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Stock Market Reaction to Food Recalls

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The costs of food recalls are examined from the perspective of capital markets. A partial event analysis technique is used in this quantitative investigation of firm-specific repercussions of incidents of microbiological contamination of food. These recalls vary by product, company size and scope, and severity. Returns to shareholders fell in some cases, but stock market reaction was not discernible in other incidents. Effects on volatility of returns also are mixed. These findings point out the potentially distinct crisis management tools that would be used for reputation in the stock market versus measures to communicate with the general public.

Foodborne illness imposes significant costs on various stakeholders, be they consumers, industry, or the public sector (see table 1). To assess the overall impacts of voluntary or mandatory food safety strategies requires a thorough understanding of each of these elements of social costs. There have been many recent advances in our understanding of consumer reactions to food safety issues (e.g., see chapters in Caswell, 1991, 1995; Baker; Misra, Huang, and Ott; Henneberry, Piewthongngam, and Qiang). In part this increased level of research has been due to several notorious foodborne illness outbreaks in the United States involving hamburgers, fruit juices, prepared meats, fruits and vegetables, and other foods. Further, consumers in other parts of the world have reacted dramatically to issues such as the link between new variant Creutzfeldt-Jakob disease and bovine spongiform encephalopathy ("mad cow" disease), the use of growth-promoting hormones in beef, and the perceived risks of process attributes such as biotechnology. Heightened analysis of government responses to regulating the safety of their domestic and internationally produced food supply has also

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Table 1. Taxonomy of social costs from foodborne illness

Allocation of Costs	Cost Center
Costs to individuals	Income and productivity losses
	Pain and suffering
	Leisure time losses
	Averting behavior costs
	Risk aversion costs
	Travel costs
	Child care costs
	Medical costs
Industry costs	Product recall
	Plant closures and clean-up
	Product liability costs
	Reduced product demand
Public health costs	Outbreak investigation
	Disease surveillance
	Clean-up costs

Source: Roberts (1989).

clarified many of the methodological (Kuchler and Golan) and practical aspects of these programs (see, e.g., chapters in Unnevehr).

Within these discussions of consumer and government costs, several authors have suggested that industry bears significant costs from food contamination incidents that lead to product recalls. However, limited empirical analysis of the various elements of these costs has been conducted to date. This is somewhat surprising as numerous applications assessing the impact of recalls on consumer demand and stakeholder wealth exist. Primarily, these papers consider the automobile and drug industries (see, e.g., Dranove and Olsen; Jarrell and Peltzman; Hartman). Hamilton applies similar event study methodology to a different issue to compare two sets of reactions (shareholder and the media selecting stories) to firm level pollution reports.

Detailed information regarding the response of stock prices to recalls is useful in several ways. First, such data can be used to discuss potential firm and industry level benefits of adopting a particular food safety intervention. The intervention could be the selection of a particular piece of equipment, promoting the development of crisis management plans in plants, or the broad adoption of an industry quality management system. Second, it is interesting to compare the market reaction to different recalls to determine if the size and scope (relative to the firms' product range) and severity (in terms of the number of illnesses or deaths associated with the product prior to recall) influence the magnitude of the reaction. Finally, the magnitude of the stock market's reaction can be compared to the direct costs (charges) assessed by the firms.

Much of the previous research on consumers' preferences for safer foods has occurred at the market level, focusing on reactions to risk for commodity groups

rather than for a particular company or brand. Within this literature, an interesting advance has been presented by Richards and Patterson. This paper presents an econometric analysis of two recent (in 1996 and 1997) contamination incidents initially linked to California strawberries which were subsequently found to be related to imported raspberries. For a third event, an outbreak of Hepatitis A following consumption of frozen desserts was discovered to be due to contaminated strawberries from Mexico that were illegally sold to the U.S. Department of Agriculture for the National School Lunch Program (see Richards and Patterson, p. 443). The industry cost of this last event was estimated to be around $40 million. The research revealed that adverse information can substantially reduce grower profits, while positive information can partially offset negative effects. Their addition of separate explanatory variables to characterize the "good news" from the "bad news" publicity within a demand system provides a useful advance. This finding suggests that managers might be able to mitigate damage among consumers through public announcements. The present event study, in contrast, measures responses linked to specific firms, and the market in question is not consumer purchases of food, but shareholders' investments in common stock. Thus any recommended changes in information sharing should be oriented to this group of stakeholders and not consumers directly.

Another difference between this study and much of the prior work on food safety is that these recalls are due to microbiological contamination rather than the presence of chemical residues. Microbiological contamination (arising from bacteria, viruses, or parasites) presents an immediate health concern for consumers, rather than the long-run chronic health effects that may result from exposure to chemical residues. Microbiological contamination causes brief illness, severe sickness, or death, with the most severe effects expected among older, very young, or immuno-compromised consumers. Presumably, microbiological risks cause different consumer reactions than the life-time risks associated with various agricultural chemicals.

The main contribution of this study is that it is the first quantitative investigation of firm-specific reputation impacts that are assessed by considering the changing valuation of publically traded food processing firms. In this context the *Wall Street Journal* reported that the Hudson Foods incident, a recall of 25 million pounds of ground beef in August 1997, "... sensitized Wall Street to food safety issues..." (Gibson and Kilman). This paper tests that claim by examining shareholders' reaction to other food recalls before and after this date, in an event study of stock returns.

To the extent that the goal of management is to enhance shareholders' wealth, it is important for researchers to consider the reputation of a firm among its owners as well as among its customers. Differences in the reaction of the two audiences, owners and customers, suggest different management responses to food safety issues. The trust-building measures that are appropriate for the general public, such as general media publicity, may not satisfy stockholders, or may not be needed at all.

Contamination Incidents

Product contamination incidents of varying severity affected Sara Lee Corp., IBP, Inc., and Odwalla, Inc., between 1996 and 1998. Sara Lee Corp. is a multidivi-

sion firm employing some 139,000 people in more than 40 countries and is ranked number 4 on the 1999 *Fortune* Global 500 list for the food industry. Sara Lee Foods division processes packaged meats by its subsidiary Bil-Mar Foods. IBP, Inc. is a large U.S. meat-packing and processing company that produces meats mainly in commodity form for further processing or export. IBP is number 8 on the 1999 *Fortune* Global 500 list for the food industry and number 2 on the "Top 100" of meat and poultry companies (*Meat and Poultry*, July 1999). Odwalla, Inc. is a small manufacturer (1999 net sales of $68 million) and distributor of fresh fruit juices and natural foods that trades heavily on its image as a provider of highly nutritious products.

In 1996, Odwalla apple juice was contaminated with *Escherichia (E.) coli* O157:H7 bacteria. One death and 66 illnesses were linked with the incident. Odwalla recalled its products after learning of the problem on October 30, 1996. Direct costs from the recall and related claims were 12.4% of sales in fiscal 1997, and 2.1% of sales in fiscal 1998 (year ending August 30; U.S. Securities and Exchange Commission 10-K report). Legal proceedings account for some of the costs. Seventeen personal injury claims were settled and mostly covered by insurance; five claims are still pending. Pursuant to a Federal grand jury investigation in July 1998, Odwalla agreed to pay, over a period of five years, $1.25 million to the U.S. government and $250,000 to three nonprofit organizations involved with advancing the cause of food safety (U.S. Securities and Exchange Commission 10-K report).

IBP, Inc. recalled ground beef after contamination with *E. coli* O157:H7 bacteria was discovered on two occasions. No illnesses were reported in connection with these recalls. The quantities affected were 282,128 pounds recalled on April 29, 1998 and 556,226 pounds recalled on November 4, 1998. Each of the IBP recalls is treated as an independent event in the analysis below. Generally the literature is unclear on how to proceed when two recalls are close together, but far enough apart to be unable to be treated as a single event. Our selection of windows for the pre-event period effectively minimizes any impact from the first recall on the second. However, if there remains a negative impact, this will, in fact, bias towards seeing more of a reaction for the second recall.

Sara Lee Corp. recalled 15 million pounds of hot dogs and deli meat products on December 22, 1998 because of contamination with *Listeria*. The recall of these ready-to-eat products was linked with 21 deaths and more than 100 illnesses in 21 states. Financial measures of severity are modest, relative to the overall income and sales of this diversified consumer products firm. Sara Lee Corp. recorded a pretax $76 million charge (which translates to $50 million net income or $0.05 per share) for the costs of the recall, compared with $10.15 billion in net sales and $660 million in net income for the six-month period in which the recall occurred (U.S. Securities and Exchange Commission 10-Q report). The charge is the company's estimate of costs of return and destruction of products from retail and distribution, destruction of inventory at the plant, and liability.

These four recalls are selected because they represent firms of different sizes and business practices. They are not intended to be an exhaustive list of all companies that recalled contaminated foods between 1996 and 1998. We include firms from $20 billion in total sales to $68 million (fiscal 1999). We consider firms specializing in food as well as one diversified in consumer products.

The cases studied include severe illnesses and deaths, and others in which no illnesses were documented. Our goal is to consider statistical procedures that might identify responses to these particular cases, not to generate any broad conclusions about stock market reaction to food safety risks in general. Other recalls by publicly traded firms occurred, particularly among producers of ground beef. Hudson Foods Company was one important recall incident and, given the fact that the event led to the sale of Hudson to Tyson, investors' attention was sparked. The Hudson event was larger in quantity recalled than the two IBP incidents, but the difficulty in tracking Hudson's stock after its acquisition by Tyson led it to be excluded from this research. We chose IBP over other ground beef recall incidents because there were two fairly close together in time and we wanted to investigate how statistical procedures work in such a situation. The importance of the recalls chosen is underscored by the fact that two (Odwalla and Sara Lee) were instrumental in policy reform. Beginning in 1998, the Food and Drug Administration required that fresh fruit and vegetable juices that were not treated to eliminate microbiological contaminants carry a warning label (pasteurization is sufficient to prevent the use of such a label). U.S. Department of Agriculture regulations for ready-to-eat products were strengthened in 1999, to reduce the potential for *Listeria* contamination.

Event Study Methodology

An event study uses financial market data to measure the impact of a specific episode on the value of a firm (MacKinlay). First, the "normal return" of the stock is estimated by comparing the returns on a company's stock to a broad index of the market over time. Then any "abnormal return," or calculated prediction error, during the period of interest can be attributed to the event. Statistical precision of these prediction errors depends strongly on the fit of the normal return model and the duration of the postevent period studied.

Daily closing stock prices for the three firms and Standard and Poor's (S&P) 500 and S&P 500–Food indices were collected from Datastream™. This database reports prices for every weekday regardless of whether the market was open or closed for a public holiday. To correct for repeated observations, such days were deleted. Daily returns were calculated as the percentage change in closing share prices, excluding dividends. Volume and daily high/low prices were taken from the finance.yahoo.com website. Both data sources include adjustments for stock splits. Descriptive statistics on the daily returns for each stock before the food contamination incidents are shown in table 2. Odwalla and Sara Lee experienced more variability in daily returns than IBP, as measured by the coefficient of variation. This variability influences the explanatory power of the normal return models. Estimated parameters of the normal return models using the S&P 500 index, the S&P Food Industry Index, and a factor model using both indices are shown in table 3.

It is critical to isolate the day on which news of the food recall reached the stock market to correctly estimate any effects. An efficient market will incorporate news into share prices quickly, so that a window that begins too late will miss immediate effects. Company press releases were the first indication of the event date. In the cases of IBP's second recall and Odwalla's recall, company announcements

Table 2. Statistics on returns, 250 days before event

	Sara Lee	IBP 1	IBP 2	Odwalla
Minimum (%)	−5.70	−4.62	−11.11	−11.11
Maximum (%)	4.99	4.84	16.38	18.82
Average (%)	0.01	−0.03	0.08	0.02
Standard deviation (%)	1.71	1.39	2.05	3.97
Coefficient of variation	133.59	−49.29	24.62	192.66

Table 3. Parameters of normal return models

	S&P 500		S&P Food			
	Parameter	Standard error	Parameter	Standard error	Constant	R^2
Sara Lee						
Market portfolio	0.4002**	(0.1290)	—	—	0.0017	0.1165
Food industry	—	—	0.7717**	(0.1315)	0.0011	0.3207
Factor model	−0.1716	(0.1642)	0.9164**	(0.1909)	0.0011	0.3308
IBP 1						
Market portfolio	0.2940*	(0.1718)	—	—	−0.0004	0.0386
Food industry	—	—	0.3876**	(0.1598)	0.0003	0.0746
Factor model	−0.0372	(0.2601)	0.4144*	(0.2467)	0.0004	0.0748
IBP 2						
Market portfolio	0.6488**	(0.1850)	—	—	0.0061	0.1442
Food industry	—	—	0.3380	(0.2201)	0.0055	0.0313
Factor model	0.9747**	(0.2788)	−0.4835	(0.3118)	0.0063	0.1719
Odwalla						
Market portfolio	1.632**	0.6091	—	—	−0.0036	0.0896
Food industry	—	—	1.872**	0.7388	−0.0049	0.0808
Factor model	1.074	(0.8410)	0.9786	(1.0154)	−0.0026	0.1012

$n = 75$.
* statistically significant at the 90% level.
** statistically significant at the 95% level.

occurred after the markets closed. Hence the event day used is the day following the press release. The company's formal announcement of the voluntary recall probably follows significant company analysis and review, perhaps initiated by the detection of bacteria in random samples. Further, public health agencies may be involved when the product has entered the final consumer market place and foodborne illnesses need to be traced to their source. In either case the stock market may be informed before the press release, resulting in share price effects prior to the event days. News reaches the stock market through unofficial sources as well, so it is important to allow for the possibility of "leakage" of information. Leakage can bias the normal return model if days in which the reaction begins

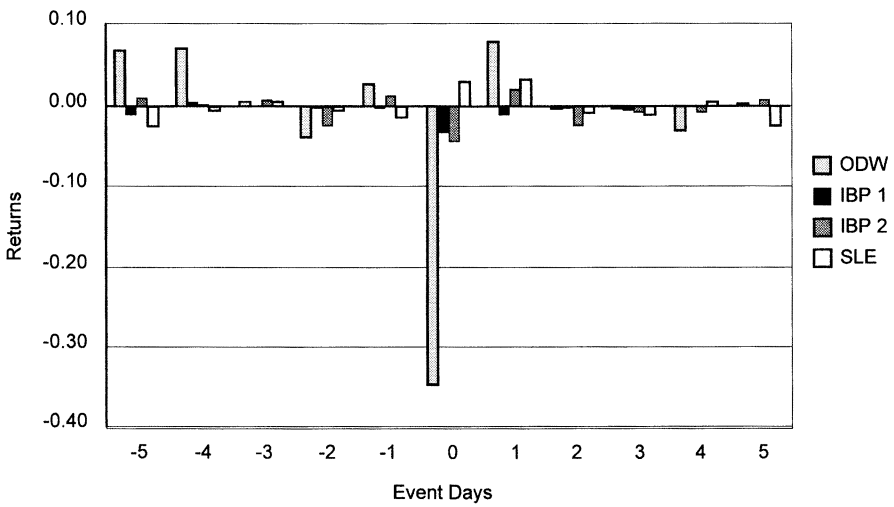
are incorrectly used in the normal return sample. Some event studies use five days before and after the event as the window, to account for earlier news and capture immediate effects (Brown and Warner).

Alternative event windows were examined to account for possible pre-event leakage and to consider the sensitivity of results to our choice of sampling periods. We used a pre-event estimation period of 75 days, starting 80 days before the event and omitting the 5 days immediately preceding the event. The postevent period during which we calculate abnormal returns begins with the event date and is extended various lengths to allow comparison of cumulative effects shortly after the recall. Following MacKinlay, 120 and 250 days estimation periods for the normal return models were also examined.[1] The parameters of the base models changed in minor ways for the longer periods, although it should be noted that the R^2 for Odwalla was improved in the models using the shorter pre-event window. Importantly, general conclusions about statistical significance of the recalls were robust to the length of the event period.

Results

Once the base model for stock market returns was developed, the parameters were used to estimate abnormal returns that occurred immediately after the event. Abnormal returns were estimated as a disturbance term calculated on an out-of-sample basis (MacKinlay). They are the difference between the market model's predicted return and the actual return. An abnormal return was calculated for each observation within a particular postevent window. Estimated daily abnormal returns for the 10-day window around each incident are shown in figure 1, underscoring the differences that occurred across firms. There is no evidence of

Figure 1. Abnormal returns around food recalls, five days before and after recall. Figures shown are obtained from market model using S&P 500 index.



any "leaking" of information in the five days prior to the four recalls. However, the figure does demonstrate the relative size (35%) of the reduction for Odwalla on the recall day. Interestingly this was followed by a large "bounce-back" the following day with an 8% abnormal return. This may be due to a large volume of "value buyers" or an overpessimistic initial response of the market. In the 30 days prior to the recall, the average volume of Odwalla shares traded was about 30,000. On the event day it was 1.3 million with 1.2 million shares traded the following day.

Sara Lee Corp. experienced returns below what the market predicted for four of the five days before the recall, but in aggregate, those returns are not statistically significant. Press reports do not suggest any alternative explanation for Sara Lee to have lower returns than the general market during these specific pre-event days. This period coincides with a general disfavor for food industry stocks, relative to the broader market (Value Line). It is also possible that news of the food contamination problem affecting Sara Lee's Bil-Mar subsidiary could have leaked to the market before the company issued its recall. The first illnesses from this event began in August 1998, well before the December 22, 1998 recall. Also, the manufacturing plant had been closed several times in earlier years due to microbiological contamination. The leakage of news, if it occurred, would impair the ability of this econometric model to find statistically significant effects associated with a recall. In fact, if news leaked as far back as August 1998, the base model estimating normal returns would be biased by including the periods in which investors are reacting to food contamination.

Sara Lee Corp. stock exhibited significant abnormal returns only in the model that included the S&P 500 market portfolio, and only for the 30-day cumulated abnormal returns. Returns were 19% below the forecast levels for the 30-day period (as shown in table 4). Estimated abnormal returns for Sara Lee are generally lower in the models that include the S&P index for the food industry compared with the model based on the general market index. The difference is likely due to the weight of the Sara Lee stock in computing the food industry index; any reaction for Sara Lee stock will pull the food industry index with it.

The first IBP recall was associated with evidence of a negative stock market reaction. Cumulative abnormal returns ranged from 5% to 18% across the 5- to 40-day postevent windows (table 4). Statistical significance was strong in all the models used, but it was greater in models using the S&P food industry as the market index compared with the S&P 500 market model. If we rely only on the market using S&P 500, we get significant effects of 5% (90% significance level) for the first 5 days, a cumulative 10% decline over 20 days, and 15% cumulative reductions over 40 days.

IBP's second recall, which was larger than the first in terms of quantity of product, was not accompanied by discernible abnormal returns in any event window. The values of the estimated abnormal returns are as high or higher than for the first IBP recall (6% to 26%; table 4), but none are statistically different from zero. The lack of apparent reaction to IBP's second recall could result from several factors. High volatility during the period of the base model used to represent normal returns prior to IBP's second recall surely contributes to the absence of statistical proof. It seems clear that this period (July 15, 1998 to October 28, 1998) was not "normal" for IBP's share price; the range of daily returns is much higher

Table 4. Cumulative abnormal returns from food contamination, for various postevent windows

	5-day	10-day	20-day	30-day	40-day
Sara Lee					
Market portfolio (%)	4.87	−2.80	−11.26	−18.66*	−11.69
Food industry (%)	3.39	−3.34	−5.23	−10.33	−4.59
Factor model (%)	3.35	−3.02	−3.93	−8.60	−3.48
IBP 1					
Market portfolio (%)	−5.25*	−6.17	−10.54*	−7.19	−14.70*
Food industry (%)	−6.45**	−7.87**	−13.26**	−10.81*	−18.15**
Factor model (%)	−6.51**	−7.97**	−13.50**	−11.12*	−18.45**
IBP 2					
Market portfolio (%)	−6.25	−15.11	−16.94	−17.09	−26.36
Food industry (%)	6.06	−13.73	−13.51	−11.04	−17.99
Factor model (%)	−6.05	−15.02	−18.74	−20.35	−29.85
Odwalla					
Market portfolio (%)	−30.42**	−27.42**	−6.37	−4.69	−17.90
Food industry (%)	−28.49**	−28.92**	−4.47	−1.80	−10.50
Factor model (%)	−30.24**	−29.14**	−6.95	−1.56	−15.08

* statistically significant at the 90% level.
** statistically significant at the 95% level.

than in earlier periods. The entire stock market underwent greater volatility during that time, yet the explanatory power of the model as measured by R^2 was generally better than each of the other recalls. It is possible that the first recall affected the volatility of returns, leading to difficulties in statistical precision for the prediction errors. The 75-day sample period used to estimate normal returns before the second recall does not include the days of the first recall, but it begins approximately 10 weeks afterward. Of course, many other events took place during that time, including earnings announcements, concerns about export markets, falling hog prices, acquisitions of value-added food companies, and other factors specific to the firm that could have caused unusual volatility for IBP. Regardless of the cause, confidence intervals are twice as large for the second IBP event, resulting in insignificant cumulative abnormal returns for the second event, even though the absolute levels of estimated cumulative abnormal returns are greater than those found for the first IBP recall.

Alternatively, the lack of reaction to IBP's second recall could suggest that the stock market has "learned" from IBP's initial recall. One possible lesson is that IBP's management reacts well to contamination incidents, and that there are few long-term expected effects on IBP's financial health from the food contamination. The microbiological contamination in the ground beef was identified before reaching consumers, a fact that could have bolstered investors' confidence in IBP's management of food safety risks. IBP also announced production changes to avoid contamination in the future.

Odwalla's recall was followed by substantial drops in returns, as might be expected from a large recall for a small company. Negative returns range between 27% and 30% and were statistically significant in the 10-day period after the recall (table 4). Share prices rebounded somewhat after an immediate 35% drop, but another 20% negative return below market predictions on the sixth day after the recall caused significant cumulative abnormal returns for the entire 10-day period after the recall. On the sixth day of the recall, the press reported that a child had died after drinking the contaminated juice. Odwalla's stock price failed to reach its prerecall levels because the initial recall costs cut into the relatively small sales so severely, and the death and serious illness evoked threats of future liabilities that concerned investors.

Overall, no statistical effect on the daily returns for Sara Lee Corp. was uncovered, even though serious illness and deaths occurred. The timing of the news of the contamination may be responsible for the absence of statistical significance, or the fact that this is a large, diversified company with nonfood successes to balance against the recall costs. The smallest company in the group experienced large and immediate drops in its daily returns. The effect on IBP appears to be modest but prolonged, lasting at least 40 days. Effects on share prices, if any, for the second recall by IBP could not be isolated.

Riskiness of Returns Following Food Recalls

The preceding analysis of abnormal returns focused on changes in the levels of returns compared with those that prior market patterns would have predicted. Riskiness of returns is also important to shareholders and business managers; investors require higher expected returns in exchange for bearing risk. Statistical analysis of the volatility of returns before and after the events provides preliminary evidence that returns are more volatile after the recall. Another perspective on risk, based on the Capital Asset Pricing Model (CAPM), is also presented.[2]

We present two measures that relate to volatility in table 5. The first, the standard deviation of daily returns, is a traditional measure of stock price risk. In addition, we computed a daily price spread and normalized it on the daily opening stock price to represent intraday price movements. This measure illustrates differences in opinion during the trading day, therefore capturing more information than the closing price used above. These measures are computed for 50, 100, and 150 days before and after the recall. The daily spread is averaged over the 50, 100, and 150 day periods. It should be noted that the 150 days before IBP's second recall overlaps with the first IBP recall. Differences in the standard deviations before and after the events were tested using an F test. Volatility differences for the intraday spread were analyzed with a t-test accounting for the samples having different variances. The reader should note that these statistical measures do not control for variability associated with the market overall, or for other factors in the company's business environment.

These raw statistical indicators are complemented by a financial market measure of risk derived from the CAPM. CAPM is an equilibrium model that measures the riskiness of an individual stock, taking into account that well-diversified investors should only be concerned with nondiversifiable risks associated with a particular security (Brigham and Gapenski). We use it here for its focus on risk.

Table 5. Volatility of stock prices before and after food recalls

	Days prior to event			Days after event		
	50	100	150	50	100	150
Sara Lee						
std. deviation of returns (%)	0.018	0.020	0.019	0.022*	0.024*	0.022**
avg. intraday spread (%)	2.504	2.909	2.619	3.107**	3.273**	3.022**
IBP 1						
std. deviation of returns (%)	0.012	0.010	0.013	0.010	0.025**	0.024**
avg. intraday spread (%)	1.764	1.783	1.842	1.548	2.223**	2.426**
IBP 2						
std. deviation of returns (%)	0.029	0.030	0.024	0.019	0.022	0.025
avg. intraday spread (%)	3.289	2.684	2.356	2.604**	2.927	3.117**
Odwalla						
std. deviation of returns (%)	0.037	0.040	0.043	0.071**	0.054**	0.050**
avg. intraday spread (%)	5.069	5.437	5.424	7.283**	6.040	5.990

Note: Average intraday spread is spread is daily high price minus daily low price, as a percent of opening price.
* statistically different from corresponding pre-event measure at the 90% level.
** statistically different from corresponding pre-event measure at the 95% level.

CAPM has been criticized because the main hypothesis is untestable, and the measure of risk, the beta in a linear model, varies with time. It has also faced criticism for omission of other factors that affect risk-adjusted returns, such as liquidity risk (Jacoby, Fowler, and Gottesman). The fact that estimated betas vary over time indicates that some structural change has occurred, causing the equilibrium relationship between assets in the market to adjust. Chugh, Hanemann, and Mahapatra used this premise to support their hypothesis that government regulations affected the riskiness of firms. We followed their conceptual approach and used a CAPM-based measure of nondiversifiable risk, and tested for statistical differences in risk before and after the food recalls. A Chow test in which the two different regimes are demarcated at 100 days before and 100 days after the event is used to determine these changes.[3]

Sara Lee Corp. shares were more volatile after the recall, according to both the standard deviation and the daily intraday spread measure. The differences in volatility were statistically significant in all periods up to 150 days following the food recall. The CAPM approach contradicts this, showing that the measure of nondiversifiable risk (beta) does not change after the event.

Volatility for IBP was not greater immediately after the recall, but increased in the periods 100 days and 150 days following the recall, which would seem to indicate the influence of other factors not related to the event. Riskiness as measured by beta did not change to a statistically significant degree after IBP's first recall. IBP's second recall was not associated with an increase in volatility; in fact there was a discernable decrease in volatility for the 50 days following the recall compared with 50 days prior to the recall. The CAPM approach also suggested a reduction in risk after IBP's second recall. The beta for the postrecall period

was not significantly different from zero, indicating that IBP was not experiencing substantial market risks. News reports during the period do not point to any specific explanation for the reduction in volatility, but the combination of several factors at work (discussed in the previous section) could explain it.

Odwalla stock was a more volatile investment than the other firms examined, both before and after the recall. Standard deviation of returns for Odwalla was larger after the recall, in all three time periods. Odwalla stock's intraday price spreads were larger in the period immediately after the recall. The volatility differences appear to persist up to 150 days following the recall, much longer than the abnormal returns. Much of the increase in risk was diversifiable, however, as there was no significant change in the beta from the CAPM model before and after the recall.

Discussion and Conclusions

This event study suggests that financial markets reacted in a limited way to certain food recalls. Returns to shareholders fell immediately after the recall for the smallest firm in the study, but recalls by the larger firms were not consistently associated with large reductions in returns. Riskiness of the stocks appeared to increase after the recalls according to certain statistical measures, but no firms in this group faced an increase in nondiversifiable risk following the recalls.

These four recalls of differing scope and severity did not point out a consistent relationship between the stock price reaction and the severity of the contamination incident. The outcomes from the contamination for the smallest firm were severe compared to the firm's revenues. Perhaps the diversification of business units outside of food protects stock prices when the food business experiences troubles, even for a contamination incident that was most severe in terms of illness and death. Other researchable hypotheses arise from the findings, some of which are testable but others are not, given the relatively small sample size of major recall events. One could ask: Is it size or diversification (either over multiple food product lines or nonfood products) that matters? Is it size or liquidity? Is it size or severity of incident relative to size of the market or firm? Is it the amount or intensity of press coverage? Or is the pattern found here purely due to chronological order, with Odwalla unfortunately the first major contamination incident traced to a food processor during our period of study?

Finally, to return to our initial question, is there any evidence to suggest that Wall Street is "sensitized" to food contamination risks? Perhaps this research points to a "desensitization," as managers have successfully kept their firms in business and responded to contamination incidents in such a way as to convince investors that the long-run value of the firm has not been significantly impaired. Correct responses to the events by managers could be minimizing the stock market reaction. The correct responses include things like Hazard Analysis Critical Control Point (HACCP) plans, investments in appropriate technology, and behind-the-scenes communications with analysts and the trade—all of which are less dramatic than the attention-grabbing headlines of illness and death from consumption of contaminated food, or the full-page ads that some firms use following an outbreak. Leakage of information about problems, in a slow and controlled manner, may also reduce a stock price response or at least smooth the reaction over a period of time.

While publicity can be an effective crisis management technique to repair a firm's reputation with the general public, this paper highlights a different approach by considering the effects of food contamination incidents on the firm's image in the stock market. Managers must be the judge of which audience most concerns them. The reaction by different audiences only matters to the extent that managers' behavior with respect to the relationship differs. A manager might work on the relationship with the stock market through annual reports, press releases designed for the analyst community, or personal communications with analysts and financial journalists. These are different tools than the popular press, the Internet, and advertising that are more oriented toward consumers.

Whether or not the managers' efforts to affect stock market reaction are different than managers' efforts to maintain consumer confidence after food contamination incidents, this study illustrates that there clearly are differences in research approaches. Share price data are a readily available way to test for firm-specific effects of a given contamination event. The econometric methodology is straightforward, but gave mixed results. The findings may be colored by biases associated with the market index, omission of certain variables, or imperfect measurements of market risk. Most of these limitations of the method are leading toward understatement of the market reaction.

The authors encourage further analysis of this exciting topic. Extensions to this general research area may arise from considering additional recalls. Also it would be interesting to attempt to gauge stock market analysts' reactions during a large recall, perhaps using a survey by companies such as First Call. Scanner data may allow a more detailed analysis of consumers' reactions at the product level, to consider whether there are positive or negative "spillovers" that affect similar products following a competitors' recall. This information can then be directly compared to stock market reactions to determine the relative efficacy of managers' communications with shareholders and consumers.

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Endnotes

[1] These results are available from the authors upon request.
[2] The authors thank an anonymous reviewer for this suggestion.
[3] Results from the Chow tests are available from the authors upon request.

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