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The Effect of Conflicting Health Information on Frozen Salmon Consumption in Alberta, Canada

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Fish has long been viewed as a low-fat protein source that provides high levels of omega-3 fatty acids. The health benefits of fish consumption have been publicized by numerous outlets, including the mainstream media, dieticians, and scientific journals. Fish oil has been found to lower cholesterol and improve heart health, and omega-3 fatty acids are required for fetal development. However, on May 29, 2002, Health Canada issued a warning against frequent consumption of fish species found to be high in mercury (Wooltorton 2002). Children and pregnant women were identified as high-risk demographics that should be fully educated about the risks of mercury poisoning. These consumers were advised to limit their intake of fish to one meal per week, with large, long-lived fish such as fresh tuna, swordfish, and shark receiving the highest level of concern. A similar advisory was issued in the United States (FDA 2001) as well as the U.K. (FSA 2003), Ireland (FSAI 2004), Australia, and New Zealand (FSANZ 2004) which followed with their own warnings from their respective food-safety agencies.

Further health warnings continued when in January 2004 *Science* magazine published research that found higher levels of carcinogenic polychlorinated biphenyls (PCBs) in farmed salmon compared to wild salmon (Hites et al. 2004). Salmon are relatively fatty, predatory fish that tend to accumulate contaminants given their higher level in the food chain. The farmed-salmon samples tested higher for thirteen of the fourteen carcinogenic chemical levels that were examined. Given these warnings, there is a concern that consumers will overreact to negative messages and remove fish from their diets, which is especially alarming since obesity is a major health issue.

Although the efficacy of these warnings has been studied, there have been inconsistent findings which have not established a clear understanding of consumer reactions to health information. Research has shown that pregnant women in the U.S. decreased their consumption of tuna as well as of light- and dark-meat fish following the federal recommendations (Oken et al. 2003). Despite the effectiveness of the American advisory, a similar study concluded that French consumers' memory of high-mercury fish species was flawed and that the recommendations were too complex to lead to a sufficient decrease in consumption of the most contaminated species (Roosen et al. 2006). Mercury warnings lead to slight declines in total fish consumption, but not of the relevant high-risk species. Because the species with highest mercury concentrations were rarely consumed, their consumption was not significantly influenced following the revelation of health information. These results imply a need for further research to assess how consumers behave given relevant health recommendations.

Due to the coverage salmon received for being high in beneficial omega-3 fatty acids as well as in both mercury and PCBs, it is an ideal dependent variable for this economic study. This paper determines the effect of conflicting media reports on frozen salmon consumption in Alberta, Canada. Achieving a better understanding of how consumers react to health-related articles could benefit both agribusiness managers and public-health agencies. In learning what messages affect consumer purchasing behavior, policies concerning health information can be more effectively designed.

Data Collection and Model Development

This study used A.C. Nielsen scanner data from frozen boxed meat and seafood sales in Alberta, which was collected every four weeks from December 30,

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This article is Journal Paper Number 08-04-012 of the Kentucky Agricultural Experiment Station. The authors gratefully acknowledge the Consumer and Market Demand Agricultural Policy Research Network for providing the data used in this study.

2000 to September 28, 2006. This period is particularly relevant as it includes the publication of both the mercury and PCB warnings as well as articles explaining the health benefits of fish consumption. The data set contained total expenditures for each product, number of pounds sold, and the average retail price per pound for 1,561 frozen items sold in Alberta grocery stores. The products were divided into the following categories: salmon, poultry, shrimp and prawns, other finfish, and other frozen foods. Other frozen foods included products such as calamari, scallops, cheese sticks, and meatballs that did not fit into any particular category. The prices of these items were calculated by dividing total expenditures by their respective volumes.

In order to compile a media index, the University of Alberta database was used to search for keywords in Canadian newspapers related to salmon, PCBs, fish, omega-3 fatty acids, and mercury. The search was limited to two Alberta papers, *The Edmonton Journal* and *The Calgary Herald*, in order to narrow the focus of media coverage to the region where the Nielsen scanner data originated. It is noted that this review does not account for the full number of articles that may have been published in the popular press or discussed on television or other media outlets, but the trends in coverage coincide with the health warnings and provide a reliable indicator for the amount of publicity these issues received.

Empirical Results and Discussion

Using a Hausman test, estimates were obtained using Ordinary Least Squares (OLS), Seemingly Unrelated Regression (SUR), Two- and Three-Stage Least Squares (2SLS and 3SLS), and Full-Information Maximum Likelihood (FIML) methods. OLS was preferred to 2SLS, with a confidence level of 0.985. Similarly, the hypothesis that 3SLS was preferred to OLS was rejected at 0.014. This evidence demonstrates there was an insignificant level of simultaneity between the equations and therefore Ordinary Least Squares was shown to be the most appropriate regression method for this demand model.

After a test for multicollinearity yielded a variance inflation factor (VIF) of 13.52, the trend variable was removed from the model, leaving nine independent variables and 75 degrees of freedom. The Breusch-Pagan and White tests for heteroscedasticity were performed and no significant indication of unequal variance was observed. Due to the time-series nature of the data, a test for serial correlation was performed. A Durbin-Watson statistic of 1.78 was calculated and fell in a range that yielded an indeterminate result.

After the regression was run on the revised model, the following equation was estimated, with standard errors in parentheses:

$$
\begin{aligned}
(1)\quad \underset{(3.585)}{\ln Q_{salmon}} = {} & -5.626 - \underset{(0.342)}{1.873(\ln P_{salmon})} + \underset{(0.930)}{3.575(\ln P_{otherfinfish})} \\
& + \underset{(0.217)}{0.077(\ln P_{shrimp})} + \underset{(0.436)}{0.0004(\ln P_{poultry})} - \\
& \underset{(1.020)}{3.231(\ln P_{otherfrozen})} + \underset{(0.247)}{1.280(\ln \text{ Total Expenditures})} \\
& + \underset{(0.025)}{0.016(\text{Media Index}_{mercury})} - \\
& \underset{(0.021)}{0.032(\text{Media Index}_{PCBs})} + \\
& \underset{(0.019)}{0.011(\text{Media Index}_{omega\text{-}3})}.
\end{aligned}
$$

The quantity of salmon demanded was significantly related to the price of salmon, the price of other fin fish, the price of other frozen boxed meats and seafood, and total expenditures per period (see Table 1). The prices of shrimp and poultry did not show any significant effect on quantity of salmon demanded. It was determined that salmon is an elastic good, as a one-percent increase in its price is related to an estimated 1.87-percent decrease in quantity demanded. Although a percentage increase in the price of other boxed meats and seafood was found to significantly decrease salmon demand by an estimated 3.23 percent, these findings are not as consistent with economic theory as are the previous results. While an increase in the price of substitutes should seemingly increase the demand for salmon, the diverse nature of products in this category may have lead to this observation.

Despite the finding that the media index for neither omega-3 fatty acids nor mercury was statistically significant, the PCB index was significant, at a level of 15 percent. The estimated parameter of −0.032 indicates that salmon demand decreased by 3.2 percent for each additional article published

Table 1. Parameter Estimates.

Variable	DF	Parameter estimate	Standard error	t-value	Pr > |t|	Variance inflation
Intercept	1	−5.62577	3.58491	−1.57	0.1214	0.00000
lnPsalmon	1	−1.87256	0.34162	−5.48	<.0001	2.86910
lnPotherfin	1	3.57480	0.92969	3.85	0.0003	4.71637
lnPshrimp	1	0.07664	0.21682	0.35	0.7249	3.29233
lnPchicken	1	0.00037699	0.43632	0.00	0.9993	5.85609
lnPother	1	−3.23097	1.01966	−3.17	0.0023	5.69066
lnTotalExpend	1	1.27959	0.24697	5.18	<.0001	5.53868
MIOmega	1	0.01070	0.01850	0.58	0.5649	1.28333
MIPCBs	1	−0.03175	0.02113	−1.50	0.1378	1.20853
MIMercury	1	0.01639	0.02473	0.66	0.5098	1.21689

about PCB contamination. This implies that consumers were more concerned about the risk of carcinogens found in salmon than they were about mercury contamination or the benefits of fish oils.

A possible explanation for the varying effects of these health issues on consumption behavior may be related to the frequency and distribution of article publication. As seen in Figure 1, articles about mercury and omega-3 fatty acids were commonly found in Alberta newspapers throughout the study period (91 and 113 total articles, respectively). In contrast, only 34 articles discussing PCBs were published, with a distinct spike following the release of the *Science* article in January 2004 (see Figure 1). This suggests that consumers tend to change their purchasing habits less given a constant supply of information than they do when faced with a novel finding that has not been widely discussed in the media. This observation is consistent with work by Breakwell (2000) as well as Fife-Schaw and Rowe (1996), which discuss the importance of new risks and public awareness of the hazard. Because the consumers were exposed to articles concerning mercury and omega-3 acids on a regular basis, they were already aware of the risks and benefits of consuming fish and therefore did not significantly change their purchasing habits given the publication of additional articles. At the advent of the PCB news coverage, it appears the risk was novel and alarming enough to have an effect on consumer demand for salmon.

Another explanation for the varying levels of concern is that cancer may be perceived as a more relevant risk to consumers. Some consumers may be more sensitive to information linking nutrition and carcinogens based on their individual predispositions or risks of developing cancer. Given that fewer deaths result from mercury poisoning than from cancer, mercury contamination may be viewed as a less pertinent threat to consumer health. According to Bocker and Hanf (2000), the most important elements of individual hazard judgments are the severity of and familiarity with the hazard. Because there was no coverage of any mercury-related fatalities during this time, the risk of mercury contamination may have been insufficient to evoke a change in consumer behavior.

Conclusion

This analysis concerning the effect of conflicting health information on consumption behavior has several management implications for those involved in the food industry. The findings of this study help identify situations to which consumers might react by changing their spending habits. Managers should take particular notice of cases where risks concerning their products may increase hazards for

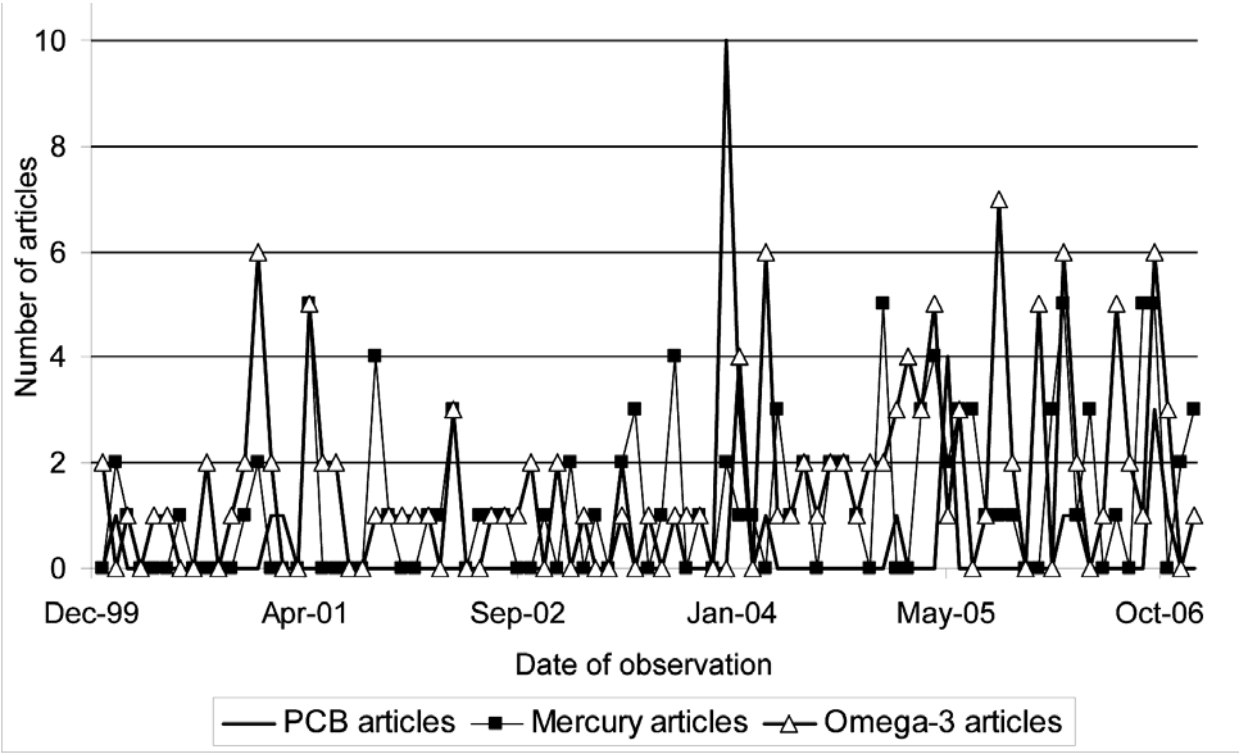

Figure 1. Media Index of PCB, Mercury, and Omega-3 Coverage, 2000–2007.

an already at-risk portion of the population. Additionally, periods of concentrated media coverage concerning a novel risk seem to have a greater effect on purchasing behavior than do frequent coverage of a more common risk factor that is spread out over time.

There may also be some benefit for management to communicate health risks before they are broadcast by the mainstream media. If producers or managers from the fish industry, for example, band together to pre-emptively distribute information about their product, they may be viewed by consumers as more trustworthy. This principle is consistent with Breakwell's conclusion that information which is given freely is more likely to enhance trust than are disclosures from outside sources (2000). In this case, salmon producers could undertake a media campaign to outline actions that target demographics could take to minimize their mercury risks and maximize their health benefits of fish consumption.

The salmon industry did come together following the *Science* article about PCBs. Numerous producers voiced their concern over contamination but also published several articles assuring the nutritive value of salmon. When the articles published after January 2004 were examined, approximately 45 percent of the articles had titles that refuted health risks and emphasized the nutritional benefits of fish consumption. While there was a decline in fish consumption associated with the appearance of additional PCB-related literature, this decrease may have been more significant had the industry not reacted in such a proactive way.

To respond to the concerns of consumers, wild salmon was marketed to fill a niche market demanded by health-conscious shoppers. Because wild salmon was found to be lower in PCBs, managers effectively recognized an opportunity to allow consumers to purchase salmon while lowering contaminant risk. The popularity of wild salmon grew to a level where demand exceeded supply,

which led to some uncertainty over whether farmed salmon was being misrepresented as wild.

Given the increased willingness to pay for wild salmon due to its limited quantities and seasonality, several grocery stores had an incentive to act unethically. A study by *The New York Times* tested samples of salmon sold as wild and found that "wild" salmon sold at six of the eight stores examined was actually farmed (Burros 2005). When confronted with the findings of the tests, some attributed the results to mistakes made by both suppliers and salespeople. Another grocer erroneously claimed, "our salmon is from Canada. All wild salmon in Canada is farm raised," which displays a lack of understanding about the product. Several managers reacted by suspending connections with suppliers, increasing requirements for source verification, and implementing spot tests to regain consumer trust.

While this presented further confusion for consumers, it also represented an opportunity for premium suppliers of wild salmon who maintained the trust of the public by verifying the source of their products. Wild salmon sold at Whole Foods, for example, is certified by the Marine Stewardship Council (Whole Foods 2007). Because of the limited supply of wild salmon, Whole Foods carries farmed salmon only from suppliers that minimize their environmental impact and add no chemicals or dyes to their fish. The fact that Whole Foods has emphasized traceability and accountability in their marketing has alleviated the burden of doubt for consumers and led to a competitive advantage for the company.

Taking this lesson from Whole Foods, producers can apply the demand for safe, low-mercury fish to new niche products. A branding program that only accepts fish with below-average levels of mercury, for example, could provide an opportunity for producers willing to meet this quality standard. Offering a safer product would tap into an underserved market and expand fish consumption to demographics usually at risk for mercury contamination. The most important issue that would arise in developing this market would be accountability. Given the example of misrepresentation of wild salmon and asymmetric information that exists, it is imperative that producers develop trust with their customers. Any steps that could be taken to inform and reassure consumers, such as verification by an unbiased inspection group similar to the Marine Stewardship Council, would benefit managers by establishing a trusted product.

While there are several avenues for further research concerning health information and consumption trends, this paper provides a comprehensive framework that encompasses econometric analysis, risk-communication issues, and implications for agribusiness managers. By understanding consumer reactions to the media, managers will be better able to predict changes in purchasing behavior. Although only one of the three media indices proved to be significant, it is as important to assess what information consumers are not listening to as it is to study those warnings which do elicit public response. Monitoring relevant health issues can allow businesses to identify untapped markets and potentially gain market share with new products. Agribusinesses that reduce information asymmetry through accountability to outside agencies will gain a competitive advantage by alleviating the public's burden of risk. In taking the necessary steps to ensure a safe, quality product, businesses can regain the consumer trust lost to health scares.

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