Effects of Meat Recalls on Firms' Stock Prices

Veronica F. Pozo
Graduate Student
Department of Agricultural Economics
Kansas State University
vpozo@k-state.edu

Ted C. Schroeder
Professor
Department of Agricultural Economics
Kansas State University
tcs@k-state.edu

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Introduction

Safety of food products is among the greatest concerns of consumers. Large and highly publicized food recalls in recent years have elevated consumer's concerns about the safety of our food. Food companies are investing substantial resources into minimizing food safety outbreaks. However, optimal investment is elusive because food safety breaches are difficult to predict and even more, the probable economic impact of a food safety event is unknown. In addition to the economic repercussions of reductions in product demand (triggered by a decline in consumer's or customer's confidence), firms involved in food safety outbreaks incur expenses related to recovering, disposing of, or reconditioning (e.g., changing the label because the product contains ingredients not listed or the label includes misleading information) potentially contaminated products already in the market pipeline (Thomsen and McKenzie, 2001). Depending on the severity of the threat and its effects on the wellbeing of consumers, firms may also face product liability costs which in turn could permanently damage a firm's reputation and in some cases, force the firm to exit the market. For example, in 1997, Hudson Foods Co. recalled 25 million pounds of ground beef (one of the largest recalls of food in the U.S.) due to foodborne contamination that caused several illnesses. This particular event resulted in the company's acquisition by Tyson Foods, after losing its largest customer, Burger King (Belluck, 1997). Furthermore, food safety outbreaks may also influence the decisions of food company investors. Evidence indicates that product recalls affect negatively stock prices, having an adverse effect on the current and future profitability of the firm involved (Salin and Hooker, 2001; Thomsen and McKenzie, 2001; Wang et al., 2002).

In this study, we focus on evaluating the impact of meat recalls on U.S. publicly traded firms. Recalls of meat products are carried out under the supervision of the United States Department of Agriculture's (USDA's) Food Safety and Inspection Service (FSIS). Meat products that have already been shipped and distributed into the market and are suspected of being potentially hazardous to public health, are voluntarily recalled by firms either by their own initiative or by the request of FSIS. The most severe type of recalls involve meat products contaminated most commonly with foodborne bacteria such as *Escherichia Coli* (*E. Coli* O157:H7), *Listeria Monocytogenes* and *Salmonella*.

Despite firms' effort to adopt preventive measures and invest in food safety enhancing technologies, firms are not always exempt from encountering food safety threats during the production, processing and/or packaging of their products, which are mostly triggered by human errors and/or by the limitations of their food safety technologies. In the last two decades, FSIS has reported approximately 1,165 meat and poultry recalls, representing nearly 503 million pounds of product, from January 1, 1994, through December 31, 2012. Of the total, almost three-fourths corresponded to the most severe class of recalls (FSIS, 2013). These recalls come at the expense of the firm directly involved and can create substantial profit losses.

Assessing the overall impact that may result from a food recall requires a thorough understanding of the costs incurred by firms. However, quantifying these costs is daunting if not impossible. A direct measurement of a firm's total costs and losses of revenue associated with a food safety outbreak requires firm-level data that is not available, and often, not even the firm involved has the data necessary to undertake an economic assessment. To overcome this severe limitation, previous work has quantified the impacts of food safety recalls by analyzing price reactions in retail and financial markets during the periods corresponding to the recall announcement. Of particular interest in this study is the assessment of price reactions in financial markets since firms' publicly traded stock prices are expected to reflect overall economic impact of a recall through the expected impacts on future profitability of the company.

Impacts of meat recalls on the value of firms depend on certain factors such the severity of the recall. For example, Thomsen and McKenzie (2001) provide evidence of significant shareholder losses when publicly traded food companies are implicated in a recall involving serious food safety hazards (e.g., foodborne disease outbreaks). However, previous work has not adequately assessed how the magnitude of stock market price reactions to recalls is determined by a broader set of important factors associated to the recall.

The objective of this study is to assess the impacts of meat recalls on firms' stock prices and determine how specific factors associated with the recall explain the magnitude of impact on firm's stock prices. More specifically, we first evaluate the effects, if any, of meat recalls on stock market prices (or security prices) of the involved firms using an event study approach. Then, we quantify the relationship between the estimated effects of food contamination incidents on stock prices and factors associated with meat recalls, which are used as explanatory variables. Here, we focus on evaluating the effects of the following factors: severity of the threat, type of foodborne pathogen, size of recall, size of firm, scope of food safety hazard, type of contaminated meat commodity, media information, firm's reputation and important meat industry events.

Different types of publicly traded firms are responsible for food safety. These firms range from producers, to processors, packagers, distributors and/or retailers and differ according to their scale of operations and levels of diversification. This distinction is important for the analysis of stock market reactions to food safety scares because we suspect that investors include into their valuations risk perceptions about firms. That is, firms likely to operate numerous plants and/or produce an array of different products that are not affected by the recall are expected to have smaller economic impact, all else constant.

Results from this study provide essential information to the meat industry. Particularly, understanding how food safety recalls impact a firm's value is necessary for firms to evaluate strategies of adopting and investing in new, often expensive, food safety technology and protocols. In addition, our findings will demonstrate how a variety of factors influence the economic impact of a contamination event. This information is valuable to managers as they assess potential costs or revenue losses associated with specific characteristics of a food safety recall. Furthermore, our results also benefit investors as they would find valuable to know information related to the duration of the effects of meat recalls in stock prices. Lastly, understanding the likely impact of meat recalls events is critical for policy makers to establish food safety regulations.

Related Literature

In recent years, several highly publicized food safety scares have been reported in the U.S. As a result, issues concerning the impact of these events on consumer demand, supply (e.g., processors adoption of food safety technologies), government regulations and financial markets have received significant attention in the agricultural economics literature. Numerous applications assessing the impact of recalls on consumer demand exist. Several studies have addressed how consumers' purchasing patterns are affected by food recalls. For example, Marsh et al. (2004) analyzed the impact of meat recalls on aggregated demand for beef, pork and poultry products using a Rotterdam demand model. Including recall indices as demand shifters, findings revealed that recalls caused small but statistically significant responses. Own and crosseffects indicated that meat recalls induce a reallocation of expenditure both within the meats group and across meat and non-meat groups. Using disaggregated data Thomsen et al. (2006) estimated sales losses experienced by food processing companies following a recall for Listeria. This study involved branded frankfurter products to assess substitution effects associated with a food scare that can be directly linked to one or more brands. Findings indicated that product sales of affected brands decreased by 22-23% after the outbreak. On the contrary, non-recalled brands experienced an increase of sales when a competing brand was involved in a recall.

The news media has long been a primary source of consumer information relating to food safety. Several studies have addressed the impacts of food safety information on consumer demand. Richards and Patterson (1999) used an equilibrium displacement approach to calculate the effects of new negative or positive news regarding a disease outbreak on the profits of strawberries growers. Findings indicated that positive and negative media articles have the expected effects on price, but negative reports have a greater effect on price than positive reports. In a more recent study, Piggott and Marsh (2004) developed a theoretical and empirical framework of consumer response to publicized food safety information on meat demand. Food safety information was specified as being inversely related to product quality. Results indicated that the average demand response to food safety events over the study period was economically small, except in periods of a significant food safety outbreak. Printed media is not the only source of information able alter consumers' demand patterns. Schlenker and Villas-Boas (2009) examined how consumers in the U.S. reacted to two highly publicized warnings about bovine spongiform encephalopathy (BSE): the first discovery of an infected cow in December 2003 and an Oprah Winfrey show that aired in 1996. They found a large and significant drop in beef sales following both episodes. Particularly, implications are that receiving coverage in one of

America's most-watched television programs can impact markets in a sizeable way compared to government warnings combined with continued general news coverage.

Food safety scares have the potential not only to alter consumers' purchasing patterns, but also shake public trust in food safety regulatory agencies and decrease confidence in the safety of the food supply chain (Onyango et al., 2008). Periodic discovery of contaminated meat and poultry products led the Food and Drug Administration (FDA) and the FSIS to develop a quality control system that improves the scientific basis for meat and poultry inspection and mitigates the firm's economic losses. In 1996, the FSIS published a final rule that mandates all federally inspected meat and poultry plants the adoption of a quality control system known as HACCP (Hazard Analysis Critical Control Points). HACCP is a food safety monitoring system designed to identify and prevent hazards (e.g. introduction of pathogens or foreign materials) along the production process. This program was established to improve the safety of meat and poultry products by placing more emphasis on preventing potential hazards, rather than detecting and treating contamination problems at the end of the production line (Unnevehr and Jensen, 1996). The movement towards the implementation of mandatory HACCP regulations led researchers to investigate the benefits and costs of such regulations. For example, Roberts et al., (1996) and McDonald and Crutchfield (1996) estimated that the cost of designing and implementing a HACCP plan is lower on a per unit basis for a larger food processing firm compared to smaller firms. Thus, the regulatory costs imposed on smaller firms negatively impacted their competitiveness. However, these econometric estimates were based on data taken before the rule was issued.

Jensen et al. (1998) discussed preliminary results of a cost-effectiveness analysis of several technological interventions for microbial control in beef and pork processing. Their results suggested that marginal improvements in food safety can be obtained at increasing costs. Antle (2000) developed a theoretical model and estimated a cost function to test the hypothesis that product safety does not affect variable cost of production in the meat industry. After rejecting this hypothesis, results from the cost function were used to estimate the impacts of food safety regulations on variable cost of production in the beef, pork, and poultry. Findings indicated that the costs of food safety regulation could plausibly exceed the benefits estimated by previous studies. More recently, Ollinger and Moore (2009) used actual data to evaluate the costs of HACCP. They found that economies of scale in the implementation of the system provide larger firms with substantial cost advantage over smaller firms. In addition, the implementation of federal mandated food safety regulations is five times more costly than using generic performance standards.

Empirically, several studies have quantified the impacts of meat recalls on meat markets and related markets. For example, Lusk and Schroeder (2002) analyzed the effect of beef and pork recalls on live cattle and lean hogs futures markets. They found that medium-sized beef and large-sized pork recalls with serious health concerns have a marginally negative impact on the nearby cattle and lean hogs futures market prices. In addition, McKenzie and Thomsen (2001) examined the impact of *E. Coli* O157:H7 on wholesale and farm-level beef prices. Results suggested that although retail prices of boneless beef are negatively affected by recalls, wholesale and farm-level prices showed either insignificant or very limited response to the recalls. Furthermore, Salin and Hooker (2001), evaluated shareholders' reactions to food recalls in an event study of stock returns. Findings showed that returns to shareholders fell immediately after the recall for the smallest firm in the study, but recalls by the larger firms were not consistently associated with large reductions in returns. Altogether, these results suggest that several factors could potentially influence the magnitude of the effects of product recalls. However, to our knowledge, none of the aforementioned studies have assessed these effects considering a broader set of characteristics of meat recalls.

Event Study Approach

To assess the impact of meat recalls on the stock market value of firms, ideally we want to compare the firm's actual stock returns to the returns the firm would have perceived in the absence of a food safety outbreak. The event study approach provides a framework for estimating this counterfactual return. This methodology was introduced by Ball and Brown (1968) and by Fama et al. (1969), and since then it has been widely used in the fields of economics, finance, accounting, and marketing. The usefulness of event studies comes from the assumption that the effects of an event will be reflected immediately in stock prices. Therefore, a measure of the event's economic impact can be constructed using stock prices observed over a relatively short time period, instead of using direct profit or cost related measures (MacKinlay, 1997).

Conceptual Framework

The theory underlying the use of event study methodology is the efficient market hypothesis (EMH). This hypothesis implies that stock prices will reflect the discounted value of future earnings and all available information that influences the market upon which a firm's stock is traded. Here, the discount rate is determined by the perceived riskiness of the firm. Therefore, changes in stock prices, and thus firm's value, reflect changes in expectations about future earnings and risk. In other words, this hypothesis assumes that new information is quickly incorporated into stock prices as investors continually re-evaluate the firm's value (Srinivasan and Hanssens, 2009).

Model

The assessment of the event's impact on stock returns requires a measure of the abnormal return. The abnormal return is defined as the difference between the actual ex post return of the stock and the normal return, both calculated over the event window. The normal return is defined as the expected return without conditioning on the event taking place (MacKinlay, 1997). For firm *i* and event date *t* the abnormal return is:

(2) $$AR_{it} = R_{it} - E[R_{it} | I_t], \quad for\ t \in \tau,$$

where R_{it} is the actual return of a stock at time *t*, $E[R_{it} | I_t]$ is the normal return conditional on some information I_t which allows to predict the expected return had the event not occurred and τ is the specified event window. A test of significance for the abnormal return is constructed using the following hypothesis:

(3) $$H_o\colon\ R_{it} - E[R_{it} | I_t] = 0, \quad for\ t \in \tau.$$

The null hypothesis is that the value of the actual return, conditional on the event, is not different from the expected value of the normal (benchmark) return. The test in equation (3) can be generalized to deal with aggregations of time periods. Note that returns on stocks' investment are used instead of stock prices in order to account for dividend payments and capitalization (Fama et al, 1969). Daily returns for particular stock prices are calculated as the percentage change in closing stock prices as follows:

(4) $$R_{it} = \frac{P_{it} + D_{it} - P_{i,t-1}}{P_{i,t-1}}, \quad for\ i = 1, \dots, N\ and\ \ t = 1, \dots, T$$

where P_{it} is the stock price of firm *i* observed at the end of day *t*. D_{it} are the dividends per share paid at time *t*, and $P_{i,t-1}$ is the stock price of firm *i* observed at the end of day *t-1*. *T* denotes the total number of observations of time series data (may vary across firms) and *N* denotes the total number of firms considered in the study.

In the application of event study to meat recalls, we follow six steps: (i) identify the event dates of meat recalls and event windows around these dates; (ii) model the normal behavior of the returns according to some benchmark model estimated prior to the meat recall announcement; (iii) predict the expected returns over the event period using the benchmark model; (iv) compute the difference between the actual and the expected returns to obtain the abnormal returns; (v) aggregate abnormal returns over intervals of the event window to obtain the cumulative impact of meat recalls in firm i ; (vi) test for the significance of the cumulative abnormal returns (CAR).

This analysis examines the impact of meat recalls on stock prices. The observations are divided into two mutually exclusive sub-periods: the estimation period and the prediction period. The estimation period (or estimation window) contains observations prior to the recall announcement. The prediction period, also referred to as the event window, contains the day of the recall announcement (i.e., $t = 0$) and observations surrounding the event day. Here, we include several trading days before the event to account for the possibility that stock markets become aware of the food safety outbreaks before the formal announcement date. The benchmark model is estimated using the observations of the estimation window (i.e., $t \in [T_1, T_2 - 1]$). Then, this model is used to predict or forecast the normal returns (those expected to occur in the absence of a meat recall) using observations from the event window (i.e., $t \in [T_2, T_3]$). Figure 1 illustrates the time line of the event study.

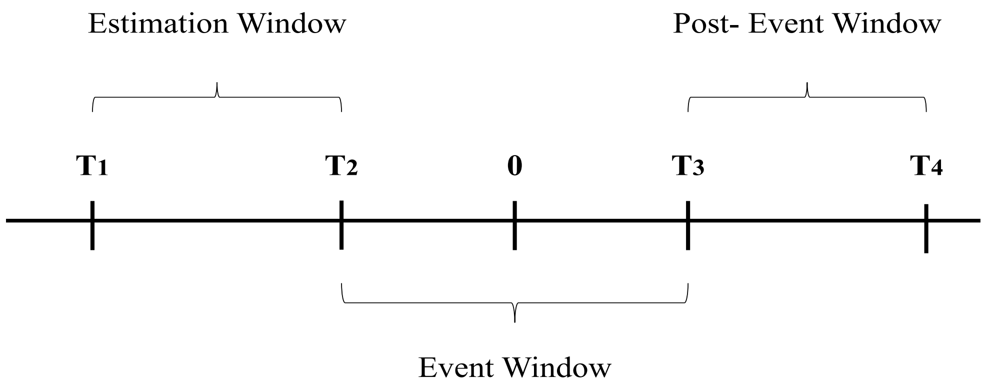

Figure 1. Event study time line

In this study, we utilize estimation windows consisting of 250 trading days to establish the normal returns behavior (Thomsen and McKenzie, 2001). Therefore, we define $[T_1, T_2 - 1]$ as [–260, –11]. In addition, we use event windows beginning at day T_2 = –10 which include the event day and several days after the recall. Following Salin and Hooker (2001), alternative length of event windows are examined to allow for comparison of cumulative effects after the recall. That is, we specify T_3 = 5, 10, 15, 20 and 30 days.

There are two main statistical approaches to calculate normal returns. These are the constant mean returns model and the market model. The constant mean returns model assumes that the average returns are constant across time and any unexpected news will cause the returns to deviate from this constant mean. Using this approach, normal returns are estimated as follows

(5) $$R_{it} = \mu_i - \nu_{it}, \; for\ all \;\; t \in [T_1, T_2 - 1],$$

were μ_i is the mean stock return for firm i and ν_{it} is the error term. On the other hand, the market model assumes that the returns of stock prices are correlated with the returns of the market portfolio (i.e., beta analysis). That is, returns are assumed to be a linear function of the overall market index (e.g., S&P 500, S&P Peer Composite, CRSP Value Weighted Index, etc.)

and deviate out of this relationship in the presence of an event. Here, normal returns are estimated as follows:

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

were R_{mt} is the return on the chosen market index at date t, α_i and β_i are parameters to be estimated and reflect the mean excess return (or unsystematic risk) and the systematic risk of stock i, respectively (Mazzocchi et al., 2009). ε_{it} is the error term assumed to be independent and normally distributed with zero mean.[1] Once the estimates of α_i and β_i are obtained over the estimation window, it is possible to predict (out of sample) normal returns of the event window as follows:

(7) $$E[R_{it} | I_t] = \hat{\alpha}_i + \hat{\beta}_i R_{mt}, \quad for\ all\ t \in [T_2, T_3];$$

then, daily abnormal returns are calculated as:

(8) $$AR_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt}, \quad for\ all\ t \in [T_2, T_3].$$

The abnormal return observations must be aggregated in order to draw overall inferences for the event of interest (MacKinlay, 1997). Here, abnormal return measures are aggregated over time into a measure of cumulative abnormal returns which reflect the change in stock prices caused by a particular meat recall during a given interval of the event window. Cumulative abnormal returns for stock return *i* are calculated over an interval $[\tau_1, \tau_2]$ consisting of one or more days, where $T_2 < \tau_1 \leq \tau_2 \leq T_3$, as:

[1] According to Fama (1976), stock returns are not normally distributed. Thus, we account for this issue when conducting hypothesis testing.

(9) $$CAR_i(\tau_1, \tau_2) = \sum_{\tau=\tau_1}^{\tau_2} AR_{i\tau},$$

Our primary interest is in the magnitude of $CAR_i(\tau_1, \tau_2)$ and whether the observed stock price movements are the result of meat recalls. Therefore, we are interested in testing the following hypothesis:

(10) $$H_0:\ CAR_i(\tau_1, \tau_2) = 0,$$
$$H_a:\ CAR_i(\tau_1, \tau_2) < 0;$$

that is, under the null hypothesis, a recall outbreak does not have a significant impact on stock prices and hence $CAR_i(\tau_1, \tau_2)$ will be zero whereas under the alternative hypothesis the recall has a significant impact on stock prices and therefore the $CAR_i(\tau_1, \tau_2)$ will be negative.

A major problem in statistical tests of abnormal returns is that stock prices are not normally distributed (Fama, 1976). Parametric (with modifications in the assumption of the data generation process of stock returns) and non-parametric tests can be used for testing these hypotheses. Parametric tests proposed by Patell (1976) and Boehmer et al. (1991), which are popular due to improved power properties, are conducted in this study. On the other hand, a nonparametric test such as the rank test proposed by Corrado (1989) is also conducted in this study.

Impact of Meat Recall Characteristics

Theoretical insights can result from examining the relationship between the magnitude of CAR and characteristics specific to the event observation (Mackinlay, 1997). After analyzing the impact of meat recalls on stock prices, we are interested in understanding whether characteristics specific to a particular meat recall can help explaining the magnitude of the observed deviation in stock prices. Given a sample of *N* cumulative abnormal return observations and M characteristics of the meat recall affecting firm i, the regression model is:

$$CAR_i = \gamma_0 + \gamma_1 X_{1i} + \cdots + \gamma_M X_{Mi} + \eta_i \quad (11)$$

where, CAR_i is a scalar or a vector of cumulative abnormal returns, $X_{mi}, m = 1, \ldots, M$ are characteristics of a specific meat recall, $\gamma_m, m = 0, \ldots, M$ are the parameters to be estimated and η_i is the error term with zero mean and assumed to be uncorrelated with the $X's$. It is important to note that during the estimation process, econometric problems such as selection bias might produce inconsistent results. This problem could arise when investors rationally use the firm characteristics to forecast the likelihood of the event occurring.

Explanatory Variables

In this study, we focus on evaluating the effects of the following factors:

a. *Severity of the threat*. There are three classes of food recalls. Class I recalls are the most serious and involve a "situation where there is a reasonable probability that the use of the product will cause serious, adverse health consequences or death." Class II recalls involve a "situation where there is a remote probability of adverse health consequences from the use of the product." And class III recalls involve a "situation where the use of the product will not cause adverse health consequences."

b. *Type of the foodborne pathogen.* While McKenzie and Thomsen (2001) examined the impact of *E. Coli* O157:H7, no previous study has considered all types of foodborne pathogens in its analysis. Here, we are interested in knowing whether the impacts of meat recalls vary depending on the type of the foodborne pathogen (e.g., *E. Coli* O157:H7, *Salmonella*, *Listeria*, etc.) that caused the recall.

c. *Size of the recall*. We intend to evaluate whether the impacts of meat recalls differ according to recall size. In this case, the determination of the recall size is relative to the size of the firm.

d. *Size of the firm*. Evidence indicates that firm's size is a potential determinant of the reductions in food company valuations caused by food recalls (Salin and Hooker, 2001).

e. *Scope of the food safety hazard*. In this case, we are interested in comparing whether a national meat recall has a different impact than a local one on the stock prices of involved firms.

f. *Type of meat commodity*. We aim to evaluate whether the type of meat affects meat recalls. In this study, we classify meat commodities into the following categories: beef, pork, chicken, turkey and other meats (e.g., lamb).

g. *Media information*. Evidence suggests that consumers are increasingly responsive to new information about the safety of food (e.g., Henson and Mazzocchi, 2002). In this study, we aim to explore whether media reports that disseminate food safety information affects the impact of meat recalls.

h. *Firm's reputation*: We are interested in evaluating if stock prices of companies that have been previously involved in a recall react differently than those who have issued a recall for first time.

i. *Important meat industry events*: The effects of certain events such as the mandatory implementation of HACCP or the mad cow disease outbreak are also evaluated in this study.

Data

In this study, we analyze the impacts of meat recalls on stock prices over the period corresponding to January 1994 to December 2012. Meat recall data were collected from the

FSIS website. When a product is recalled, FSIS issues a recall release to the media in the affected area, sends it to public health partners and stakeholders and posts it on the FSIS website. The announcement contains specific information about the recall such as date, information related to the company recalling the product (e.g., company name, location, etc.), type of product recalled, number of pounds recalled, cause of the recall, recall class and states where unsafe product was distributed. A total of 1,165 recalls have been issued during the period of interest of this study. However, not every firm involved in these recalls is publicly traded. To identify public companies, we consulted online sources. In most cases, this information allowed us to determine whether the establishment is privately held, publicly held, a cooperative, or the subsidiary of a public company. In addition, daily stock price data are collected from different sources (e.g., Yahoo Finance and Bloomberg).[2]

[2] This paper is a work in progress. The results section is forthcoming soon.

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