$

where w_t is 4×1 vector of expenditure shares at time t, Π is $4\times K$ matrix of unknown parameters in the system at time t, Z_t is $K\times 1$ vector of explanatory variables at time t , and ε_t is 4×1 vector of error terms at time t that are assumed to follow multivariate normal distribution with mean zero and covariance Σ.

Estimating the system in (4) without correcting for serial correlation can lead in inefficient parameter estimates. Berndt and Savin (1975) outlined a procedure to correct for the presence of first order serial correlation as follows:

Assume that the error term follows first order serial correlation, the can be written as follow:

$$\varepsilon_{t-1} = R\varepsilon_t + v_t \qquad (5) \qquad \text{where } t=2,\ldots\ldots,T$$

Where R is 4×4 matrix of unknown parameters and v_t are independent N(0, Σ) .

The adding up restriction requires that elements of the R matrix to be restricted such that $\iota' R = c$ where c is unknown constant. Berndt and Savin 1975 suggest dropping one equation and then the restriction $\iota' R = c$ can be substituted by $\iota' R^* = 0$ where R is a 3 by 3 matrix with element $r^*_{ij} = r_{ij} - r_{i4}$ where i,j=1,…,4. An alternative approach is to force R to be diagonal matrix and have the same diagonal elements; this will require that all share equations to have the same first order serial coefficient estimates (e.g., Park *et al*. 2004).

DATA AND ESTIMATION METHODS

Data used in this analysis are quarterly time series data covering the period 1985(1)-2006(4). All quantities (i.e., landings by region and imports) have been specified on a per capita basis. The prices and quantities are derived from the data maintained by the National Marine Fishery Service (NMFS). [ixx] A summary of the data used in the analysis is provided in Table 1. As indicated, the Gulf share represented more than one-half of the total during the period of analysis with the Pacific share representing an additional quarter.

The system comprised of four share equations in (1) with the theoretical restrictions (homogeneity and symmetry) imposed was estimated using Iterative non-linear seemingly unrelated regression estimation procedure (ITSUR) in SAS. Given the fact that the expenditure shares add up to one, the error covariance matrix of the residuals is singular, implying that one of the equations needs to be deleted prior to estimation. The result of the system is invariant to the choice of equation to be dropped, and parameter estimates associated with the deleted equation may be retrieved using the adding up conditions. In order to correct for first order serial correlation in the error terms we used the method proposed by Berndt and Savin (1975).

Table 1: Summary Statistics Associated With Variables Used in Analysis

	Mean	Std	Min	Max
Shares				
Gulf	0.518	0.0733	0.326	0.6708
Chesapeake	0.0902	0.1167	0.0001	0.5062
Pacific	0.2525	0.0844	0.0712	0.4929
Imports	0.1393	0.0714	0.0315	0.3624
Landings (LBS/1,000 persons)				
Gulf	19.5937	5.7589	8.8983	41.4726
Chesapeake	3.2942	5.5028	0.0007	30.9031
Pacific	8.976	2.9778	2.8307	20.335
Import	6.4954	2.6618	2.5131	14.6391

RESULTS AND DISCUSSION

The parameter estimates of the four IAIDS model are presented in Table 2. As indicated, most of estimated parameters exhibited the theoretically expected signs. The proposed model seems to fit the data well based on the values of the adjusted R-squares (Table 2). The parameter estimate associated with the warning label (φ) was negative (-0.064) and statistically significant in the Gulf equation. This indicates that the warning labels and associated media attention depressed the demand for Gulf product.

As was the case for the Gulf, the parameter estimate associated with the warning label for the Chesapeake share equation (φ) was also found to be significant and negative (-0.039). This implies that that the warning labels on Gulf product negatively impacted the demand for Chesapeake product. The magnitude of the negative impact on the Chesapeake product, however, is smaller than that associated with the Gulf product (i.e., -0.039 vs. -0.064). The negative impact of warning labels on Gulf product on the demand for Chesapeake product is consistent with the findings reported by Keithly and Diop (2001 a) and suggests imperfect information (in terms of media exposure) being received by the consuming public and/or the inability of the consuming public to identify product source. This may be particularly relevant since, as noted, the same oyster species (i.e., the Eastern oyster) is harvested in both the Chesapeake and the Gulf.

Unlike Gulf and Chesapeake product, however, mandatory warnings on the Gulf product was found to increase the demand for both the Pacific product and imported product. The impact of the warning label is nearly identical in magnitude for both the imported product and product from the Pacific region (0.0506 vs. 0.0526). These results would suggest that that warning labels on the Gulf product resulted in substitution of the Gulf product (and Chesapeake product) to Pacific and imported products. This is consistent with what was reported by both Bartholomew (1999) and Hardesty (2001).

The coefficient of the non-linear intercept shifter(s) (S) was positive and statistically significant in all four share-equations. This would imply that the full impact associated with the warning label on oyster demand was not immediate but, rather, occurred during an approximate five-year period. A graphical representation of the impact of the warning labels on the Gulf share is presented in Figure 3. As indicated, the full impact is an approximate 12% reduction in share compared to what would have been the case in the absence of warning labels and associated media attention.

The positive and significant coefficient of the time trend variable in the Gulf share equation indicates that despite all the negative publicity associated with Gulf oysters, there is still positive trend in the consumption of the oyster products harvested in the Gulf of Mexico. This positive shift in the consumer preferences in favor of Gulf products will partially reduce the overall negative effect that the warning labels on the demand of the Gulf oysters. On the other hand, the coefficient of the time trend variable was negative and highly significant in the import share equation. This indicates that holding all other factor constant, there is a downward trend in the demand for the imported product.

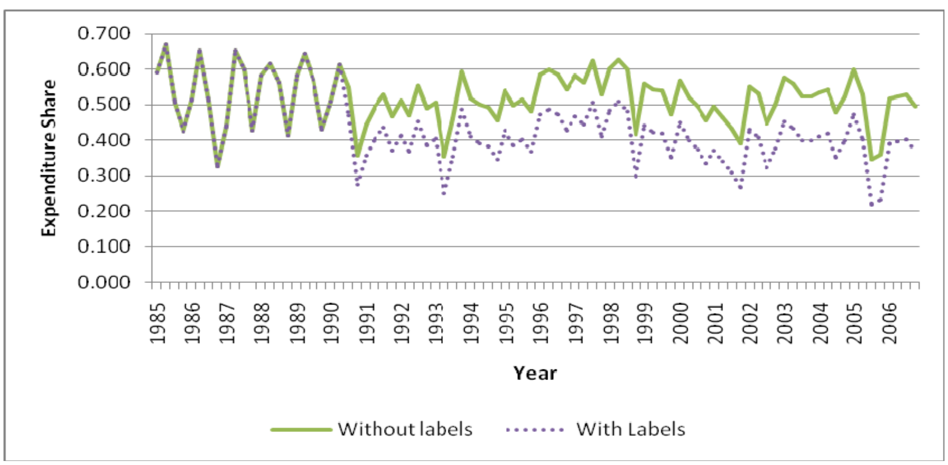

Figure 3. The impacts of the warning labels on the market share of the Gulf oyster

Table 2: Estimated parameters from the IAIDS model for oysters [a]

	α_i	γ_1	γ_2	γ_3	γ_4	β_i	δ_1	δ_2	δ_3	φ_i	λ_i	S	ADJ.R2	DW
Gulf	**0.562**	**0.201**	**-0.013**	**-0.118**	**-0.070**	**-0.102**	0.011	0.032	0.020	**-0.064**	**0.002**	**0.660**	0.56	1.79
	(0.091)	(0.023)	(0.005)	(0.016)	(0.011)	(0.036)	(0.017)	(0.023)	(0.026)	(0.019)	(0.001)	(0.240)		
Pacific	0.059	**-0.118**	0.001	**0.170**	**-0.054**	0.045	**0.039**	**0.076**	**0.073**	**0.053**	0.000		0.83	1.94
	(0.078)	(0.016)	(0.004)	(0.014)	(0.008)	(0.029)	(0.013)	(0.018)	(0.021)	(0.017)	(0.001)			
Chesapeake	0.069	**-0.013**	**0.016**	0.001	**-0.005**	**0.083**	**-0.055**	**-0.107**	**-0.076**	**-0.039**	0.000		0.75	1.94
	(0.100)	(0.005)	(0.006)	(0.004)	(0.002)	(0.036)	(0.018)	(0.024)	(0.028)	(0.017)	(0.001)			
Import	**0.312**	**-0.070**	**-0.005**	**-0.054**	**0.129**	-0.026	0.004	-0.001	-0.017	**0.051**	**-0.002**		0.92	1.82
	(0.046)	(0.011)	(0.002)	(0.008)	(0.009)	(0.017)	(0.007)	(0.011)	(0.013)	(0.013)	(0.001)			

[a] The standard errors are reported in parenthesis. Note: bold numbers indicate that the parameters are statistically significant at 5%level of significance.

The uncompensated price and scale flexibilities (calculated at the sample means) along with the appropriate standards errors are reported in Table 3. All own- price flexibilities were negative and less than one in absolute value, implying that all four oyster products are price inflexible. Gulf and Chesapeake products exhibited the largest own-price effects among the four oyster products. For example, a 1% increase in Gulf supply was found to result in a 0.72% decline in the normalized Gulf ex-vessel price. Similarly, a one percent increase in Chesapeake supply was associated with approximately 0.74% decline in the normalized ex-vessel price of the Chesapeake product. All cross price flexibilities, with the exception of three pairs (Gulf- Chesapeake, Import-Chesapeake, and Chesapeake-Pacific) were negative and statistically significant, suggesting the majority of oyster products are gross substitutes. The cross price flexibility for the Pacific on the Chesapeake oyster is positive and statistically significant which cannot easily be explained.

All scale flexibilities (i.e., the percentage change in the normalized price of each oyster product for a proportional change in production of all four types of oyster products), with the exception of the Chesapeake, are negative and statistically significant. A 1% increase in supply of all four oyster products was found to result in a 1.2 % decline in the normalized price of the Gulf and imported products and a 0.82% decline in the normalized price of the Pacific product.

Table 3: Uncompensated Price Flexibilities [a]

	Gulf	Chesapeake	Pacific	Import	Scale
Gulf	**-0.715**	**-0.043**	**-0.277**	**-0.163**	**-1.197**
	(0.0382)	(0.0131)	(0.042)	(0.0266)	(0.0695)
Chesapeake	0.334	**-0.736**	**0.248**	0.073	-0.080
	(0.2122)	(0.0838)	(0.108)	(0.0606)	(0.4032)
Pacific	**-0.374**	0.022	**-0.28021**	**-0.190**	**-0.822**
	(0.0614)	(0.0208)	0.0714	(0.0364)	(0.1166)
Import	**-0.600**	**-0.052**	**-0.436**	-0.099	**-1.187**
	(0.0752)	(0.0214)	(0.0712)	(0.068)	(0.1224)

[a] The standard errors are reported in parenthesis. Note: bold numbers indicate that the flexibility estimates are statistically significant at 5%level of significance.

CONCLUSIONS

The results of the IAIDS model developed in this paper indicate that warning labels (and associated media attention) on the Gulf product significantly lowered the demand for the product. Furthermore, the impact of the warning labels on the demand for Gulf product was not immediate but occurred over time. The results also suggest that mandatory labeling of the Gulf product also reduced the demand for Chesapeake product. This negative impact can be attributed to either imperfect information (in terms of media exposure) being received by potential consumers and/or the inability of the consuming public to identify product source due to the similarity between the two oyster products.

Unlike Gulf and Chesapeake product, however, mandatory warnings on the Gulf product was found to increase the demand for both the Pacific product and imported products. This suggests that potential oyster consumers, as a result of warning labels on the Gulf product, may have substituted these two products for the Gulf and Chesapeake products.

The results also indicate that despite the negative influence that warning labels have left on the demand for Gulf product, there is still a positive shift toward Gulf product as it is indicated by the positive and highly significant of the coefficient of the time trend variable in the Gulf share. On the other hand, the time trend variable was negative and significant in the import equation suggesting that there is a negative shift toward the consumption of imported product..

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ENDNOTES

[i] Louisiana and Florida mandated a "generic" warning label at about the same time that California mandated the specific warning label. These warning labels, which received relatively little publicity vis-à-vis the California warning label, pertained to the consumption of raw shellfish.

[ii] As discussed in greater detail in a later section, the primary oyster producing regions in the United States have historically been the Gulf, the Chesapeake, and the Pacific. Much of the remaining U.S. production can be attributed to the New England, particularly Connecticut. Production in this region averaged approximately one-million pounds annually during the 1980s but increased sharply during the early 1990s, peaking in 1993 at about eight million pounds. Since 1993, New England production has fallen sharply. In addition to domestic production, the U.S. imports a significant quantity of oysters.

[iii] Specifically, oysters from the James River were used primarily in either seeding activities or in canning. The impact from contamination publicity related to the James River was used to examine the impact on hucked oysters distributed through the Baltimore wholesale market.

[iv] The observed decline in the two most recent years (i.e., 2005 and 2006) likely reflects the impacts from Hurricane Katrina.

[v] For purposes of analysis, imports are limited to certain products that are likely to compete with the domestic product. Products excluded are primarily canned and smoked oysters.

[vi] Interestingly, despite the sharp decline in Chesapeake production since the early 1990s, the associated deflated price of the product generally declined until 2000.

[vii] Mazzocchi et al. (2004) employed this functional form to measure the consumer welfare loss associated with withholding information about the link between the BSE and vCJD in Italy.

[viii] The second quarter of 1991 is selected as the impact point associated with *Vib* because it coincides with the period that California mandated warning labels on raw Gulf product.

[ix] A portion of the Pacific production is collected only on an annual basis. To include these nonspecified annual quantities into the calculation, they were proportionally distributed on the each month. For instance, the new harvest quantity for month i will equal its current quantity (qi) plus its share of the annual nonspecified quantity.