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Abstract

Using event study methodology, we examine the effects of three Starlink corn food safety events on the risk and returns of directly involved agribusiness firms and the diffusion effects on other firms in the industry. We test the hypothesis that Starlink food safety events do not have an impact on the magnitude and volatility of the returns and the nondiversifiable risk of the firms. Based on the results of this study, we conclude that Wall Street is not sensitive to the Starlink corn food safety events.

Keywords: event study, food safety, GMO, Starlink corn.

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Introduction

Public concern about food safety has increased rapidly during the last decade. Food safety concerns are at the forefront of much of the work in the food and agribusiness industry. Food safety involves a wide array of issues including but not limited to microbiological food borne pathogens, chemical toxins, labeling, bioterrorism, and technological and new product developments. Food safety events include the Starlink corn controversy, the alar issue within the apple industry, and the *e-coli* issues in the meat packing industry. Previous research has generally explored consumer preferences and consumer reactions to food safety issues (Baker; Henneberry, Piewthongngam and Qiang; Misra, Huang and Ott). However, consumers are not the only group impacted by food safety; firms and the industry, involved in food recalls and other food safety issues, also bear significant costs. These expenses can relate to closing production facilities and disposing or recovering recalled products. More important, the firm incurs a reduction of demand for its products, and if a firm invested in its image, these investments may turn out to be a net loss.

To estimate wealth losses due to involvement in food safety issues, one may use event-study methodology and measure the changes in market valuations of the firms involved in the event. Recent work has expanded the area of inquiry to include the examination of the reaction of stock returns of publicly traded firms to specific food recall events (Salin and Hooker; Thomsen and McKenzie), thereby providing a starting point for understanding return and risk responses to food safety issues. However, additional research in this area is necessary to more completely quantify shareholder reaction to food recalls and other food safety events.

One such food safety issue is that of human consumption of genetically modified organisms (GMOs). Several events have focused around GMO Starlink corn and the controversy over its use in human foods during the last years. Aventis invented Starlink corn by incorporating Cry9C, a protein isolated from common soil bacteria, into corn. The Cry9C protein is effective against caterpillars. StarLink corn was approved by the U.S. Environmental Protection Agency (EPA) for animal feed but not for human food until additional testing was completed because the protein Cry9C is considered a medium risk potential human allergen. The controversy began when traces of DNA from StarLink corn were found in taco shells and other corn related products. These events were followed by the series of food recalls and closing of production facilities for checking and cleaning.

A number of food and agribusiness firms have either been involved in or impacted by Starlink corn food recalls. Most of the recalls were conducted by local manufacturers, which are not publicly traded. For this study, three events were identified that directly involved three publicly traded firms. Two of the events are the Kraft Foods recall of Taco Bell taco shell products from grocery stores on September 22, 2000, and the Kellogg recall of Morningstar

Farms Corn Dogs on March 14, 2001. The third event happened on October 17, 2000, when the *Wall Street Journal* (WSJ) announced that ConAgra Foods had closed its only corn mill located in Atchison, Kansas, because it might have received Starlink corn.

The general objective of this research is to quantitatively examine the effects of the Kraft Foods recall of Taco Bell taco shell products, the Kellogg recall of Morningstar Farms Corn Dogs and the announcement about ConAgra Foods' closed plant on the risk and the returns of food and agribusiness firms. Not only stocks of directly involved firms, but also stocks of indirectly affected firms are examined in order to assess the diffusion of the impact of the events to other firms in the industry. Specifically, a partial event analysis is used to measure and analyze changes in the magnitude and volatility of the returns and the nondiversifiable risks of agribusiness firms due to the three food safety events. We test the null hypothesis that such events have no impact on the amount of risk associated with the firm and on the firm's returns. As noted by Sara Lee's Corp. CEO in an interview for Reuters (Factiva), "…U.S. consumers do not seem concerned about the use of bioengineered ingredients in food, despite recalls related to a certain strain of genetically modified corn…."

The paper is organized into 6 sections. Section two provides an overview of the relevant research. Section three is devoted to the methodology used; section four describes the data; section five provides estimation results, and section six is the conclusion.

Relevant Literature

One method to measure the effects of food safety events on a firm is to apply event study methodology (Fama et al.; MacKinlay). This method does not require measurement of direct costs that may result for the firm due to the event; rather, it gives the measure of the economic impact on the firm involved based on the changes in equity market or product market valuations. The relevant event studies can be divided into two groups. The first group of studies includes research devoted to quantifying the effects of food safety events on the prices of contaminated products. The second group includes literature investigating the effects of food safety events on the stock prices of the involved firms.

Lusk and Schroeder, and McKenzie and Thomsen represent the first group of studies in this literature review. Lusk and Schroeder examined the effect of meat recalls on live cattle and lean hog futures prices. They found that the announcement of recalls did not have a strong effect on either price series. Using event study methodology, McKenzie and Thomsen examined the impact of beef recalls due to E. Coli O157:H7 contamination on wholesale and farm-level beef prices. They found that prices of boneless beef reacted negatively to recalls; however there was no reaction in the live cattle prices and very little reaction in the boxed beef prices. They concluded that there are incentives for packing firms to control food contamination and invest in food safety technology, but there are no such incentives at the farm level.

Thomsen and McKenzie, Salin and Hooker, and Henson and Mazzocchi represent the second group of studies, investigating the effects of food safety events on the stock prices of affected firms. Thomsen and McKenzie analyzed federally supervised meat and poultry recalls

from 1982 to 1998. They used standard event study methodology to quantify the effects of the announcements of the class 1, 2 and 3 recalls on the stock returns of the recalling firm. Thomsen and McKenzie found evidence that class 1 recalls involving serious threats to consumer health, translated to shareholder losses while recalls involving less serious violations had no negative impact.

Salin and Hooker used the partial event analysis method to quantify firm-specific effects of incidents of microbiological (arising from bacteria, viruses and parasites) contamination of food, which lead to immediate health concerns for consumers. They investigated four recalls conducted by three agribusiness firms. These recalls were different in scope and severity, and the firms differed by size and diversification. With partial event study analysis, the specific abnormal performance of each firm was quantified and statistically tested. Salin and Hooker found that returns fell after the recall only for the smallest firm in the study. Riskiness of the stocks, measured by volatility, increased after the recalls, but none of the considered firms experienced an increase in nondiversifiable risk following the recall. Salin and Hooker concluded that financial markets reacted in a limited way to certain food recalls.

Henson and Mazzocchi examined the impact on agribusinesses of the United Kingdom government's announcement of a possible link between Bovine Spongiform Encephalopthy and human health. They found that significant negative abnormal returns in the beef, pet food, animal feed, and dairy sectors and positive abnormal returns in other meat sectors.

Previous studies have focused only on the firms directly involved in food recalls, or they have examined industry effects in aggregate. In this study, we investigate the effects of Starlink food safety events on the risk and the returns of food and agribusiness firms that were not only directly involved, but also indirectly affected by the incidents in order to assess the diffusion impact in the industry.

Methodology

Perhaps the most comprehensive analysis of the event study methodology was published by MacKinlay. The event study methodology rests on the notion of market efficiency. Given the semi-strong form of market efficiency any new information will be quickly reflected in the market value of the affected firms and the event's economic impact can be measured using changes in the stock prices around the event. After the event date is determined, the event window, the period over which the security prices of the firms involved in the event will be examined, and market model estimation period are identified. When an event is an announcement on a given day, the length of the event window is one or two days. If leakages of information may occur, it is appropriate to expand the event window.

In this study, abnormal returns are measured to assess event impacts. The abnormal return is the actual post event return of the security over the event window minus the normal return of the firm over the event window. The normal return is the return which would be expected if the event did not take place. MacKinlay discusses the fact that there are three common choices for

modeling the normal return: the constant mean return model, the market model, and the factor model. In this study, the market model is used, where the normal return is defined as:

$$R_i = X_i\theta_i + \varepsilon_i \quad , \tag{1}$$

where R_i is a vector of estimation-window returns on security i, and $X_i = [l\ R_m]$ is a matrix with a vector of ones in the first columns and vector of market returns R_m in the second column, ε_i is the zero mean disturbance term with variance $\sigma_{\varepsilon i}^2$, and θ_i are parameters of market model. The estimation window is a subset of data prior to the event window. The event window itself is not included in the estimation period to prevent the event from influencing the normal performance model parameters estimates (Campbell, Lo, and MacKinlay). Abnormal returns are aggregated over the event window and post event windows for each firm in order to draw overall inferences for the event of interest.

Both parametric and nonparametric tests have been used for testing whether the abnormal returns are statistically different from zero. To conduct a parametric test, we adopted the method described in Campbell, Lo, and MacKinlay.[1] This approach is based on specific assumptions about the distribution of abnormal returns. The alternative nonparametric tests allow the robustness of conclusions based on the parametric tests to be checked. The Wilcoxon rank-sum test examines whether two samples came from populations with the same distribution. This test is used in this study to test the null hypothesis that the actual and predicted returns by the normal model (1) over
[-5, 0], [0, 5] and [0, 10] windows came from the same distribution, or that the event does not have an impact on the returns.

Statistical analysis of the volatility of returns before and after the events can give some estimate of the effects of the recalls on the stock price risk. To analyze the volatility of returns, we use a form of the Goldfeld – Quandt test. We denote the volatilities of returns of firm i before and after the recall as σ_{1i}^2 and σ_{2i}^2 respectively. Then, under the assumption that returns are normally distributed, $\hat{\sigma}_{2i}^2 / \hat{\sigma}_{1i}^2$ is distributed as $F(n_2\text{-}1, n_1\text{-}1)$, where $\sigma_{2i}^2 > \sigma_{1i}^2$ and n_2 and n_1 are days after and before the event over which variances σ_{2i}^2 and σ_{1i}^2 are estimated. This allows the null hypothesis that $\sigma_{2i}^2 = \sigma_{1i}^2$, or the event has no impact on the stock price risk, to be tested. The alternative hypothesis is that the stock price risk after the event is greater than it was before the event. We conducted this test for 30, 50, 100, 120 and 150 days before and after the event. It is important to notice that this test does not control for overall variability of the market environment.

The last test used in this study is devoted to examining the changes in nondiversifiable risk of the securities due to the events. Riskiness of returns is an important characteristic of firms' stocks because investors require a higher expected return in exchange for bearing higher nondiversifiable risk. Following Salin and Hooker, we use a Chow test to statistically test the change in risk, estimated with beta, the Capital Asset Pricing Model (CAPM) measure of nondiversifiable risk of the firm, before and after the event.

Data

Data in this study consist of daily rates of return to common stock for seventeen food and agribusiness firms that were directly or potentially indirectly affected by the three Starlink corn events during 2000-2001 and the rates of return for the *Center for Research and Security Prices* (CRSP) Value Weighted market index. All return data were obtained from the CRSP.

Starlink corn food safety events were identified using the Food and Drug Administration (FDA) web page for information on food recalls. Thirteen recalls occurred during the last years due to contamination with Starlink corn. However, most of these recalls were conducted by local manufacturers, which are not publicly traded. Three events directly involving three publicly traded firms, Kraft Foods, Kellogg and ConAgra, were identified. Factiva and LexisNexis were used to identify the Starlink Corn food safety event dates. Kraft Foods announced a voluntary recall of all Taco Bell taco shells contaminated with Starlink Corn from grocery stores shelves on September 22, 2000; however, news discussing the possible incident hit the papers on September 18, 2000, in the *Washington Post.* Kellogg announced a recall of Morningstar Farms Corn Dogs on March 14, 2001; however, news of this incident was published on March 8, 2001, in the *Los Angeles Times.* The event dates used in this study are those corresponding to the first news of the food contamination (September 18, 2000 and March 8, 2001) since those are the dates when the market first potentially reacted to the news.

The market model for these two events was estimated using 120 calendar days, which is equivalent to 78 business days for the Kraft recall and 76 business days for the Kellogg recall, with the 5 days prior to the event day omitted. This choice allows any overlapping of market model periods for the two events to be avoided. The abnormal returns were estimated over [-5, 10] event window to examine the effects of the recalls on the firms' returns. The abnormal returns were further aggregated over 5, 10, 30, 50 and 100 days after the event to examine the cumulative impact of the recalls over time.

The FDA Enforcement Report on November 15, 2000, indicates that ConAgra Foods recalled cornmeal, corn flour, snack meal and flaking and polenta grits because these products appeared to contain Starlink corn. The products where distributed in 11 states. The interesting thing about this event is that ConAgra started to recall its products on October 4, 2000, but the FDA did not publish an announcement until November 15, 2000. To determine the announcement day, Factiva and LexisNexis were searched for any news about ConAgra during the Fall 2000. The first news related to the recall appeared in the WSJ and other publications simultaneously on October 17, 2000. According to the news (Factiva), on October 11, 2000, ConAgra Foods closed its only corn mill located in Atchison, Kansas, because it might have received Starlink corn. Interestingly, the company very quietly started the recall on October 4, quietly closed the plant on October 11, allowed the news to go out on October 17, and then the official FDA report did not appear until November 15. Given this situation, it is very difficult to identify the event date. Potentially, October 17, 2000, was the first day that the market could have received new information about the relatedness of ConAgra to Starlink corn and the possible food contamination. Since this was the date of the first public announcement, this date was used as the event date in this study. The market model estimation period and event window

for this event were chosen to be, respectively, 120 business days from t=-125 to t=-6 and from t=-5 to t=10 relative to announcement date t=0.[2] Note, the market model estimation period includes the Kraft Foods recall, but the event window does not. Also, October 11, 2000, the date when the mill was actually closed, is included in the event window.

The news (Factiva) on October 17, 2000, underlined that the mill could have received "the same type of genetically modified corn that sparked a nationwide recall of some taco-shell brands." It is not clear whether the effect on the stock returns of this announcement is positive or negative. Given that in September 2000 Kraft Foods announced a Starlink food recall, and given that ConAgra's announcement on October 17, 2000, did not say that contamination was found, the fact that the mill was closed may actually be perceived by the market as a preventive action. An announcement of such preventive action may have a positive impact on stock returns.

In addition to the companies directly involved in the events examined, this study also examines various firms within the industry in order to determine the diffusion of the impact of the events to other firms in the industry. Hoover's Online was used to identify the competitors of Kraft Foods and Kellogg in the breakfast cereals, snacks, bakery, frozen foods and other markets involving corn products, and the competitors of ConAgra in the agricultural products, ingredients and corn flour markets. Possible competitors for Kraft Foods and Kellogg are Dannon, Sara Lee, General Mills, Heinz, Quaker Oats, Frito-Lay, Keebler, Lance, Inc., Unilever (UK), and Unilever (Netherlands, NV). ConAgra's competitors are Archer Daniels Midland (ADM) and Corn Products International. Our expectation about changes in the stock prices of these competitors is mixed. The reaction may be positive because these firms are competitors of the affected firms, and during the event windows, representatives of these competitor companies made announcements that they do not use and have never used Starlink corn (Factiva). ADM announced that they tested their deliveries at the elevators for Starlink corn during the ConAgra event window (Factiva). With respect to the Kellogg and Kraft events, announcements contained information that Unilever and Frito-Lay use only GMO-free ingredients. On the other hand, Kellogg, General Mills, Quaker Oats and other companies are mentioned in the press during the event windows as companies using genetically modified corn, not Starlink corn but other types of GMOs (Factiva). So, the market reaction may be negative as well.

Taco Bell, a company dealing considerably with corn products and whose name is exactly the same as the name of the product contaminated with Starlink corn, was also included in this analysis to see if the events had any effects on its value. Also, according to the news, Taco Bell tested its corn based products for Starlink corn because it might have received contaminated products (Factiva). Aventis, the firm that invented Starlink corn, was blamed in the news by government officials as a company that "…was supposed to ensure that farmers kept Starlink corn separate from other varietes, but failed to do so" (Factiva, Associated Press Writer, 10/26/2000). Aventis was included in the sample to see if negative publicity around the events had any negative impact on its stock prices. Thus, seventeen total food and agribusiness firms that were directly or potentially indirectly affected by the three Starlink corn events during 2000-2001 were chosen for the analysis.[3]

Results

First, we present results for two recalls, and then we discuss the results for the ConAgra closed plant event. Figure 1 and 2 show Kraft Foods daily stock price movement around the recall of Taco Bell taco shell products and Kellogg daily stock price around the Kellogg recall of Morningstar Farms Corn Dogs, respectively. It seems that the stock market value of Kellogg is not sensitive to the recall of its product, when the value of the Kraft Foods was negatively impacted by the recall. The figure 1 indicates possible leakage of information before the news. However, to make a conclusion about the impact of the event on the firm, it is important to take into account overall stock market movement. Figures 4 and 5 depict the abnormal returns of some of 17 companies during [-5, +10] window around the Kraft Foods and Kellogg events, respectively. For the Kraft Foods event, 13 of the 17 firms experienced negative excess returns on the event date when the news was first released about the potential issue. However, four days later, on September 22, 2000, when Kraft announced the actual recall, only two firms, Keebler and Taco Bell, experienced negative excess returns. Kraft experienced negative excess returns on the event date, two days after the event date, and one through four days prior to the event date. Somewhat similarly, Taco Bell experienced negative excess returns on the event date, one and four days after the event date, and two, four, and five days prior to the event date.

The parametric t-test results indicated that Kraft did not experience any significant abnormal returns during the event window. Sara Lee, Frito-lay, ADM and Corn Products International experienced significant negative abnormal returns on September 20, 2000, two trading days after the announcement. Dannon experienced very large positive abnormal returns on September 22, 2000, when Kraft announced the actual recall. The Wilcoxon nonparametric rank-sum tests for -5, +5, and +10 days, however, indicate that only Sara Lee and Keebler experienced actual returns that were statistically different at the $\alpha=0.05$ level from the expected normal returns. Interestingly, only Corn Products International experienced large negative abnormal returns on the event day and two days after with large positive returns on the third day after the event. Additional investigation of the news about Corn Products International revealed that from September 15 to September 19, 2000, there were several announcements in the press about a reduction of yearly earnings by 40% compared to the previous year (Factiva). On September 21, 2000, Reuters announced that Corn Products International had their investment rating raised. Thus, the observed price movement for Corn Products International around September 18, 2000, is more likely due to earnings and investment rating announcements, instead of the Kraft Foods recall event.

With respect to the Kellogg recall, only 4 of the 17 companies experienced negative excess returns on the event date of March 8, 2001, and Kellogg was not one of these firms. However, four trading days later, on March 14, 2001, when Kellogg officially announced the recall, 14 of the 17 companies experienced negative excess returns; Dannon, Keebler, and Corn Products International experienced positive excess returns. Kellogg experienced negative excess returns on one and four days prior to the event, and on one, two, four, and six through nine days after the event date, but not on the event date. The parametric test indicated that none of the firms experienced significant negative abnormal returns on the event day. Kraft and Unilever, NV experienced significant negative abnormal returns on the second day after the

announcement, and Dannon experienced significant negative abnormal returns on the third day after the announcement. Unilever, LTD and Unilever, NV experienced significant negative abnormal returns for days 9 and 10 of the event window. Kellogg did not experience any significant negative returns during the event window.

Results of the Wilcoxon nonparametric rank-sum tests indicate that Kraft, Dannon, and Lance, Inc. experienced actual returns that were statistically different from the expected normal returns for 5 days prior to the event date. Kraft, General Mills, Quaker Oats, Frito-Lay, Taco Bell, Unilever (LTD), and Unilever (NV) experienced significant returns for 5 days after the event, which is consistent with the results of the parametric test. Kraft, General Mills, Heinz, Quaker Oats, Frito-Lay, ADM, Unilever (LTD), and Unilever (NV) experienced statistically different returns for 10 days after the event, and Kellogg did not experience returns significantly different from normal returns based on the Wilcoxon test.

The abnormal returns were further aggregated over intervals of 5, 10, 30, 50, and 100 days after the event date to examine the cumulative impact of the recall over time. At most, 5 of 17 firms experienced negative cumulative abnormal returns for any of the post Kraft Foods event time periods examined, and this result occurred for the [0,5] window. The number of negative cumulative abnormal returns for the Kellogg Starlink corn recall is much greater. Negative cumulative abnormal returns were experienced in 80% of the companies and post event time periods examined. This finding may suggest that the Kellogg recall had a larger negative impact than the Kraft Foods recall, or that the food industry experienced a down movement during that time period when compared with the overall market. To address this question, we reestimated the market model with the S&P food industry index, obtained through Datastream, as an explanatory variable. Results using the S&P food industry index are similar to the results described above for both events in terms of sign and magnitude of the returns. The Kellogg recall leads to a slightly less persistent reaction when measured with respect to the S&P food industry index; the number of negative cumulative abnormal returns is fewer, which can be explained as some down movement experienced by the food industry around the Kellogg recall. After accounting for the food industry down movement, we conclude that the Kellogg recall had a larger total negative impact in the market than the Kraft Foods recall. However, the parametric test indicated that none of the cumulative abnormal returns for any event are statistically significant. The cumulative abnormal returns over [-5, t] event windows, where t belongs to [-5, 10] interval were also estimated for both events. Strikingly, many of the cumulative abnormal returns are negative, but none are statistically significant.

Next, we compare stock price risk, measured by standard deviations of the stock returns, before and after the recalls for different windows around the event days. For the 30 day window, six firms experienced a statistically significant increase in the volatility of the returns after the Kraft Foods recall. Kraft Foods is not among the affected firms. With respect to the Kellogg recall, for the 30 day window, five firms experienced a statistically significant increase in volatility after the event. Again, Kellogg is not among the affected firms. A statistically significant increase in volatility is also detected for larger windows for several firms. No statistically significant increases in the volatility are found for the 150 day window for the Kraft Foods recall, and only Quaker Oats and Keebler show significant increases in volatility for the

150 day window for the Kellogg event. Such results for a large post event window are expected because the potential effect of the recall should disappear after a larger period.[4]

Next, the differences in risk, estimated with the CAPM-based measure of nondiversifiable risk, beta, before and after the events are statistically tested. If the values of the beta coefficient have increased for companies affected by the recalls, one can infer that recalls have increased risk, which investors have to bear. A Chow F-statistic is used to test shifts in beta. Table 1 reports the results of the tests. General Mills and Frito-Lay experienced significant changes in nondiversifiable risk immediately after the Kraft Foods recall. Kraft is not among the affected firms. The pre-event beta and post-event beta of General Mills, estimated over a 30 day window, are –0.16 and 0.02 respectively. That is, the beta changed in sign and the absolute magnitude of the beta decreased. The Chow test shows this change in sign. However, the nondiversifiable risk of General Mills decreased, not increased as was expected. For the 30 day window, Frito-Lay's pre-event beta is 0.16 and the post-event beta is –0.61. That is, the sign on the beta changed, which reflects the change of the direction of the stock movement relative to the market, and beta increased in absolute magnitude reflecting the increased nondiversifiable risk. ADM, Unilever, LTD and Unilever, NV show significant changes in nondiversifiable risk, but these changes happened for larger post event time periods, which suggests that these changes are not due to the considered recalls.

Kellogg recall had a greater impact on the nondiversifiable risk of the firms. Table 1 indicates Kraft, Frito-Lay, ADM, Unilever, LTD and Unilever, NV experienced significant changes in the nondiversifiable risk immediately after the recall. However, Kellogg is not among the affected firms. Betas of these firms were negative before the event, but positive and greater by absolute magnitude after the event. That is, there is some evidence that the Kellogg recall increased the riskiness of these firms.

Figure 3 shows down movement of ConAgra daily stock price after the ConAgra's announcement that it had closed its only corn mill. Seven firms, including ConAgra, experienced negative abnormal returns on the event day, but none of these abnormal returns were statistically different from zero. None of the cumulative abnormal returns over the [-5, t] event windows, where t belongs to [-5, 10] interval, were statistically significant.[5] Again, no impact of the event and no persistence of negative abnormal returns, as it was with the Kellogg recall, were detected. The volatilities of the returns of four of the considered stocks, including ConAgra, did change immediately after the event. For ConAgra, the results are significant for all periods considered. For nine firms, volatilities changed not immediately after the recall, but within the 50 day period, which would seem to indicate the influence of other factors not related to the event. Chow tests (Table 1) indicate changes in the market regime for ADM, Unilever, LTD and Unilever, NV.

Conclusions

Interest in food safety issues is at a high level in the U.S., and food safety events affect business and industry, consumers, and the general public. Previous research has found shareholder losses occur when companies are implicated in serious food safety hazards and that stock market reaction to food safety issues has differed by incident and by firm.

The objective of this research was to quantitatively examine the effects of Starlink corn food safety events on the risks and the returns of food and agribusiness firms, directly and indirectly affected by the events. In this study, abnormal returns and cumulative abnormal returns of 17 agribusiness firms around Kraft Foods' and Kellogg's Starlink corn food recalls and ConAgra's closed plant event were estimated and tested. Results suggest that the company enacting the recall does not necessarily experience the largest or even significant impacts on its stock returns. Only a few firms experienced significant abnormal returns on some of the days during the event-window period. The results of parametric tests and Wilcoxon rank-sum tests are consistent only for some of these few firms. The levels of returns of the firms enacting the recalls were not affected by the events. Based on parametric tests, none of the cumulative abnormal returns over the [-5, *t*] event windows, where *t* belongs to the [-5, 10] interval, were statistically significant. None of the cumulative abnormal returns over intervals of 5, 10, 30, 50 and 100 days after the event date were statistically significant.

Analysis of the overall riskiness of returns before and after the events revealed that at most six firms experienced greater volatility after the events, and the changes in volatility were significant for short post event windows. The analysis of the nondiversifiable risk before and after the events showed that only Frito-Lay experienced an increase in nondiversifiable risk after the Kraft Foods recall, which is consistent with the results of the volatility analysis. Kellogg recall had a greater impact on firms' risk and returns and affected a greater number of firms: Kraft, Frito-Lay, ADM, Unilever, LTD and Unilever, NV experienced significant changes in the nondiversifiable risk after the event. Kellogg recall occurred nearly 6 months after the Kraft Foods recall, however had greater effect. This result may suggest that as new food safety events occur that relate to prior events and additional information is incorporated in the market, the impacts of food safety issues such as food recalls may increase. The ConAgra event seems to have had no impact on the level of the stock returns and some impact on the volatility of the returns. Probably, the information about ConAgra was revealed too gradually to the market over more than one month, which can explain the absence of a reaction on the level of returns but the presence of some reaction on volatility.

Results of this analysis indicate that it is not possible to reject the hypothesis that Wall Street is not sensitive (in terms of levels of returns) to the Starlink corn food recalls. Overall riskness of the stocks, measured by volatility, and nondiversifiable risk of the stocks appeared to increase after the events for some of the firms. However, it is not clear whether these effects are only due to the Starlink corn events or due to something else also, since during the event and post event windows other announcements about the considered firms, but unrelated to Starlink corn, took place.

We conclude that financial market reaction to the considered Starlink corn food safety events is very limited. One of the possible explanations is that management had in place proper tools to minimize the impact of the event to preserve the image of the firm in the stock market. It could also be that the sales of contaminated product were a minor component of the corporate revenue. Finally, previous research has found wealth losses occur when companies are involved in serious food safety hazard situations. However, the consumption of foods contaminated with

Starlink corn may result in allergies, but does not lead to immediate health concerns. Investors may perceive that involvement in the Starlink corn food safety events does not destroy the firm's image and does not significantly impair the long-run value of the firm which may explain the absence of statistically significant stock market reaction to these events.

Endnotes

[1]See Appendix for the detailed description of the test.

[2]Here it was not possible to avoid overlapping the market model period for the ConAgra event with market model period for the Kraft Foods event. So, the market model estimation period is chosen to be 120 business days.

[3]During the market model estimation period, Kraft was owned by Philip-Morris; Quaker Oats was acquired by Pepsico in August 2001; Frito-Lay was owned by Pepsico; Keebler was acquired by Kellogg in March 2001; Taco Bell was owned by Tricon Global Restaurants; Unilever (UK) and Unilever (NV) trade separately. These issues are accounted for in the stock returns used.

[4]We also examined the standard deviations of the stock returns before and after the recalls for different windows around the [-5, 5] period, but excluding the [-5, 5] window. This should leave out the increased volatility of returns around the event, which is reflected in the smaller number of significant changes of the volatilities of the stock returns. In general, the exclusion of [-5,5] period does not change the results.

[5]Here and for the volatility and nondiversifiable risk analyses, the post event windows are restricted by 90 days to avoid overlapping with the Kellogg event.

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Figure 1. Kraft Foods daily stock price around the Kraft Foods recall of Taco Bell taco shell products.

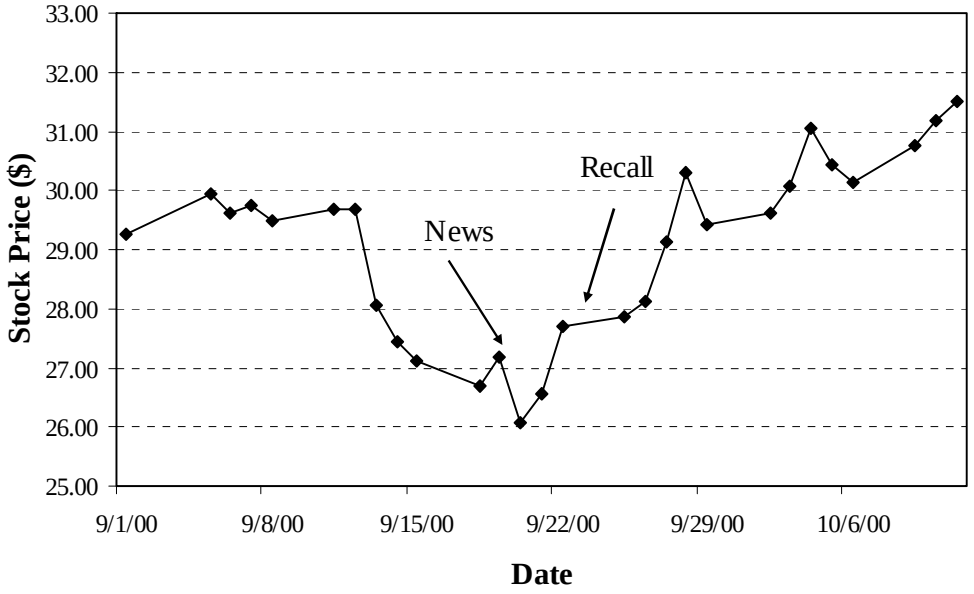

Figure 2. Kellogg daily stock price around the Kellogg recall of Morningstar Farms Corn Dogs.

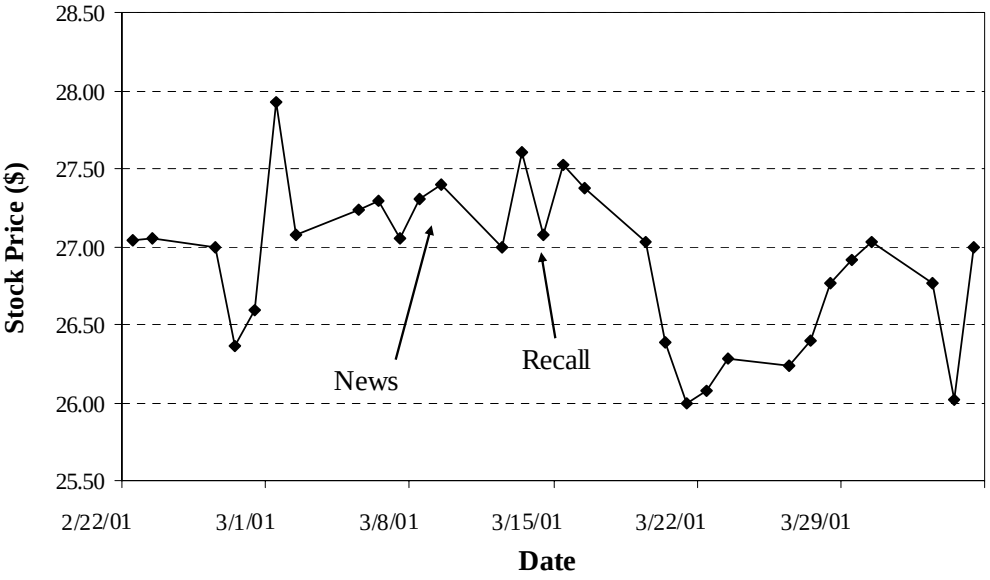

Figure 3. ConAgra Foods daily stock price during the period when ConAgra closed its only corn mill.

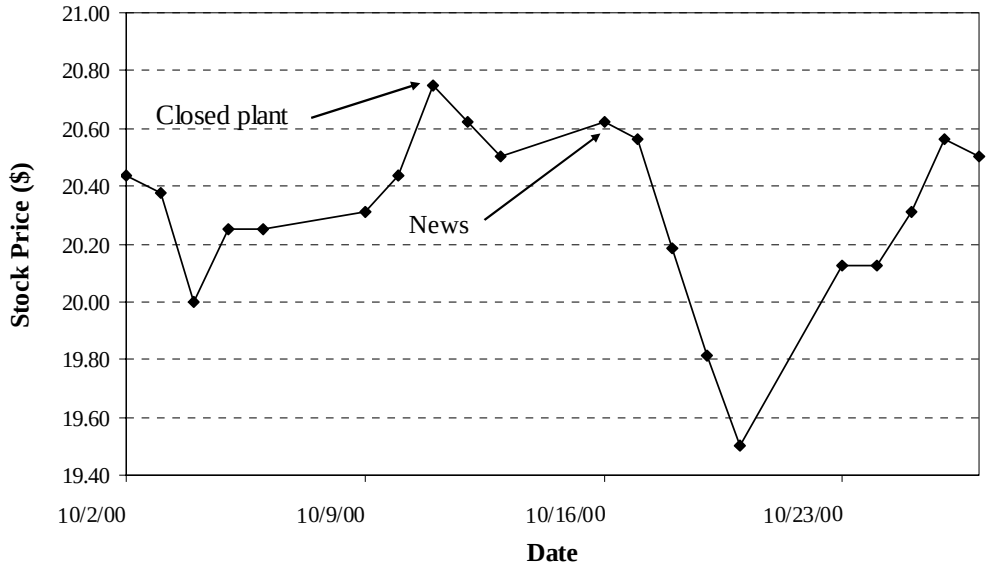

Figure 4. Abnormal returns around Kraft Foods event for some of 17 considered firms, five days before and 10 days after the event. Abnormal returns are calculated using market model using CRSP value weighted market index.

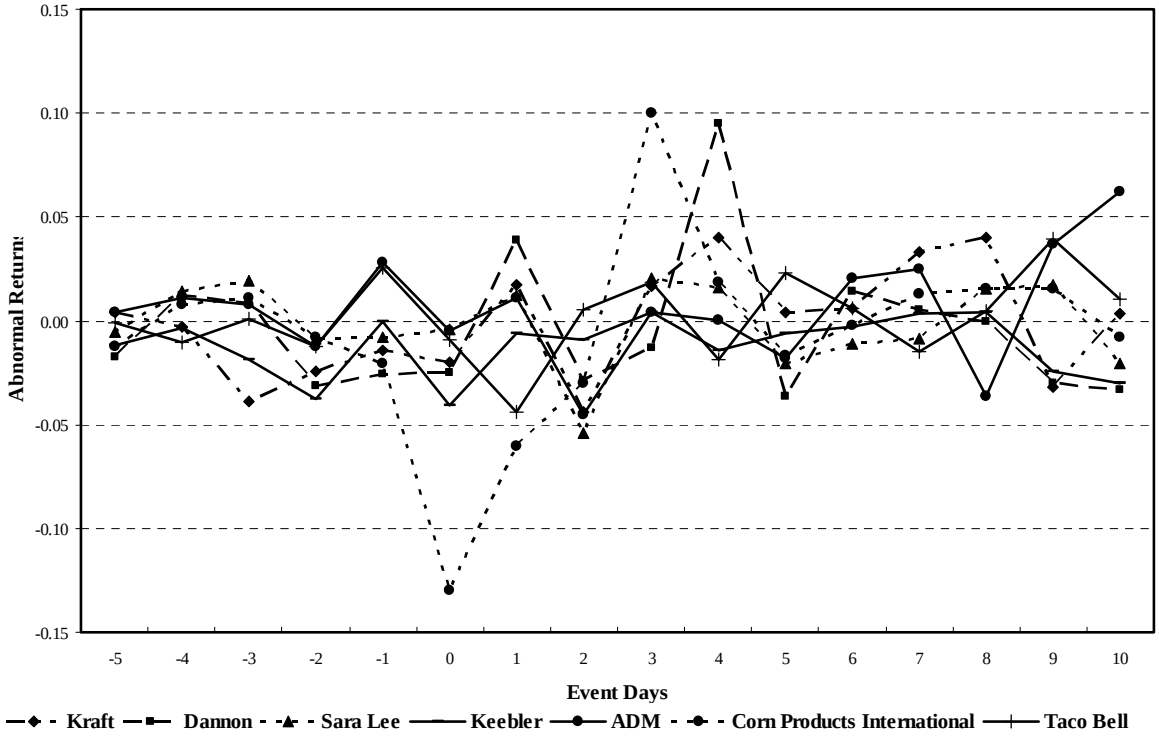

Figure 5. Abnormal returns around Kellogg event for some of 17 considered firms, five days before and 10 days after the event. Abnormal returns are calculated using market model using CRSP value weighted market index.

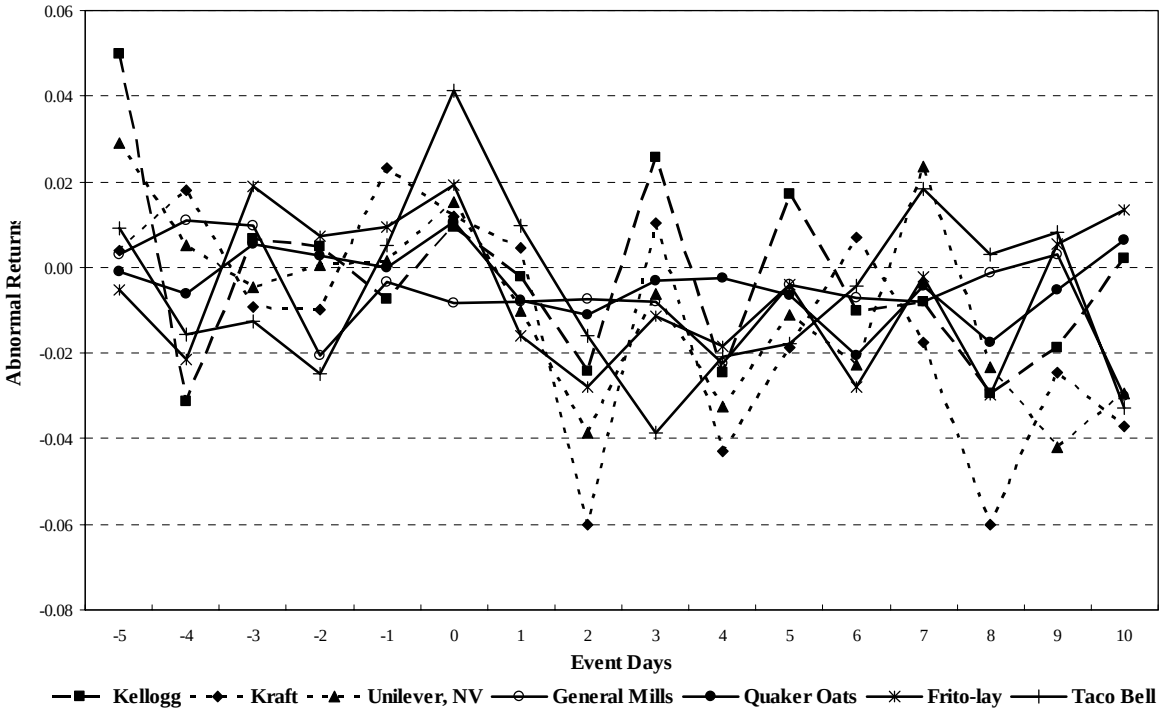

Table 1. Results of Chow tests for changes in CAPM-based measure nondiversifiable risk, beta, before and after the events.

Company	09/18/2000 event					03/08/2001 event					10/17/2000 event		
	30 days	50 days	100 days	120 days	150 days	30 days	50 days	100 days	120 days	150 days	30 days	50 days	90 days
Kraft						***	***	***	***	***		**	**
Dannon													
Sara Lee													
General Mills	*	***	**	*	*								
Heinz						*		**	***	***			
Kellogg								*	*	**			
ConAgra													
Quaker Oats								*					
Frito-Lay	*	**			*	**	**	***	***	***			
Keebler													
ADM		*	**	**	**	**	***	**	**	**	*	*	
Corn Products Int'l				*									
Lance													
Taco Bell													
Aventis										*		**	**
Unilever. LTD		**	***	**	**	***	***	***	***	***	***	**	***
Unilever. NV			**	**	*	***	***	***	***	***	**	**	**

*** Significant at 1% level.
** Significant at 5% level.
* Significant at 10% level.

Appendix

To conduct a parametric test, we adopted the method described in Campbell, Lo, and MacKinlay (1997). If we denote the length of the estimation window as L_1, the length of vectors R_i and X_i is L_1. Then, the ordinary least squares (OLS) estimators of the market-model parameters $\hat{\theta}_i$ and $\hat{\sigma}^2_{\varepsilon i}$, using an estimation window of L_1 observations, are:

$$\hat{\theta}_i = (X_i' X_i)^{-1} X_i' R_i \tag{2}$$

$$\hat{\sigma}^2_{\varepsilon_i} = \frac{1}{L_1 - 2} \hat{\varepsilon}_i' \hat{\varepsilon}_i \tag{3}$$

$$\hat{\varepsilon}_i = R_i - X_i \hat{\theta}_i \tag{4}$$

$$Var[\hat{\theta}_i] = (X_i' X_i)^{-1} \sigma^2_{\varepsilon_i} \tag{5}$$

L_2 denotes the length of the event window. The vector of abnormal returns, $\hat{\varepsilon}^*_i$, over the event window for security i can be found using market model estimates of the normal returns:

$$\hat{\varepsilon}^*_i = R^*_i - X^*_i \hat{\theta}_i \ , \tag{6}$$

where R^*_i is a vector of event-window returns on security i and $X^*_i = [\iota \ R^*_m]$ is a matrix with a vector of ones in the first column and vector of event-window market returns R^*_m in the second column. We make the assumption that, conditional on the market return over the event window, the abnormal returns are jointly normally distributed with zero conditional mean and conditional covariance matrix V_i:

$$\hat{\varepsilon}^*_i \sim N(0, V_i) \tag{7}$$

$$V_i = I\sigma^2_{\varepsilon_i} + X^*_i (X_i' X_i)^{-1} X^{*\prime}_i \ \sigma^2_{\varepsilon_i} \ , \tag{8}$$

where I is a square identity matrix of size L_2. Distributional properties (7) can be used to test the null hypothesis that the event has no impact on the mean or variance of the returns. Abnormal returns are aggregated into cumulative abnormal returns. Let $CAR_i(t_1, t_2)$ define the cumulative abnormal return for security i for interval $[t_1, t_2]$, where $t_1 \leq t_2$ and t_1 and t_2 belong to event window of length L_2. Note, when $t_1 = t_2$ the $CAR_i(t_1, t_2)$ is simply $AR_i(t_1)$. That means that a statistical procedure to test *CARs* can be used to test *ARs* over the event window as well. Let γ be a vector of length L_2 with ones in positions $[t_1, t_2]$ and zeros elsewhere. The estimated $CAR_i(t_1, t_2)$ and its variance are calculated as:

$$CAR_i(t_1, t_2) = \gamma' \hat{\varepsilon}_i \, * \tag{9}$$

$$Var[CAR_i(t_1, t_2)] = \gamma' V_i \gamma = \sigma_i^2(t_1, t_2) \, . \tag{10}$$

The estimate of the variance of $CAR_i(t_1, t_2)$, $\hat{\sigma}_i^{\,2}(t_1, t_2)$, are obtained by substituting (3) into the expression (8). Under the null hypothesis,

$$CAR_i(t_1, t_2) \sim N(0, \sigma_i^2(t_1, t_2)) \, . \tag{11}$$

The standardized cumulative abnormal return is:

$$SCAR_i(t_1, t_2) = CAR_i(t_1, t_2) / \hat{\sigma}_i(t_1, t_2) \, , \tag{12}$$

which is distributed as the Student t-statistic with L_1-2 degrees of freedom. This provides for a test of null hypothesis that $CAR_i(t_1, t_2) = 0$, or the event has no impact on the returns to be tested.