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86-103

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August 1986

Agricultural Economics Staff Paper
Number 86-103

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This paper is based upon research supported by the Economic Research Service under Cooperative Agreement No. 58-3J23-1-0334X. The authors gratefully acknowledge the advice and support of Clark Burbee, Economic Research Service.

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Abstract

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Chemical contamination of livestock can have a number of economic impacts on producers. One of these is lost sales due to consumer reaction to news of a contamination incident. This paper reports a procedure that can be used to estimate this type of sales loss and applies it to the 1982 case of heptachlor contamination of milk on Oahu, Hawaii.

# THE EFFECT OF HEPTACHLOR CONTAMINATION ON DAIRY SALES IN OAHU

In March 1982 over eighty percent of the milk produced on Hawaii's most populous island of Oahu was found to be contaminated with the pesticide heptachlor. An investigation revealed that all but two of the sixteen dairy herds on Oahu had become contaminated from a feed produced from spent pineapple plants. Following the incident, approximately 36 million pounds of milk valued at over $8.5 million was removed from market. Oahu dairy farmers were reimbursed for this milk by the federal Dairy Indemnification Program. However, sales of uncontaminated milk were depressed following the incident. Both producers whose herds were not contaminated and those that were later cleared of contamination experienced sales losses due to consumer reaction to the incident.

The purpose of this paper is to present a method for estimating this sales loss. An econometric model of consumer demand for milk is developed. The model is used to estimate actual milk sales following the incident and to project what milk sales would have been had the incident not occurred. The difference between the two estimates gives the total change in milk sales due to the heptachlor incident. Subtracting out the amount of milk that was dumped due to excessive heptachlor residues gives the additional loss in sales resulting from consumer reaction to the incident. Since milk not sold for fresh use can be diverted to other uses, an opportunity cost approach is employed to estimate the value of this additional loss to dairy producers. Other policy implications of the model are explored as well.

## CONCEPTUAL FRAMEWORK

Under normal circumstances, purchases of milk by Oahu consumers are determined by the price of milk, prices of milk substitutes, personal income, population, demographic and other changes over time, seasonality, and product advertising. However, the conventional specification of the demand function for milk could not adequately explain the depressed level of milk sales which occurred for some period of time following the contamination announcement. Since constraints on supplies of milk can be ruled out as the cause of depressed sales, the question is how the demand function should be respecified.[1]

One way to approach the problem would be to simply include a dummy variable representing the onset of the contamination incident. However, this approach is not theoretically defensible. Including only a dummy variable in the demand model would be akin to treating the contamination incident as if it were a public health warning to consumers that milk remaining on store shelves was unsafe to drink. With this new information, consumers would then change their purchasing behavior depending on their desire to avoid the new risk. However, public officials in fact declared that milk remaining on store shelves was safe because milk bearing residues of heptachlor above the federal action level had been banned from sale. Therefore, it can not be assumed that consumer reaction to the heptachlor incident was simply due to information about a known risk.

Swartz and Strand suggest that consumers may have imperfect information about what portion of product supplies are actually suspect. They argue that media coverage of contamination incidents where food has been recalled or banned from sale may not be sufficiently detailed so that consumers can determine what portion of supplies are safe or unsafe. This imperfect information affects consumer perceptions of product quality much in the same way as that of advertising, although the direction of the effect is negative. They illustrated this by studying the effect of kepone contamination of Virginia oysters on the demand for oysters in Baltimore. They found that negative media coverage of the contamination incident was significant in explaining purchases of uncontaminated oysters in Baltimore and that the news reports had a lagged effect on purchases.

Swartz and Strand's explanation is noteworthy because it implies that consumers react to news reports in much the same way as they have been found to react to public health warnings (Brown; Hamilton; Mowen; Mowen and Pollman; Shulstad and Stoevener; Schuker, et. al.). Thus, negative media coverage of incidents where product supplies have been banned for sale should be specified in a a model designed to explain consumer response to such incidents. However, Swartz and Strand's reasoning that negative media coverage acts much like "negative" advertising suggests that positive media coverage (e.g., public officials' statements that supplies are safe) might have the opposite effect on consumers. Therefore, some measure of positive media coverage should be included as well.

It should be kept in mind that Swartz and Strand were specifically interested in the effect that a ban on sales in one geographical market would have on another control market in which no ban or recall had taken place. Explaining consumers' response to products from an area already known to have experienced contamination problems requires elaboration on the idea that consumers judge the quality of a product based upon information they have about it. While news reports are an important, albeit imperfect, source of information about product quality, actual recalls or bans are an important source of information about the reliability of producers' implied or direct claims to quality. If recalls or bans have taken place, consumers may change their perception of the degree of control that producers actually have over product quality, and thus, discount producers' implied or direct quality claims unless those producers can demonstrate a change in their method of control. Empirical studies of auto recalls (Hoffer and Wyne) suggest that the number and timing of recalls may be important in explaining consumer response. Thus, some measure of the amount of product that has been banned or recalled should also be included in a consumer demand model.

Finally, effects of public health warnings and product recalls and bans often persist for a period of time beyond the incident. Indeed, the effects of a single contamination incident may last for more than a year (Brown). During this time, consumer purchasing habits will likely change, producing a change in the slope of the demand curve as well as a downward shift. This possibility should be accounted for in any empirical investigation of the response of consumers to a contamination incident.

THE MODEL AND DATA

Per capita daily fluid milk consumption is specified as a function of the retail price of milk, the price of a substitute, per capita personal income, seasonality, the onset of the incident, trends in purchasing habits over time and after the incident, amount of product dumping, and media coverage. Product advertising was omitted since no generic advertising occurred during the period studied. The price of fluid milk was assumed to be exogenous since farm level milk prices are set by the Hawaiian milk commissioner; hence, ordinary least squares was used to estimate the model. Because the income variable was found to be highly collinear with the trend variable representing changes in purchasing habits over time, the regression equation was estimated conditional upon an income elasticity of 0.27 (Renaud).

Monthly data from January 1977 to June 1983 were used in the analysis. This period included five years of data prior to the incident and 16 months afterward. Information on the amount of bottled milk (Class I utilization) and the amount of milk dumped due to excessive heptachlor residues was obtained from the Hawaii Division of Milk Control. Class I utilization was assumed to approximate fresh fluid milk demand prior to the contamination. Because this assumption was questionable after the contamination announcement, Class I utilization was adjusted for imported milk and the amount of product returned from grocery stores and other outlets. Further, from September through December 1982, schools were supplied with imitation milk to avert retail shortages. Therefore, the amount of milk that would have been sent to shcools was added to the Class I utilization data for that period. Finally, a calendar composition factor (Schlenker and Christ) was used to account for variation in "high sales" days across years.

Per capita fluid consumption calculations were complicated by the fact that tourists comprise about 10 percent of total population, though this varies by month. Hence, estimates of the monthly number of tourists on Oahu were calculated based on data from the Hawaii Visitors Bureau and were added to the population estimates.

A consumer survey done by one of Oahu's dairy processors indicated that the appropriate milk substitute was fruit juice or drinks. Further analysis showed fruit nectar to be the best substitute in terms of sign and significance of its coefficients, its estimated elasticity, and its ability to explain variation in consumption.

Average retail food prices in eight Oahu supermarkets were obtained from the major Honolulu newspaper which publishes a weekly food price guide. Monthly per capita personal income was calculated from Hawaii State personal income and population data.

Media coverage of the incident was coded from articles in the two major Honolulu newspapers during the study period. Each article was coded as presenting positive, negative, or neutral informaton about milk safety, the level of government protection, and milk producers' or processors' concern for consumer welfare. These codes were weighted by the prominence of each article using the "attention score" developed by Budd. The weighted codes were summed for each month to obtain measures of monthly negative and positive media coverage.

During model testing the measures of positive and negative media were found to be highly correlated, both having a negative effect on consumption. This suggested that any type of coverage of the contamination incident served to increase awareness of product quality problems. However, since the sum of the two variables did not explain substantially more of the variation in consumption than did the negative media variable alone, only the negative media variable was used in the model. Both the current and previous period's effect of negative media were measured; beyond one lag period the media effect was found to be insignificant.

MODEL RESULTS

The estimated model (see figure 1) explained more than 90 percent of the variation in average daily milk consumption. Variable coefficients were of the expected sign. The Durbin-Watson statistic indicated a low probability of serial correlation.

The estimated own-price elasticity of demand was -0.511. Although the magnitude of the own-price elasticity may seem large, it is not unreasonable given that Honolulu retail milk prices are the highest in the nation, and it is well within the range of estimates currently available (Tomek; Cook, et. al.; Boehm; Thompson and Eiler; Kinnucan).

Inclusion of variables representing the scope of the incident (i.e., the dumping loss) and a change in consumption habits improved the estimation results. This suggests that the scale of a contamination incident should be considered in estimating its short and long run effects.

The sum of the coefficients of current and lagged negative media coverage was -0.0149. Evaluated at the mean, a combined direct and carryover media elasticity of -0.022 was calculated. In other words, a 1 percent increase in negative media coverage reduces consumption about 0.02 percent. This estimate is nearly identical in size, but opposite in sign, to the estimate of Thompson, Eiler, and Forker for the direct and carryover elasticity of generic milk advertising in New York City. However, it is substantially less than the estimate of the effect of negative media coverage obtained by Swartz and Strand.

## ESTIMATE OF LOST SALES

Utilizing the estimated demand equation, a projection of monthly milk sales in the absence of contamination was compared to the estimated actual sales patterns during the period March 1982 to May 1983; the difference reflects sales lost due to consumer awareness of the contamination problem (Figure 2). The difference between the two lines in Figure 2 is the effect of the negative media, the amount of milk dumped, and habit change.

To determine the quantity of sales lost due to consumer awareness, monthly estimates of total sales loss were corrected for the amount of milk dumped each month. For example, the difference between projected and estimated March 1982 consumption was 3,617,860 pounds of milk. However, 3,155,170 pounds of milk were dumped, leaving a difference of 462,690 pounds that were available, but not used for Class I purposes. Sales losses were determined on the assumption that the uncontaminated milk not utilized as Class I could have been used for Class I purposes if "normal demand" existed (i.e., the estimated expected level of demand in the absence of contamination).[2] Due to awareness of the contamination problem, it was estimated that about 6.5 million pounds of milk that would have been used for fluid consumption in the 16 months following the incident were not.

## ESTIMATE OF VALUE OF SALES LOST

The opportunity cost concept is extended to the valuation calculations. Dollar losses were determined by multiplying the amount of milk used in each non-Class I use by the difference between the Class I price and the price for each alternative use.[3] According to this procedure, for the 16-month post-contamination period, the total net loss due to consumer awareness of the incident was $481,415.[4]

Although the $481,415 may seem small relative to the amount of milk dumped, it amounted to some $30,000 per producer. Producers had to absorb this loss themselves since only contaminated milk qualified for reimbursement under the federal indemnification program. In total, marketings were off an average of 2% from what would have normally been expected in the 16 months following the incident.

CONCLUSIONS

Like Swartz and Strand, our results underscore the importance of negative media coverage in explaining consumer response to bans and recalls of a food product. This suggests the importance of accurate information in avoiding unnecessary losses following such incidents. In particular, it suggests a role for collective action by producers or public action in setting the record straight.

However, the finding that positive, as well as negative media coverage had a negative effect on consumer purchases leads us to question the interpretation that the observed consumer response is due to imperfect information alone. Although government officials assured consumers that milk remaining on store shelves was safe, consumers appeared to have heavily discounted their statements. The basis of the discount is suggested by the significance of the amount of product banning over time (i.e., there were multiple recalls) in explaining variation in milk consumption on Oahu. This implies that efforts by producers or the government to assure the public are ineffective, and, perhaps, counterproductive. Rather, some demonstrated change in quality control programs may be more effective in minimizing sales losses. In Oahu, this may have been a practical approach. Even if dairy producers had tested their herds every day, the cost would have still been below the loss in sales that might have been prevented.

Some of the change in purchases appears to be due to habit change which was facilitated, but not caused by the contamination incident. This result may have occurred because of the length and scope of the Oahu incident. After 16 months, sales were still not back to their pre-contamination levels, though they were approaching them.

Finally, it should be noted that the market structure in Hawaii was quite different from mainland markets. Sales of mainland fluid milk was prohibited on Oahu by the Hawaiian Milk Commissioner prior to and after the incident. Therefore, good substitutes to local milk were not available to consumers on Oahu. Had they been, local dairy producers would probably have experienced greater sales losses than they did. However, shortly after the period covered by this study, Safeway of California became successful in its bid to supply mainland milk--partly because of the pressure of Oahu consumer groups. Thus, the heptachlor incident will have a continued influence on the long-run survival of Oahu dairy producers.

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## FOOTNOTES

1 In the first several weeks following public announcement of the incident, some spot shortages of milk occurred due to recalls and condemnations of milk supplies. In the months following the incident, adequate supplies of milk were available, and Hawaiian officials repeatedly assured consumers that these supplies were safe.

2 After February, 1983, however, some of the milk not used as Class I may have been used in other uses had the contamination not occurred. This was considered in estimates of sales loss.

3 During the period of analysis, milk not used for Class I, Class IA or export and Class II purposes, received a nominal salvage value.

4 A larger figure of $625,858 is obtained if known, rather than estimated, actual sales is subtracted from projected sales.

FIGURE 1

$$
\begin{aligned}
Q = 5.6800 & \underset{(1.73)}{-\ 3.070\ DPM} \underset{(0.79)}{+\ 0.663\ SUB} \underset{(\text{see text})}{+\ 0.000311\ INC} \underset{(2.32)}{+\ 0.309\ JAN} \\
& \underset{(2.08)}{+\ 0.2750\ FEB} \underset{(0.87)}{+\ 0.117\ MAR} \underset{(3.75)}{+\ 0.514\ APR} \underset{(3.34)}{+\ 0.457\ MAY} \underset{(2.2.)}{-\ 0.300\ JUN} \\
& \underset{(2.29)}{-\ 0.3190\ JUL} \underset{(0.89)}{-\ 0.123\ AUG} \underset{(3.52)}{+\ 0.528\ SEP} \underset{(2.99)}{+\ 0.400\ OCT} \underset{(1.51)}{+\ 0.207\ NOV} \\
& \underset{(0.08)}{+\ 0.0305\ DV} \underset{(2.97)}{-\ 0.00582\ TRND} \underset{(1.02)}{-\ 1.909\ DVTRND} \underset{(4.46)}{-\ 3.70 \times 10^{-7}\ DUMP} \\
& \underset{(4.49)}{-\ 0.0103\ NEGM} \underset{(1.64)}{-\ 0.00463\ NEGM(-1)}
\end{aligned}
$$

$R^2 = 0.93$; $DW = 2.03$

| | |
|---|---|
| Q | =per capita daily fresh milk consumption in ounces by month |
| DPM | =deflated (by Honolulu consumer price index) retail price of whole milk in paper half gallons |
| SUB | =deflated price of milk substitute (fruit nectar) in half gallon containers |
| INC | =deflated per capita personal income |
| JAN... NOV | =11, zero-one dummy variables with December as the base |
| DV | =Zero-one dummy variable that is zero before the March 1982 contamination and 1.0 thereafter |
| TRND | =A trend variable (1,2...) to account for demographic, habit, & other changes over time |
| DVTRND | =an interaction variable (TRND x DV) to allow for a possible change in the slope of the trend variable after the contamination incident |
| DUMP | =pounds of contaminated milk dumped monthly |
| NEGM | =the negative or unfavorable media (newspaper) coverage of the incident |
| NEGM(-1) | =negative media lagged by one month |

Figures in parentheses are computed t-ratios of the estimates.

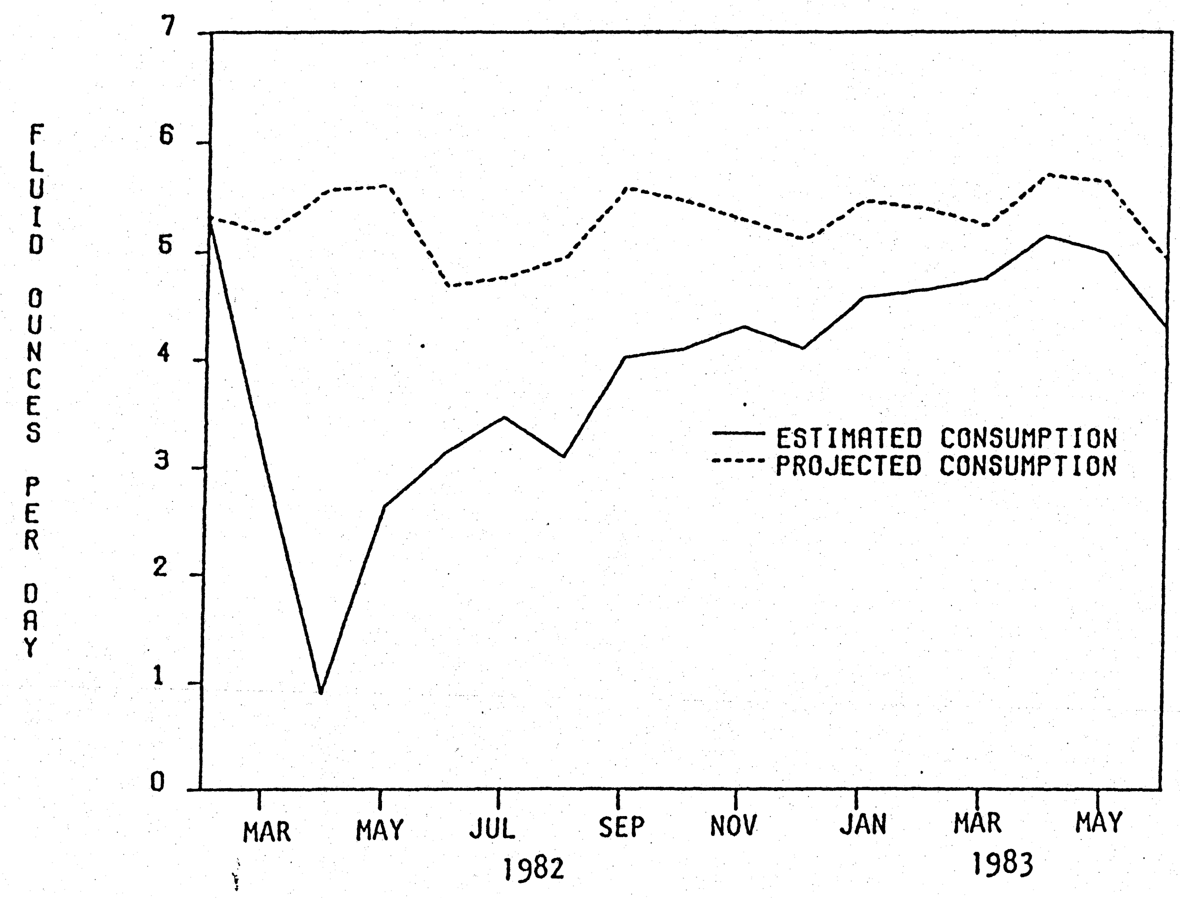


Figure 2 --Per capita consumption: Projected and estimated, February 1982-June 1983.