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Market Learning After Recurrent Meat and Poultry Recalls

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MARKET LEARNING AFTER RECURRENT MEAT AND POULTRY RECALLS

by

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ABSTRACT

MARKET LEARNING AFTER RECURRENT MEAT AND POULTRY RECALLS

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Several studies have been conducted to evaluate the cost of meat and poultry product recalls to food firms. The goal of this analysis is to formally test whether or not subsequent recalls are associated with less negative stock price returns, and whether or not there is a difference in the magnitude of returns between a first, second, and third or more recall. This is completed through an event study analysis. Results indicate that recurring recall events affecting a firm within 12 months of the first recall incident are indeed associated with less impactful negative outcomes. On average, *initial* recall events are associated with short-term reductions in shareholder wealth of up to $236 million, 5 days after the recall announcement, while no negative reactions are found for s*ubsequent* recall events after the initial recall announcement date.

Introduction

Food safety is a topic that has continued to find itself in media headlines. In 2015, the Mexican food franchise Chipotle issued a recall due to an *E. coli* O26 outbreak that sickened dozens. In 2013, a recall was issued by Sunland Inc. for peanut butter infected with *Salmonella*, an incident that sickened 42 people, and eventually caused the company to file Chapter 7 bankruptcy later that year (CDC, 2012a; U.S. Bankruptcy Court, 2013). Food firms regularly recall products for a variety of reasons, however recalls of meat and poultry products are of particular concern because these products are often contaminated with deadly pathogens such as *E. coli*, *Salmonella*, and *Listeria*. Meat and poultry recalls account for roughly half of all food related recall incidents in the U.S. (Salin et al., 2006). In recent years, the number of U.S. meat and poultry recall incidents has increased. In 2015, the U.S. Department of Agriculture's (USDA) Food Safety and Inspection Service (FSIS), which monitors meat and poultry recalls, reported 150 recalls within the year. This represents a 53 percent increase over the number of 2010 incidents (FSIS, 2016).

Because of the potential human health risks, meat and poultry recalls are a cause of great concern for consumers, food firms, and the food industry as a whole. In 2014, the U.S. Center for Disease Control and Prevention (CDC) identified nearly 20,000 cases of infection caused by food-borne pathogens which resulted in 4,445 hospitalizations and 71 deaths. Besides the unpleasant, and sometimes dangerous symptoms caused by foodborne illnesses the costs to consumers also come in the form of lost income, decreased productivity at work, additional child care costs, and lost leisure time (Buzby and Roberts, 1996; CDC, 2012b). Food recalls have a substantive negative economic impact on food firms, and the food industry in general, as they have been shown to substantially decrease product demand as well as the prices of associated food products (Mckenzie and Thomsen, 2001; Piggott and Marsh, 2004; Moghadam et al., 2013). Food recalls can be very costly to firms for a number of reasons. Firms must front the costs of disposing of contaminated material, cover the costs of any litigation brought against them, and sustain losses while their production process is halted. In addition to upfront costs, firms may suffer long-term losses due to a worsened reputation and decreased stakeholder confidence.

Several studies in the past have been conducted to estimate and understand the costs to firms that result from food recall events (Salin and Hooker, 2001; Thomsen and Mckenzie, 2001; Wang et al., 2002; Pozo and Schroeder, 2016). Because obtaining dollar amounts for total private, firm-level costs associated with a food recall can prove difficult, researchers have instead analyzed the effects of these incidents on firms' share prices. Assuming the market is rational and efficient, the economic impact of a food recall on firm value can be captured by estimating price reactions in financial markets (Mackinlay, 1997).

Previous literature has indicated that meat recalls have, on average, a significant negative economic impact on shareholder wealth (Thomsen and McKenzie, 2001). However, one interesting finding that has come from these analyses is that this impact appears to be lessened when firms issue subsequent recalls after an antecedent event (Salin and Hooker, 2001; Wang et al., 2002; Seo et al., 2013; Pozo and Schroeder, 2016;). These results go against conventional wisdom, as one would expect multiple recall events from the same company to decrease stakeholder confidence in the firm. One hypothesis that has been proposed by these studies is that the market learns after it observes a firm successfully handling a recall event, and it is less reactive when a consecutive incident occurs. However, conclusions from these studies are only based on the analysis of a few recall incidents, or have not been formally tested.

The goal of this study is to systematically test the hypothesis that subsequent recall events for meat and poultry products are less impactful to food firms than those caused by initial recall events. This is accomplished through an event study analysis of stock price returns for publicly traded firms issuing meat and poultry recalls in the last 22 years. In this analysis we do not attempt a direct measurement of losses incurred by a firms as result of a recall, but instead quantify the effects of meat and poultry recalls on food companies' using a drop in market valuations shortly after the incident as a proxy for overall cost. This is accomplished through an event study analysis of firms' share prices. Ultimately, conclusions are drawn by examining abnormal returns calculated for first-time and subsequent recall events. This study adds to the previous literature as this hypothesis has yet to be formally tested by comparing abnormal returns for a large sample of meat and poultry recalls.

The results found here contribute to a better overall understanding of costs associated with food recall events. Understanding and measuring the costs to food firms associated with recalls is important for several reasons. Food safety and contamination prevention measures most often take place at the firm level. Thus understanding costs and benefits in prevention efforts for firms allows for effective cost-benefit analysis of food safety measures to be performed. Previous attempts at such analysis have been limited by the lack of information on these costs (Ivanek et al., 2005). When the managers of firms fully understand the potential costs associated with product recalls they can make more informed decisions about investing in food safety measures. Another reason it is important to understand costs to firms caused by recall events is that there is limited evidence that external government regulations have been effective in the prevention of recalls at the firm level (Kafetzopoulos, 2013). For this reason, examining internal incentives for firms to prevent recall events provides valuable information to all who have stake in food recall prevention.

Literature Review

The negative impacts of recalls to the food industry in general have been well covered by previous literature. Marsh et al. (2004) found a statistically significant decrease in the demand of beef and pork products during time periods in which high volumes of recalls were being issued. They also found that the demand for substitutes is generally shifted to non-meat products as opposed to shifting to chicken or other meat products. Similarly, Piggott and Marsh (2004) found that negative news, often caused by recall events, can have substantial effects on consumer demand of meat and poultry products. The estimated demand for poultry was found to decrease by up to 6.9 percent during times when poultry-related negative media attention was most abundant.

Several studies have also shown that recalls have adverse effects on prices of meat and poultry products. Through an event study analysis, McKenzie and Thomsen (2001) found that meat and poultry recalls significantly affect prices of wholesale boneless beef. On the day of a recall announcement, wholesale boneless beef prices displayed a drop of 0.99 percent. Considering the 2015 yearly U.S. beef consumption of 23.69 billion pounds, and the average 2015 Choice beef price of $6.29 per pound this, translates into a total cost to the industry of $4.47 million per recall event day (National Cattlemen’s Beef Association, 2015). In addition to wholesale meat, live cattle futures prices have also been shown to be negatively impacted by food recall events. Moghadam et al. (2013) found that, on average, one *E. coli O157:H7* recall is associated with an estimated $13.4 million loss to cattle producers.

Costs of recall events at the individual food firm level have also been examined (Salin and Hooker, 2001; Thomsen and McKenzie, 2001; Wang et al., 2002; Seo et al., 2013; Pozo and Schroeder, 2016). For example, Thomsen and McKenzie (2001) found significant shareholder losses in the short term after a recall involving severe food safety hazards. On average, a Class I recall, the most severe type of recall event, reduced shareholder wealth by 1.5 to 3 percent. In addition to measuring the negative impact on shareholder wealth caused by contamination incidents, several of these studies have further revealed that this negative impact is lessened for firms issuing subsequent recalls after a first-time recall event (Salin and Hooker, 2001; Wang et al, 2002; Seo et al., 2013; Pozo and Schroeder, 2016).

In Salin and Hooker's (2001) analysis, several recall events were compared including two large *E. coli* related recalls issued by IBP, Inc.[1] The first recall occurred on April 29, 1998, and the second, several months later on November 4th 1998. The authors found a statistically significant, negative impact on stock price returns, as well as higher volatility associated with the first IBP recall event, but found no statistically significant negative abnormal returns associated with the second event. This result was obtained despite the fact that the second recall event was almost twice the size in terms of pounds of product recalled. Wang et al. (2002) further analyzed these two IBP recall events, as well as a third IBP recall event occurring on June 23rd, 2000 (also issued for *E. coli* contamination). Increased volatility caused by the first recall event was addressed by applying a Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model. Even after accounting for increased volatility, a strong negative impact was identified for the first recall event but the negative impact for the second and third recall was significantly smaller.

[1] IBP, Inc. was a large U.S. meat and packing company that was acquired by Tyson Foods in January of 2001 (Barboza, 2001).

In 2016, Pozo and Schroeder conducted an event study of stock returns for a large sample of food firms that had issued meat and poultry recalls. The magnitudes of abnormal returns were estimated, and subsequently modeled, as a function of several firm, and recall-specific characteristics, including whether or not the specific firm had experience handling a recall in the previous year. Stock prices of experienced firms were found to be, on average, 2 percent higher than stock prices of inexperienced firms. Seo et al. (2013) applied an event study framework to all food recall events reported through the CDC. A one-way ANOVA method was used to compare differences in mean abnormal stock price returns for different types of recall events. The authors found returns to be 9 percent lower than expected for recalls issued by firms with no history of a recall event while returns for firms with a history of recall events were only 2 percent lower than expected.

The finding that subsequent recall events have smaller economic impacts than original recalls is intriguing and somewhat counter-intuitive. Work by Coombs (2004) on Situational Crisis Communication Theory (SCCT) suggests that a history of similar crises for organizations should intensify the threat of negative reputation when an additional crisis event occurs. Seo et al. (2013) explain, “A past crisis similar to a current crisis indicates that the crisis occurs regularly rather than irregularly, resulting in higher crisis attribution or responsibility. If a firm is perceived as highly responsible for a crisis outbreak, people are more likely to have a negative reaction compared to a firm with no crisis history.”

One possible explanation for this interesting phenomenon is that investors perceive well-handled previous recalls as a positive signal. For example, it may be the case that when the market observes that a firm has handled an initial recall incident well, it is more confident in the firm's ability to handle the later recall and is less reactive[2] (Salin and Hooker, 2001; Seo et al. 2013; Pozo and Schroeder, 2016). Following this logic, it is a possibility that the market perceives a previous voluntary recalls as an act of corporate social responsibility (CSR). Analysis performed by Klein and Dawar (2003) examined the role of CSR on the brand evaluations of firms after a crisis event. It was found that consumers generally put less blame for product-harm events on firms that had previously displayed CSR as opposed to firms who had never displayed an act of CSR. This decreased blame translates into better brand evaluations, which in turn, predict buying intentions.

Mowen et al. (1981) found that after a recall issued by Ford, favorability towards the company was increased when consumers perceived the recall as an act of social responsibility. When consumers were under the impression that Ford issued the recall voluntarily at a cost to itself, in order to ensure the safety of its consumers, they responded less negatively toward the company when a subsequent recall was issued. Of course, the market is not naïve to the fact that firms' motives behind voluntary product recall are not wholly altruistic. For example, in the case of meat and poultry recalls, firms may face large by not issuing a necessary product recall including litigation costs if their product is implicated as a cause for severe illness or death. In addition, while all meat and poultry recalls are technically issued on a voluntary basis, FSIS has the authority to seize a firm's products in commerce that are suspected to be unsafe. These penalties could potentially outweigh the cost of issuing the recall in the first place. However,

[2] As recalls occur at random, it is unlikely that smaller negative reactions to subsequent recalls are simply caused by stakeholder's expectations for subsequent recalls to occur. There is no clear pattern as to when, and if subsequent recall events for a firm will occur. Additionally, FSIS does not usually issue subsequent recall events when additional defective product is found from the same contamination event. Instead a recall extension is issued. These recall extensions are not treated as a separate recall in the analysis performed here.

firms can influence the way that their recalls are perceived through media campaigns and statements to investors.

This phenomenon of less severe effects associated with subsequent recalls may also have to do with learning on the firm side. It may be that firms learn how to better handle recall events and instill stakeholder confidence through previous experience (Seo et al., 2013). Sociological research has, in fact, shown that organizational leaders develop new routines from inference and learning based off previous experiences (Levitt and March, 1988). Another possibility is that firms that have not yet experienced a recall event carry a certain ‘liability’ that comes with having a good track record. Research on recalls in the automobile industry demonstrated that highly reputable firms are more highly penalized by the market when product safety issues occur than firms that have a history of lower quality product (Rhee and Haunschild, 2006). In fact, Dawar and Pillatula (2000) found evidence that consumers’ reactions to product harm crises have more to do with previous expectations for the firm than with the actual severity of the crises. Research has confirmed that firms’ reputation creates expectations about the quality of their products (Shapiro, 1983).

Methods

The empirical analysis of this study is accomplished using an event study of stock prices as described by MacKinlay (1997). An event study is built upon the assumption of the efficient market hypothesis. This theory, as explained by Fama (1970) and supported by a large body of evidence, states that relevant market information is always incorporated into a firm’s share price. This means if a recall event has substantially harmed a company through direct private costs or potential future earnings, this will be immediately reflected by a downward stock price movement. The primary benefit of an event study analysis using stock prices is that it allows for measurement of the total economic impact of an event, without the need for collecting data on all direct costs incurred by a firm. For example, to obtain a measurement of total private costs to a firm as a result of one meat and poultry recall, dollar amounts would need to be obtained for the costs of recapturing and disposing of the product, lost revenues, litigation costs, and lost future sales. Collecting this information for one recall event is a considerable task, while doing so far a large sample of recalls is not practical. For this reason, event studies using share prices have been used extensively in previous literature to measure the impact of recall incidents on food firms as well as in the pharmaceutical, automobile, and airline industries (Jarrel and Peltzman, 1985). In this analysis, the event study is used to accomplish the goal of quantifying the impacts of different types of meat and poultry recalls on firms by analyzing abnormal drops in share price shortly after the recall incident.

An event study analysis can be broken down to four general steps. First, a benchmark model is estimated using historical stock and market index prices. Second, this benchmark model is used to predict what the expected returns for the firm should have been, had the recall event not occurred. This is done for a chosen window surrounding the recall event. Third, the predicted returns are subtracted from actual returns to obtain abnormal returns (ARs) for each trading day in the specified window. Abnormal returns are then accumulated over time windows of interest and averaged over all of the recall events in the sample to obtain cumulative average abnormal returns ($CAARs$). And fourth, $CAARs$ are classified into different groups and tested as to whether or not they are significantly different from zero.

Before beginning the event study analysis, a time frame of interest around each recall event must be determined. Let T denote the time period surrounding each recall event, comprised of t individual trading days. T is then divided into two non-overlapping time periods, the estimation period, where $t \in [T_1 + 1, T_2]$, and the event window, $t \in [T_2 + 1, T_3]$. The event window includes the event day of interest which is denoted as $t = 0$. For this analysis $t = 0$ is defined as the date of the official recall announcement by FSIS, or the next trading day if the announcement was made on a weekend or holiday when the markets were closed. The benchmark model is estimated using data from the estimation period and predictions are made over the event window.

The market model is used as a benchmark model in this analysis. This model was chosen as opposed to the constant mean return model because of its increased power (MacKinlay, 1997). The market model assumes a linear relationship between a particular firm's stock price return and a market index. It is estimated as

(1) $R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$, $\quad\quad \forall\ t \in [T_1 + 1, T_2]$

where R_{it} is the expected return for firm i at time t, and α_i, and β_i are parameters to be estimated. The time index t represents trading days. The error term, ε_{it} ,is assumed to have a mean of zero and constant variance $\sigma_{\varepsilon_i}^2$. R_{mt} is the market return, represented by the return at time t for a major portfolio index. A unique model is estimated for each recall event in the sample. Each model is fit with several different indices used for the value of R_{mt}.[3] For each estimated model, a Ljung-Box test for serial correlation of the error term was carried out. If serial correlation was present in the basic benchmark model, an autoregressive distributed lag model (ARDL) of the form

(2) $R_{it} = \alpha_i + \gamma_{1i} R_{it-1} + \beta_{1i} R_{mt} + \beta_{2i} R_{mt-1} + \varepsilon_{it},$ $\quad\quad \forall\ t \in [T_1 + 1, T_2]$

[3] The model with the best fit according to AIC criterion was used as the selected benchmark model.

was fit, as opposed to the linear model in (1). This model was also tested for serial correlation and additional lags of R_{it} and R_{mt} were added to the right hand side of (2) if serial correlation continued to present itself.

Simple daily firm and market returns used in the benchmark model were calculated as:

(3) $R_{it} = 100 \times \left(\frac{p_{it}}{p_{it-1}}\right)$, $R_{mt} = 100 \times \left(\frac{p_{mt}}{p_{mt-1}}\right)$

where p_{it} is the observed firm stock price and p_{mt} is the market index measured at time t.

Before estimating the benchmark model, it is important to appropriately define the time window over which it will be estimated. Longer estimation windows can lead to increased accuracy of benchmark models. However, the use of very long estimation windows increases the risk that extraneous factors, such as previous recalls will unduly influence the model (Armitage, 1995). If a benchmark model is estimated during a time period when another recall occurred for the same firm, the model will be biased, and will likely have increased volatility caused by the first recall event (Wang et al., 2002). In this analysis, an estimation window of 120 trading days is chosen. This is a shorter window than the 250 trading day windows employed by Pozo and Schroeder (2016) and Thomsen and McKenzie (2001). However, Salin and Hooker (2001) estimated their benchmark model using 75, 120, and 250 trading days and found no significant difference in their results. A meta-analysis of event studies done by Armitage (1995) found that results are not usually sensitive to varying estimation window length as long as the estimation window exceeds 100 days[4].

The second step of the event study, after the benchmark model is estimated, is predicting stock price returns for an event window of interest. Using the basic market model, predictions are obtained as

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[4] Varying estimation windows were not tested in this analysis.

(4) $\widehat{R_{it}} = \hat{\alpha} + \widehat{\beta_{1i}} R_{mt}, \qquad \forall\, t \in [T_2 + 1\,, T_3]$

where $\hat{\alpha}$ and $\widehat{\beta_i}$ are the estimates obtained from fitting (1) with data from the chosen event window. R_{mt} are realized market returns also occurring over the chosen event window. Predictions when an ARDL model is fit are obtained similarly:

(5) $\widehat{R_{it}} = \hat{\alpha} + \widehat{\gamma_{1i}} R_{it-1} + \widehat{\beta_{1i}} R_{mt} + \widehat{\beta_{2i}}\, R_{mt-1}, \qquad \forall\, t \in [T_2 + 1\,, T_3]$

where $\hat{\alpha}$, $\widehat{\gamma_{1i}}$, $\widehat{\beta_{1i}}$, and $\widehat{\beta_{2i}}$ are estimated from (2) and R_{it-1} and R_{mt-1} are realized lagged firm and market returns, respectively.

Investigations into contamination incidents may point to a specific company before a recall announcement is officially formalized by FSIS. Also, once a company learns that a product has been adulterated they have 24 hours to report the issue to FSIS (FSIS, 2013). Therefore, it is possible that employees and shareholders become aware of a contamination incident before an official announcement. To account for this, 5 trading days preceding the recall announcement day are included in the event window of interest. This allows for testing of information leakage into the market. Therefore, we denote the first day of our estimation window as $T_2 + 1 = -5$. Predictions of returns are calculated up to 20 trading days after the event day so that $T_3 = 20$. The 120 days of the estimation window fall before the prediction window so that $T_1 + 1 = -125$ and $T_2 = -6$.

After the benchmark model has been estimated and used to predict stock price returns, $\widehat{R_{it}}$, over the event window, we proceed to calculate abnormal returns. Abnormal returns (ARs) for each firm, i, and trading day, t, are defined as

(6) $AR_{it} = R_{it} - \widehat{R_{it}}$

where R_{it} are the realized stock returns at time t for company i and $\widehat{R_{it}}$ are the predicted returns calculated using the benchmark model (equations 1 and 2). The effects on returns over different intervals of time are of interest in an event study. τ_1 and τ_2 are denoted as the first and last day of the interval of interest, respectively. Abnormal returns for each event are accumulated over this interval to obtain cumulative abnormal returns (*CARs*) as follows:

(7) $CAR_i(\tau_1, \tau_2) = \Sigma_{t=\tau_1}^{\tau_2} AR_{it}$

In this analysis, *CARs* are calculated over several windows of interest between -5 and 20 trading days so that $T_2 + 1 = -5 \leq \tau_1 \leq \tau_2 \leq T_3 = 20.$ A measure of the overall impact of all events in this study is obtained by calculating the average *CAR* for all of the N events in the sample. This is denoted as *CAAR* and is calculated as

(8) $CAAR(\tau_1, \tau_2) = \frac{1}{N} \Sigma_{i=1}^{N} CAR_i(\tau_1, \tau_2).$

After *CAARs* are calculated, hypothesis testing is conducted. Consistent with previous literature, under the null hypothesis, recall events have no impact on the stock price returns of firms. That is,

(9) $H_0: CAAR(\tau_1, \tau_2) = 0$

$H_A: CAAR(\tau_1, \tau_2) < 0.$

To test this hypothesis, a nonparametric generalized rank t-test (GRANK-T) proposed by Kolari and Pynnonen (2011) is used. This test statistic is robust to the increased volatility induced by event day clustering, occurring when recall events happen close to each other in time.

The particular goal of this analysis is to examine how effects of successive recall events differ from initial events. To accomplish this, *CAARs* are calculated separately for two different recall classifications. In the first classification, *CAARs* are compared for *subsequent* recall events versus *initial* events. Following Pozo and Schroeder (2016), *subsequent* recalls are recalls issued by firms that have issued another recall within the previous 12 months. A recall is designated as an *initial event* if it had never issued a recall, or if more than 12 months had passed since the firm had last issued a recall. For the second classification, differences in stock price reactions when firms have experienced multiple recalls occurring over a short time frame are examined. Sequences of recalls, all occurring over no more than 36 months, were identified from the data. Recall events were then classified as either a *first* recall, *second* recall, or *third or higher* recall.

Data

FSIS is the division of the USDA tasked with ensuring the safety of the U.S. supply of meat and poultry products. When a meat or poultry product recall is initiated by a firm, FSIS oversees the recall and reports the information publicly on their website. FSIS maintains an archive of recall cases as far back as January 1994. Information from the FSIS recall case archives regarding firm names and recall dates was gathered for all meat and poultry recalls between January 1994 and February 2016. Publicly traded firms were identified through financial news terminals and internet searches. For the purpose of this analysis, firms designated as subsidiaries of publicly traded firms were treated as if they were issued by their parent organization.

The initial data collected from FSIS includes information on 1,405 recalls.[5] Of these, 170, or roughly 12 percent, were recalls issued by firms publicly traded on U.S. markets. Following Thomsen and McKenzie (2001), the sample of recalls issued by publicly traded firms was then 'de-clustered', only allowing for inclusion of recall events occurring a certain number of days apart. For this analysis a de-clustering time frame of 60 days was used[6]. If a particular firm had issued a recall within the previous 60 trading days, the recall of interest was removed from the

[5] When FSIS discovers that more product has been contaminated then initially discovered, a recall expansion will be issued. For this analysis information on recall expansions was not collected. Only information from the original recall announcement was used.
[6] As an added robustness check 'de-clustering' windows ranging from 60 to 120 days were tested. Overall results remained consistent with use of the various windows.

sample. While the G-Rank T statistic employed is robust to event clustering, this step is taken as an extra precaution against the potential adverse effects of event day clustering. After removal of the clustered events, the total sample size used for the analysis consisted of 140 total recall events from 33 different food firms. Table 1 provides summary statistics on several firm and recall specific characteristics. These are categorized by (i) all of the recall events on FSIS records, (ii) recall events by publicly traded companies, and (iii) the recall events in the de-clustered sample used in this analysis.

Recall size is measured as the total number of pounds of product recalled. Firm size is the market capitalization of a firm in billions of dollars, measured 10 days before a recall incident. Recalls per firm is the average number of recalls that each firm in the sample experienced between January 1994 and February 2016. Class is a three-tiered rating system, I, II, and III, created by FSIS that indicates the perceived risk of the contaminated product.[7] A recall event is classified as *subsequent* if the incurring firm had issued another recall in the previous 12 months. Note that information on the size of firm for the category "All Firms" was not possible to obtain because a large number of these firms are privately held corporations.

Table 1 shows that the distribution of experience varies substantially for all recalls and for public firm recalls. For "All recalls", only 12 percent of recall events are designated as *subsequent*, while for recalls issued by publicly traded firms, this category represents 46 percent of the total count. The distribution for experience for all public firm recalls and the recalls in the de-clustered sample is fairly similar.

[7] Class I recalls are considered the most severe while Class III recalls are associated with the lowest risk. Class I recalls are issued when there is a high risk of adverse health reaction, such as when pathogens like *E. coli* or *Salmonella* are present. Class II recalls are issued when there is a remote risk of adverse health reaction such as small amounts of undeclared allergens. Class III recalls are issued when there is a very remote risk of adverse health reaction, for example, when safe undeclared substances are present such as excess water ("USDA FSIS", 2013).

Data on daily stock prices, as well as market indices, corresponding to the period 120 days previous to and 20 days after each recall, were collected using Bloomberg. Following Pozo and Schroeder (2016), data for six different indices were collected and used to estimate market returns, R_{mt}, in the benchmark market model in (1): the S&P 500 Composite Index (S&P 500); S&P 500 Food, Beverage and Tobacco Industry Group Index (S&P 500 FBT); S&P 500 packaged Foods Industry Index (S&P 500 PF); NASDAQ Global Select Market Composite Index (NQGS); New York Stock Exchange Composite Index (NYA); and the Russell 2000 Index (RTY).

Recalls were categorized and compared under two different classifications, *initial* and *subsequent*, and *first* recall, *second* recall, *third or higher* recall. A recall is classified as a *subsequent* recall if the firm issuing the recall had handled another recall event in the previous 12 months. To create the classification corresponding to the recall sequential order, sequences were constructed starting from the first recall for a firm appearing in the data and going up by 36 month periods[8]. Thus, all recalls in a sequence took place over a time period of no longer than 36 months. For example, three recalls issued by ConAgra on November 8th 1994, September 15th, 1995, and August 1st, 1997 would be considered a sequence of three recalls.

In total, across the dataset, seventy-five sequences were identified. There are 42 instances in the data where there was only one recall identified within the 36-month time window. These recalls correspond to a sequence of length one, and are classified as *first recalls*. There were 9 sequences identified of length two, and 18 sequences of three recalls occurring over the 36-month time window. For a small number of firms (Tyson, ConAgra, Nestle, and IBP), there were

[8] The previous literature examining sequences of food recall events examines recalls occurring up to a 24-month window (Salin and Hooker, 2001; Wang et al., 2002). In this analysis, the window was extended slightly to 36 months to allow for a larger number of recall sequences to be captured.

as many as 4 to 6 recalls occurring in the allotted 36-month window. Because there were so few of these, the 4th, 5th, and 6th recalls from these longer sequences were grouped with *third recalls* into a *third and higher* category. Table 2 shows the breakdown of the number of recalls falling into each classification. *Initial* recalls outnumber *subsequent* recalls in the de-clustered sample, by almost double. The total number of *first recalls* in the sample is 75. Note that a large number of these *first recalls* are also *initial recalls;* however, the number of first recalls is greater than the number of initial recalls due to the fact that there was not necessarily 12 months of time that passed between the last recall of a previous sequence and the first recall of the next sequence.

Results

In this section, results of the event study analysis, performed for the two different classifications, are shown. *CAARs* accumulated over varying windows, are examined for *initial* and *subsequent* recalls, as well as for sequential series, comparing *first* recall, *second* recall, and *third or higher* recall. The goal in examining abnormal returns for *initial* versus *subsequent* recalls is to determine if the results of the analysis align with what has been previously suggested by the literature. That is, that stock price returns of firms that have experienced a recall in the recent past are impacted less by a recall event compared to those that have not handled a previous recall. The goal in examining sequences of recalls is to determine if this trend continues over time. For example, if a second recall event is less impactful to the stock price compared to the first one, is a third recall even less impactful than the second one? Below we proceed with this discussion.

Initial versus Subsequent

Estimation of the benchmark models for each event yielded expected results and are consistent with previous literature. In general, the intercept term of the fitted models, $\hat{\alpha}$, is very close to zero and the coefficient of R_{mt}, $\widehat{\beta_1}$, is very close to one. The average estimated, $\hat{\alpha}$ was 0.03 and the average estimated $\widehat{\beta_1}$, was 0.83. In cases where the ARDL model was fit, the autoregressive and lagged market return coefficients were usually close to zero but ranged from -0.48 to 0.75 The index most often used for R_{mt} in the benchmark model is the S&P Packaged Food Index. The best index was selected using the Akaike Information Criterion (AIC).[9]

CAARs were calculated for both *initial* and *subsequent* recall events. Recall events were classified as *subsequent* if the company had issued another recall within the previous twelve months, and *initial* otherwise. Table 3 shows calculated *CAARs* for *all* recall events, *subsequent* recalls, and *initial* recalls over several event window intervals. These intervals range between five trading days before and twenty trading after the recall announcement day.[10] Consistent with previous literature, this analysis finds that consecutive recalls issued by a company have, in general, a smaller negative impact than first time or inexperienced recall events (Salin and Hooker, 2001; Wang et al., 2002; Seo et al., 2013; Pozo and Schroeder, 2016).

Examining table 3, significantly negative abnormal returns ($\alpha = 0.05$) can be seen for several windows associated with *initial* recalls. In particular, examining the arbitrary window $[1, 20]$, *initial* recalls are shown to be associated with nearly a 1.8 percent decrease in stock price returns, 5 days after a recall announcement. As reported in Table 1, the average market equity of the firms in the sample is $13.13 billion. Therefore, this 1.8 percent decrease in returns translates

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[9] In total, the S&P Packaged Food Index was used to estimate the benchmark model 70 times. The Russell 2000 Index was used 21 times, the New York Stock Exchange Index 19 times, the S&P Food Beverage and Tobacco 13 times, and both the S&P 500 and NASDAQ Global Select 9 and 8 times respectively.

[10] Those days previous to recall announcement day will be denoted as negative, while days after the announcement date will be positive.

into an average of $236 million loss in shareholder wealth within 5 days following the recall announcement, when an *initial* recall event occurs. Table 3 also shows evidence of immediate short-term effects following the recall announcement. On the day after the recall announcement (window $[1, 20]$) firms experiencing an *initial* recall show an average 0.49 percent decrease in stock price returns, corresponding to an average decrease in firm value of $64 million.

Examining the $CAARs$ for *subsequent* recalls in table 3, there is evidence of a short term negative effect in window $[0, 20]$. For example, the day corresponding to the recall announcement date is associated with a 0.43 percent decrease in stock returns. However, there exists no evidence of significantly negative abnormal returns after the initial recall announcement date. In some instances, $CAARs$ for *subsequent* recalls are actually positive in sign. However, these positive returns for *subsequent* recalls are small in magnitude and not significantly different from zero at the 0.05 significance level.[11] Table 3 also shows that, in general, *initial* $CAARs$ are higher in magnitude than the corresponding $CAARs$ for *all* recalls. This follows from the removal of the non-negative, *subsequent* $CAARs$, which offset the $CAARs$ for *all* recalls.

Contrary to Thomsen and McKenzie (2001), table 3 shows no evidence of information leakage into the market on days previous to the day of the recall announcement, $t = 0$. There are no significantly negative $CAARs$ for windows between days -5 and -1. Interestingly, when examining *all* recalls, no statistically significant $CAARs$ are observed on the day of recall announcement, day $t = 0$. This suggests a possible lag in market response, however, one reason this may be observed is that information on the specific time of day of the recall announcement

[11] One tailed tests with the alternative hypothesis $H_0: CAAR = 0, H_A: CAAR > 0$, were conducted to confirm this.

is not available. If a recall announcement was made after the markets had closed for the day, a negative response would not be expected until the markets re-opened on day $t = 1$.

In Figure 1, $CAAR$ values for *initial* and *subsequent* recalls are plotted as the event window is gradually extended starting at day -5 and going up to 20 days after the recall event. By day 20, *initial* recalls are associated with a statistically significant, overall decrease of -1.52 percent. In the same time frame *subsequent* recalls show no significant abnormal returns. Figure 1 illustrates that for *initial* recalls, stock returns do not rebound to their original level even after 20 days from the original recall announcement date. Thus, this analysis finds that negative effects on stock price returns for *initial* recalls are persistent for at least 20 trading days after the recall event, while no persistent negative effects are observed for *subsequent* recalls.

Sequential Recall Events

For this section of the analysis, $CAARs$ were calculated separately depending on their sequence classification. Sequences were created from the de-clustered data by windowing over 36 month periods starting with the first recall on record for each firm. Recalls that are contained within the 36-month window were considered part of the same sequence and classified as either *first* recall, *second* recall, or *third or higher* recall. Table 4 shows calculated $CAARs$ for the sequence classification for several event windows. Overall, there is strong evidence that first recalls are associated with negative effects on the value of meat and poultry firms. Focusing on window $[1, 20]$ for *first* recalls, the value of $CAAR$ is -2.00 percent, 5 days after the recall announcement. This corresponds to a total loss of $263 million dollars in firm value. First recalls are also associated with short term abnormal effects that persist up to 20 days after the day of the recall announcement. Window $[1, 20]$ shows a statistically significant abnormal return of -1.41 percent up to 20 days post-recall.

Examining $CAARs$ of *second* recalls in table 4, there is no evidence of negative impacts to stock price returns. *Second* recalls are actually associated with statistically significant positive effects in some windows. For example, a 1.04 percent increase in stock price returns is observed 20 days after the recall announcement date (window $[-5, 20]$). However, significantly positive effects for *second* recalls do not occur consistently over varying windows and may be a result of other extraneous events occurring during the same time frame of the recall, or may simply be due to chance. A robustness check of implementing differing de-clustering windows showed that these statistically significantly, positive returns do not occur consistently over differing de-clustering windows. However, the finding that *second* recalls are associated with less negative returns than *first* recalls remained consistent throughout robustness checks.

Interestingly, the trend of less negative effects associated with recurring recalls does not extend to *third or higher* recalls. Focusing on window $[1, 20]$, the average value of $CAAR$ is -0.51 percent, 5 days after the recall announcement. Also, table 4 shows that negative effects to stock price returns persist up to 20 days after the recall event for *third or higher* recalls. Focusing on window $[0, 20]$, *third or higher* recalls are accompanied by a -2.34% decrease in stock price returns, on average. This corresponds to an average $307 million reduction in shareholder wealth 20 days after a recall announcement.

Figure 2 shows $CAARs$ plotted for event windows between -5 and 20 days for *first*, *second*, and *third or higher* recalls. This figure illustrates the difference in magnitude of $CAARs$, as the $CAAR$ plot corresponding to *second* recall is always above that of *first* recall. The finding that *third or higher* recalls cause more negative effects to firms than *second* recalls is also illustrated. By day 20, returns for *second* recalls reach a statistically significant 1.04 percent increase while *third or higher* recalls are associated with a significant decrease of -2.17 percent.

A possible explanation for the more negative *CAARs* observed for *third or higher* recalls as opposed to *second*, may be some sort of risk tolerance threshold that exists in the market. The results in the previous section show that, in windows after the initial announcement date, *subsequent* recalls are associated with less negative short-term abnormal returns than first time, or *initial* recalls. One possible explanation for this is that, despite the increased risk that is associated with a *subsequent* recall event, when the market has observed a firm handling a previous recall well, it is less reactive to the *subsequent* recall. Similarly, in this section, we see that *second* recalls have less negative impacts than *first* recalls. However, when a *third or higher* recall event for a company occurs in a short time period, this may by a 'breaking point' for the market. At the point of a *third or higher* recall event, investors may feel that the overall risk caused by many recall events outweighs the positive signal that is given when firms successfully handle a previous recall event. It is also possible that the results from this classification are being driven by the *initial* versus *subsequent* factor, as many *first* recalls are also *initial* recalls. Further sub-classification could be useful in uncovering this but, is not employed here due to sample size limitations.

Conclusions

In this analysis, the market's reaction when food firms issue multiple product recalls over a short period of time is examined. This is done by calculating abnormal returns for firms that have already issued a recall in the past. These are designated as *subsequent* recalls and are compared to *initial* recall events, where the issuing firm has not issued another recall in the previous 12 months. Abnormal returns associated with sequences of recall events occurring over 36-month time frames are also examined. This analysis is conducted in a way that minimizes the possibility that conclusions are drawn only as a result of increased volatility from original recall events. When benchmark models used to estimate abnormal returns include effects from previous recalls, estimates for *subsequent* recalls will be biased. However, in this study, a G-Rank T-statistic as well as a de-clustering process is used to reduce these effects. In addition, abnormal returns averaged over many recalls and firms are presented. The sample used contains enough heterogeneity so that wide conclusions can be made about all publicly traded firms.

The results found here, contribute to the evidence that firms that have had experience handling a recall receive a less substantial negative impact on stock price returns. Long run costs to shareholders up to $279 million are found when *initial* recall events occur. No strong evidence of negative abnormal returns for *subsequent* recall events is found in the long run. Similarly, when examining sequences of recall events, *first* recalls are associated with long term negative impacts on stock returns, with an average cost to shareholders of up to $263 million, 20 days after a recall announcement. However, *second* recalls were not associated with statistically significant negative outcomes in any windows. This trend of less negative outcomes does not continue however with recurring recalls after the *second* recall. *Third or higher* recalls are associated with a decrease in stock returns of up to -2.34%, or $307 million in total private costs to food firms.

It is important to note that the results found here are for the ‘average’ publicly traded firm. These results may vary greatly for firms that are much larger or more or less diversified than the average publicly traded firm. Nonetheless, the result that firms issuing secondary recalls generally fare better than those issuing first-time recalls, in the short term, is interesting and goes against conventional wisdom. One might naturally expect worsened reputation and higher perceived risk when firms issue multiple recalls. The theory developed to explain communication during company crises (Situational Communication Theory), states that the risk of negative reputation should become greater the more times a company experiences a crisis event (Coombs, 2004).

There are several possible explanations for these counter-intuitive results. It is possible that investors' confidence is increased when the market observes that a firm has successfully handled a previous recall event (Salin and Hooker, 2001; Seo et al, 2013; Pozo and Schroeder, 2016). It also may be the case that investors view voluntary recalls as acts of corporate social responsibility. It has been shown that increased perceived social responsibility causes consumers to place less blame on firms when negative events occur (Mowen et al., 1981; Klein and Dawar, 2004; Cheah et al., 2007). Another probable explanation is that firms learn how to better handle recall events and communicate with investors when they have had experience handling a previous incident (Levitt and March, 1988; Seo et al., 2013). Additional research suggests that firms with better reputations are more impacted by negative events as these events defy previous consumer expectation (Rhee and Haunschild, 2006). Interestingly however, the results of this analysis suggest that these benefits are not extended when firms experience 3 or more recall events over a short time period. This appears to be a potential 'breaking point' for the market and significant negative effects to share prices are observed for these recalls.

This analysis contributes to the growing body of literature on the topic of food recalls and how they affect food firms. More specifically, the private costs of recall events for food firms are examined. Obtaining a measure of the cost of repeated recall events is important for companies and the industry to fully understand the potential costs associated with food recalls, and make more informed decisions on effective risk management strategies. As there has been little evidence shown that external regulatory mandates, such as HACCP, have been effective in reducing the overall number of food contamination incidents, it is important to understand intrinsic motivations for firms to adopt better food safety practices (Kotsiopoulos, 2013). This analysis, along with studies that measure indirect costs in the form of decreased demand and prices should be examined as a whole to obtain a more cohesive picture of the overall costs of recalls to food firms (Jarrell and Peltzman, 1985; McKenzie and Thomsen, 2001; Marsh et al, 2004; Piggot and Marsh, 2004; Moghadan et al., 2013).

The confirmation that *subsequent* recalls are less economically impactful than first time, or *initial* recalls, lays a groundwork for examining how these results might differ for different types of firms. For example, the lessened impact of *subsequent* recalls might be different for larger firms versus smaller firms, or younger firms versus more established firms. Theoretically, this could be examined by classifying *CAARs* into *initial* versus *subsequent* groups and then further classifying into sub-groups like *small firms*, *medium firms*, and *large firms*. Another question that naturally arises from these results is how changing the definition of *subsequent* and *initial* recalls might affect the results. In this analysis, a cutoff of 12 months is used to classify a recall as a *subsequent* recall. However, it may be interesting to compare results using cutoffs of 9, 24, and 36 months.

References

Armitage, S. (1995). Event study methods and evidence on their performance. *Journal of economic surveys*, *9*(1), 25-52.

Barboza, D., and Sorkin, A. R. (2001). Tyson to Acquire IBP in $3.2 Billion Deal. *The New York Times*. Retrieved from: http://www.nytimes.com/2001/01/02/us/tyson-to-acquire-ibp-in-3.2-billion-deal.html

Buzby, J. C., and Roberts, T. (1996). Economic costs and trade impacts of microbial foodborne illness. *World health statistics quarterly. Rapport trimestriel de statistiques sanitaires mondiales*, *50*(1-2), 57-66.

Centers for Disease Control and Prevention. (2012a). Multistate Outbreak of Salmonella Bredeney Infections Linked to Peanut Butter Manufactured by Sunland, Inc. (Final Update). (2012, November 30). Retrieved December 05, 2016, from http://www.cdc.gov/salmonella/bredeney-09-12/index.html

Centers for Disease Control and Prevention. (2012b). Signs & Symptoms Multistate Outbreak of Salmonella Typhimurium and Salmonella Newport Infections Linked to Cantaloupe (Final Update). (2012, October 05). Retrieved December 14, 2016, from: https://www.cdc.gov/salmonella/typhimurium-cantaloupe-08-12/signs-symptoms.html

Cheah, E. T., Chan, W. L., and Chieng, C. L. L. (2007). The corporate social responsibility of pharmaceutical product recalls: An empirical examination of US and UK markets. *Journal of Business Ethics*, *76*(4), 427-449.

Coombs, W. T. (2004). Impact of past crises on current crisis communication insights from Situational Crisis Communication Theory. *Journal of business Communication*, *41*(3), 265-289.

Crim, S. M., Griffin, P. M., Tauxe, R., Marder, E. P., Gilliss, D., Cronquist, A. B., and Lathrop, S. (2015). Preliminary incidence and trends of infection with pathogens transmitted commonly through food—Foodborne Diseases Active Surveillance Network, 10 US sites, 2006–2014. *MMWR Morb Mortal Wkly Rep*, *64*(18), 495-499.

Dawar, N., and Pillutla, M. M. (2000). Impact of product-harm crises on brand equity: The moderating role of consumer expectations. *Journal of Marketing Research*, *37*(2), 215-226.

Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. *The Journal of Finance*, *25*(2), 383-417.

Fama, E. F. (1991). Efficient capital markets: II. *The Journal of Finance*, *46*(5), 1575-1617.

Food Safety and Inspection Service (FSIS) 2016. FSIS Recall Case Archive. (2016, February 22). Retrieved December 05, 2016, from www.fsis.usda.gov

Food Safety and Inspection Services (FSIS) 1996. The Final Rule on Pathogen Reduction and Hazard Analysis and Critical Control Point (HACCP) Systems. Backgrounders. 1996. Available at http://www.fsis.usda.gov/OA/background/finalrul.html

Ivanek, R., Gröhn, Y. T., Tauer, L. W., & Wiedmann, M. (2005). The cost and benefit of Listeria monocytogenes food safety measures. *Critical Reviews in food Science and Nutrition*, *44*(7-8), 513-523.

Jarrell, G., and Peltzman, S. (1985). The impact of product recalls on the wealth of sellers. *Journal of Political Economy*, *93*(3), 512-536.

Kafetzopoulos, D. P., Psomas, E. L., and Kafetzopoulos, P. D. (2013). Measuring the effectiveness of the HACCP food safety management system. *Food control*, *33*(2), 505-513.

Klein, J., and Dawar, N. (2004). Corporate social responsibility and consumers' attributions and brand evaluations in a product–harm crisis. *International Journal of research in Marketing*, *21*(3), 203-217.

Kolari, J. W., and Pynnonen, S. (2011). Nonparametric rank tests for event studies. *Journal of Empirical Finance*, *18*(5), 953-971.

Levitt, B., and March, J. G. (1988). Organizational learning. *Annual review of sociology*, *14*(1), 319-338.

MacKinlay, A. C. (1997). Event studies in economics and finance. *Journal of Economic Literature*, *35*(1), 13-39.

Marsh, T. L., Schroeder, T. C., and Mintert, J. (2004). Impacts of meat product recalls on consumer demand in the USA. *Applied Economics*, *36*(9), 897-909.

McKenzie, A. M., and Thomsen, M. R. (2001). The Effect of "E. Coli" O157: H7 on Beef Prices. *Journal of Agricultural and Resource Economics*, 431-444.

Moghadam, A. K., Schmidt, C., and Grier, K. (2013). The impact of E. Coli O157: H7 recalls on live cattle futures prices: revisited. *Food Policy*, *42*, 81-87.

Mowen, J. C., Jolly, D., and Nickell, G. S. (1981). Factors influencing consumer responses to product recalls: a regression analysis approach. *Advances in Consumer Research Volume 08*.

National Cattlemen's Beef Association. (2015). Directions Statistics. Retrieved December 19, 2016, from National Cattleman's Beef Association, http://www.beefusa.org/CMDocs/BeefUSA/Producer%20Ed/2015%20CattleFax%20section.pdf

Piggott, N. E., and Marsh, T. L. (2004). Does food safety information impact US meat demand?. *American Journal of Agricultural Economics*, 86(1), 154-174.

Pozo, V. F., and Schroeder, T. C. (2016). Evaluating the costs of meat and poultry recalls to food firms using stock returns. *Food Policy*, *59*, 66-77.

Pruitt, S. W., and Peterson, D. R. (1986). Security price reactions around product recall announcements. *Journal of Financial Research*, *9*(2), 113-122.

Rhee, M., and Haunschild, P. R. (2006). The liability of good reputation: A study of product recalls in the US automobile industry. *Organization Science*, *17*(1), 101-117.

Salin, V., Darmasena, S., Wong, A., and Ping, L. (2006). Food-Product Recalls in the U.S., 2000-2003. *Journal of Food Distribution Research*, *37*(1), 149-153.

Salin, V., and Hooker, N. H. (2001). Stock market reaction to food recalls. *Review of Agricultural Economics*, *23*(1), 33-46.

Seo, S., Jang, S. S., Miao, L., Almanza, B., and Behnke, C. (2013). The impact of food safety events on the value of food-related firms: An event study approach. *International Journal of Hospitality Management*, 33, 153-165.
Chicago

Shapiro, C. (1983). Premiums for high quality products as returns to reputations. *The Quarterly Journal of Economics*, *98*(4), 659-679.

Thomsen, M. R., and McKenzie, A. M. (2001). Market incentives for safe foods: an examination of shareholder losses from meat and poultry recalls. *American Journal of Agricultural Economics*, *83*(3), 526-538.

United States Bankruptcy Court: District of New Mexico (2013). Sunland, Inc. Retrieved December 12, 2016, from http://nmb.uscourts.gov/sunland

United States Department of Agriculture Food Safety and Inspection Service USDA 2013. RECALL OF MEAT AND POULTRY PRODUCTS. (2013, Sept. 19). (FSIS Directive 8080.1) Washington DC.

Wang, Z., Salin, V., Hooker, N. H., and Leatham, D. (2002). Stock market reaction to food recalls: a GARCH application. *Applied Economics Letters*, *9*(15), 979-987.

Table 1. Summary Statistics for All Recalls, Recalls Issued by Public Companies, and De-Clustered Sample

	All Recalls *n=1,405*		**Public Firm Recalls** *n=170*		**De-clustered Sample Recalls** *n=140*	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Recall Size (lbs.)	475,045	5,027,4467	1,646,058	8,134,821	1,723,381	8,483,565
Firm Size (mkt cap $B)	-	-	12.67	31.16	13.13	32.40
Recalls Per Firm	1.26	0.77	5.13	7.50	4.30	5.50
	Frequency		Frequency		Frequency	
Class						
I	0.72		0.71		0.71	
II	0.20		0.24		0.24	
III	0.08		0.05		0.05	
Experience						
Subsequent	0.12		0.46		0.34	
Initial	0.88		0.54		0.66	

Table 2. Recall Classifications of De-Clustered Sample

Initial vs Subsequent		Sequence	
Category	Number of Recalls	Category	Number of Recalls
Initial	47	*First Recall*	75
Subsequent	93	*Second Recall*	32
		Third or Higher	33
Total	140	*Total*	140

Table 3. Cumulative Average Abnormal Returns, Initial vs Subsequent Recalls

	$\tau_1 = -5$			$\tau_1 = -2$			$\tau_1 = 0$		
τ_2	All	Initial	Subsequent	All	Initial	Subsequent	All	Initial	Subsequent
-5	0.201	0.268	0.067						
-1	0.249	0.237	0.273	0.168	0.358	-0.208			
0	0.334	0.580	-0.153	0.253	0.701	-0.634	0.085	0.343	-0.426**
1	0.184	0.091	0.369	0.103	0.211	-0.111	-0.065	-0.147*	0.096
2	0.050	-0.089	0.326	-0.031	0.031	-0.155	-0.199	-0.327	0.053
3	-0.262	-0.501	0.209	-0.344	-0.380	-0.271*	-0.512	-0.738	-0.064
4	-0.346	-0.592	0.139	-0.428*	-0.471	-0.341**	-0.595**	-0.829*	-0.134*
5	-0.675	-1.239*	0.439	-0.757**	-1.118*	-0.041	-0.925***	-1.476**	0.167
10	-0.428	-0.961	0.629	-0.509*	-0.841	0.148	-0.677**	-1.199*	0.356
15	-0.497	-0.812*	0.127	-0.578**	-0.692*	-0.353	-0.746**	-1.050**	-0.146
20	-0.907**	-1.517**	0.299	-0.989**	-1.397**	-0.182	-1.157**	-1.755**	0.026

	$\tau_1 = 1$		
τ_2	All	Initial	Subsequent
-5			
-1			
0			
1	-0.150*	-0.490***	0.522
2	-0.284	-0.670**	0.479
3	-0.596	-1.081*	0.363
4	-0.680**	-1.172**	0.292
5	-1.009**	-1.819***	0.593
10	-0.762*	-1.542*	0.782
15	-0.831***	-1.393**	0.281
20	-1.242***	-2.098**	0.452

Significance at the 1%,5%, and 10% level for H_0: $CAAR = 0$ and H_A: $CAAR < 0$ are denoted by ***, **, and * respectively

Table 4. Cumulative Average Abnormal Returns, Recalls Sequences

	$\tau_1 = -5$			$\tau_1 = -2$			$\tau_1 = 0$		
τ_2	First	Second	Third or Higher	First	Second	Third or Higher	First	Second	Third or Higher
-5	0.114	0.517	0.091						
-1	-0.078	0.684	0.573	-0.039	0.156	0.650			
0	0.047	0.942	0.398	0.086	0.414	0.476	0.125	0.258	-0.174
1	-0.622**	1.347*	0.888	-0.582***	0.819	0.966	-0.543***	0.663	0.316
2	-0.894*	1.411	0.876	-0.855***	0.883	0.954	-0.816***	0.727*	0.304
3	-1.334*	1.300	0.660	-1.295*	0.771	0.738	-1.256*	0.616	0.088
4	-1.352**	1.105	0.534	-1.313**	0.576	0.611	-1.274**	0.421	-0.039
5	-1.956**	1.747	-0.114	-1.916***	1.219	-0.037	-1.877***	1.063	-0.687**
10	-1.547**	1.779	-0.023	-1.508**	1.251	0.055	-1.469**	1.095	-0.595**
15	-1.429*	2.211*	-1.005	-1.389***	1.683	-0.927	-1.350**	1.527	-1.577**
20	-1.360**	1.040**	-1.768	-1.320**	0.512	-1.691**	-1.281*	0.356	-2.341***

	$\tau_1 = 1$		
τ_2	First	Second	Third or Higher
-5			
-1			
0			
1	-0.668***	0.405	0.490
2	-0.941**	0.469**	0.478
3	-1.381**	0.357	0.262
4	-1.399**	0.162	0.135
5	-2.002***	0.805	-0.513**
10	-1.594**	0.837	-0.421**
15	-1.475**	1.269	-1.403**
20	-1.406**	0.098	-2.166*

Significance at the 1%,5%, and10% level for H_0: $CAAR = 0$ and H_A: $CAAR < 0$ or $CAAR > 0$ are denoted by ***, **, and * respectively.

Figure 1. Cumulative Average Abnormal Returns for Subsequent and Initial Recalls

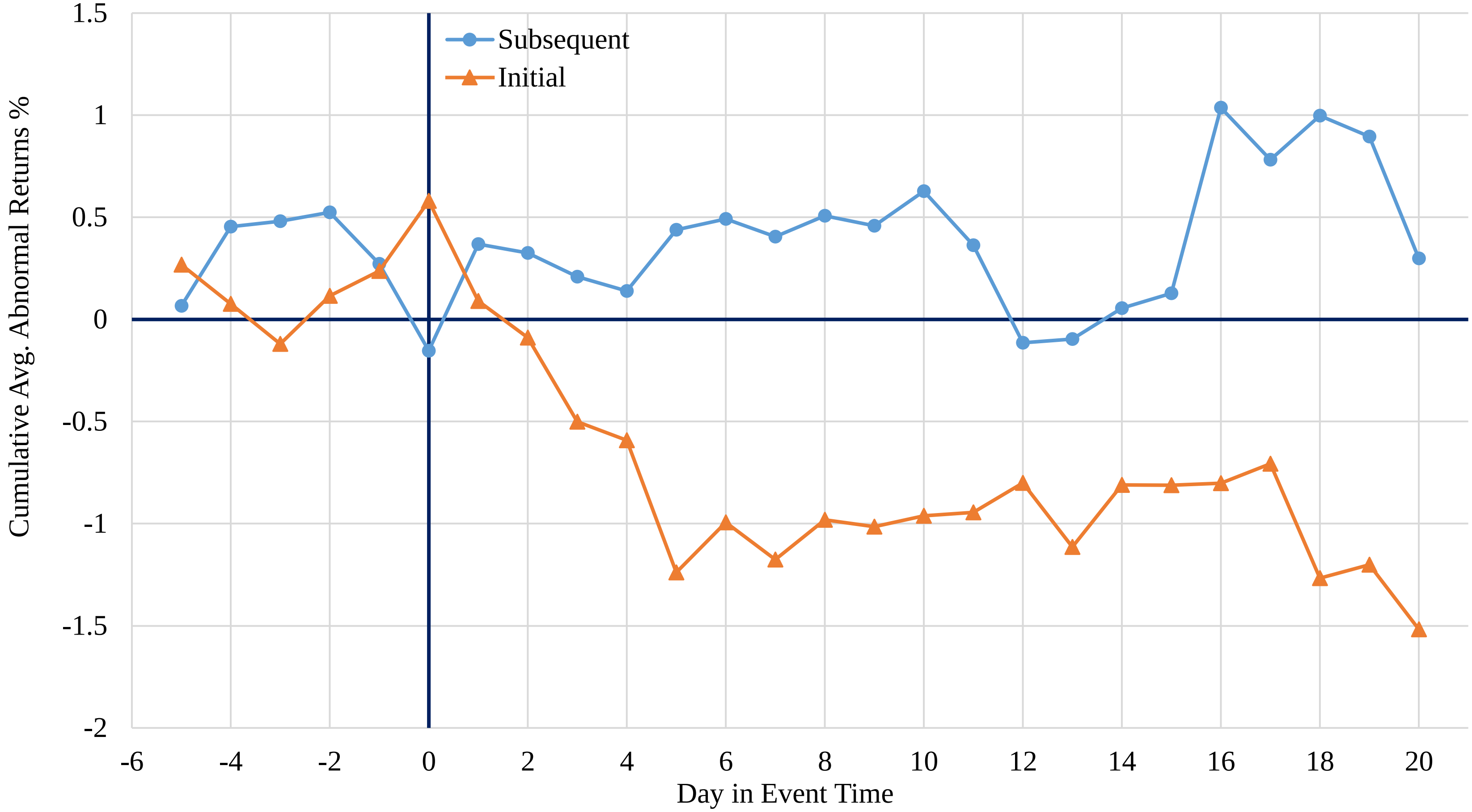

Figure 2. Cumulative Average Abnormal Returns for First, Second, and Third or Higher Recalls