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Factors Determining Media Coverage of Meat and Poultry Recalls: Evidence From the AP Newswire

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FACTORS DETERMINING MEDIA COVERAGE OF MEAT AND POULTRY RECALLS: EVIDENCE FROM THE AP NEWSWIRE

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By

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ABSTRACT

Food safety is an important public health issue. Product recalls are an important part of the overall food safety system and occur when potentially unsafe products enter the marketplace. However, it is important that information about the recall ultimately reaches the public. This research assesses the publicity that recalls receive by the popular media. The focus is specifically on recalls of meat and poultry products. Publicity is measured by coverage in the AP Newswire. Data were gathered from the United States Department of Agriculture's Food Safety and Inspection Service (FSIS) and cover meat and poultry recalls from 1982 to 2009. These data were then matched to stories on product recalls from the AP Newswire to arrive at article counts for each recall event. The data compiled indicate that roughly 25 percent of meat and poultry recalls receive at least one story in the Newswire. Count data models were estimated to identify characteristics that make a meat and/or poultry recall event more likely to be publicized. Article counts were expressed as a function of recall characteristics. In particular, this study utilized the zero-inflated negative binomial and zero-inflated Poisson models. Results suggest that the volume of product recalled is a major driver of media coverage. Large recalls are more likely to receive coverage and are covered more intensively than small-volume recalls. In addition, recalls due to the presence of pathogens, especially *E. coli* O157:H7 and *Listeria monocytogenes,* receive more publicity than recalls for other reasons. When the problem was discovered by the FSIS, recall events are more frequently covered by the AP Newswire. No significant differences in coverage were observed by the day of the week a recall is announced.

This thesis is approved for recommendation
to the Graduate Council.

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CHAPTER 1: INTRODUCTION

Food safety is been an increasing concern among consumers and food producers over the years and perceptions of this issue are enhanced as new cases of foodborne illnesses take place and are publicized. Since the early 1980s there has been an increase in incidents of illness and outbreaks linked to emerging pathogens. For instance, according to the Centers for Disease and Control and Prevention (CDC), the first US case of listeriosis linked to the consumption of meat and poultry products was in 1989. Nowadays, such events have become more frequent and, in some cases, more deadly. As I was in the process of writing this thesis, there were two high profile examples food safety events. Most recently was an outbreak of S*almonella* Heidelberg infections affecting 78 persons in 26 US states. This was linked to ground turkey meat produced by Springdale, AR based Cargill Meat Solutions and resulted in a 36 million pound product recall on August 3, 2011 (FSIS 2011). Earlier, in May 2011, food safety was in the headlines because of an outbreak tied to a novel and aggressive strain of *Escherichia coli* (*E. coli*), which struck mainly Germany and 13 other countries in Europe, was responsible for 4,075 cases of illnesses and 50 deaths (World Health Organization 2011), and is believed to have been linked to bean sprouts.

A major focus in the existing literature is on the effects of recalls on the company's equity returns (Pruitt and Peterson 1986; Thomsen and McKenzie 2001; Salin and Hooker 2001; Wang et al. 2002; Chu, Lin, and Prather 2005), the impact of recalls on resale prices and sales volume (Hartman 1987; Thomsen, Shiptsova, and Hamm 2006), and how to communicate and manage the crisis that a recall represents to the firm (Miller and Littlefield 2010; Greyser 2009; Jolly and Mowen 1985; Hooker, Teratanavat, and Salin 2005; Souiden and Pons 2009).

My focus is a bit different in that I address the publicity that meat and poultry recalls receive through the news media. Specifically, the objective of my research is to identify the characteristics of meat and poultry recalls that affect the likelihood and amount of media coverage. This topic is important because the news media are the primary venue by which consumers learn about product recalls. While there have been very highly publicized food recalls, my research suggests that the majority of meat and poultry recalls receive very little coverage, even when they involve serious health hazards. My study examines nearly three decades of stories about meat and poultry recalls appearing on the Associated Press Newswire.

Meat and Poultry Recalls in the USA

The Food Safety and Inspection Service (FSIS) is an agency within the US Department of Agriculture (USDA) that is responsible for the regulating safety of meat and poultry products. FSIS supervises product recalls. According to FSIS directive 8080.1 Revision 6 (U.S. Department of Agriculture 2010), a recall is the process whereby a firm removes meat or poultry products from commercialization, after they have been placed into the food distribution system. This action occurs when there is reason to believe the products are misbranded or adulterated under terms of the Federal Meat Inspection Act or the Poultry Products Inspection Act and pose a health hazard to the public. The recall is a voluntary action of the company. When FSIS learns about the tainted products, it can recommend that the company perform a recall. However, the company decides whether to follow FSIS recommendations. If a company chooses not to comply with a request for a product recall, FSIS utilizes other mechanisms to ensure the consumer's safety. The agency can remove the product from commerce and issue press releases to inform consumers of the potential health hazards associated with the suspect product. FSIS releases public health alerts instead of recalls when products are no longer available for sale in retail stores, but there is a reason to believe they might still be in consumers' possession (FSIS 2008). The agency also utilizes this tool when a foodborne illness outbreak is ongoing but cannot be linked to a specific product and company.

FSIS is involved in the recall process jointly with the firm. When a recall takes place, the company is in charge of creating and employing an "effective recall strategy" (U.S. Department of Agriculture 2010) which is used to inform the consignees of the necessity of withdrawing recalled product for the market. FSIS investigates the effectiveness of the firm's strategy and its execution of the product recall. Again, the agency has authority to take further actions such as issuance of public health alerts or to intervene with detentions and seizures of contaminated products in order to decrease the risk to the public when a company does not properly remove the recalled products from commerce. FSIS closes recalls upon complete removal of recalled product from commerce and evidence of no further illnesses related to the product.

FSIS classifies recalls based on the severity of health hazards presented by the product being considered for recall. The recall can be classified as class I, which involves hazards with the potential to cause serious health consequences or death; class II recalls are for products that present a small chance of causing adverse health consequences when consumed; and class III recalls are assigned to cases where use of the product does not present adverse health consequences for the consumer. FSIS usually does not issue press releases for recalls under class III.

Research Questions and Hypotheses

Recalls target consumer safety, but the negative impacts to the recalling companies has been intensively described in the literature (some of which is cited above). Nash (2010) mentions the high cost of the recall, which can include indirect and direct costs, lawsuits and fines. However, the indirect costs are usually difficult to quantify. Recalls represent a major negative impact not only for the recalling company but can shake consumer confidence in the safety of the food supply. Stinson et al. (2008) find that consumers' confidence in food safety and food defense decreases after a major national recall. All these harmful consequences of the recall likely provide incentives for companies to maintain safety of their products (Nash 2010).

Although FSIS issues press releases, there is no guarantee that these announcements will reach the broader population. The media covers in fairly great detail cases in which illness outbreaks are involved, as seen in this summer's *Salmonella* event. However, recalls related to outbreaks account for just a portion of the meat and poultry recalls announced by FSIS. In order to guarantee consumers' safety and to improve removal of recalled products from the market and households, it is important that recall information ultimately reaches the public.

The objective of this study, as mentioned before, is to identify characteristics that make a meat and/or poultry recall event more likely to be publicized. To meet this objective, I analyzed articles appearing in the AP Newswire and developed article counts for each recall contained in FSIS records from 1982 to 2009. Based on the literature review presented in the next chapter and descriptive analyses of my data, the hypotheses to be tested revolve around characteristics of a meat or poultry recalls and whether they impact the amount of coverage in the Newswire. Specifically, the null hypotheses are that characteristics of recalls such as size of the recall (volume of product recalled), reason for the recall, and entity discovering the problem leading to the recall does not change either the likelihood of the recall event being published in the AP Newswire nor the number of Newswire articles devoted to the recall case. I expect that these null hypotheses will be rejected in favor of the following alternative hypotheses:

1. Recalls accounting for large volumes of products will be more frequently publicized.
2. Meat and poultry products recalled due to presence of pathogens are more likely to be published and receive greater amounts of coverage than recalls for other reasons.
3. Recalls for problems discovered by governmental entities will be more likely to receive coverage than will recalls for problems discovered by the company.

I also explore whether there is the potential to influence coverage by timing the recall announcement. Specifically, I examine whether recalls announced on Fridays, at the end of the weekly news cycle, receive less coverage than recalls announced on other weekdays. I address these hypotheses through count data models where article counts are modeled as a function of recall characteristics.

Organization of this Thesis

The remainder of this thesis is organized as follows. In chapter 2, I review pertinent articles available in the literature. Chapter 3 presents a detailed description of my data collection process and an examination of key features of the data set that was compiled for analysis. Chapter 4 describes the count data models employed in the thesis. In chapter 5, the main empirical results are presented and explained. Finally, chapter 6 concludes with a summary of the main findings, a discussion of limitations of the research, and suggestions for future studies.

CHAPTER 2: LITERATURE REVIEW

Stock Prices and Market Response

The negative consequences of a product recalls for companies are widely discussed in the literature. For public traded companies, a variety of the studies focus on the impact of product recalls on the company's stock returns. Reasons for is research include availability of data and the importance of the subject to shareholders and investors. Pruitt and Peterson (1986), Thomsen and McKenzie (2001), Salin and Hooker (2001), Wang et al. (2002), and Chu, Lin, and Prather (2005) have measured responses in stock returns to product recalls. Pruitt and Peterson (1986) examine, using an event study, the impact of non-automotive product recalls on equity holders of the recalling firm. Their study used recall data from January 1968 to December 1983 from the *Wall Street Journal Index* and the companies' daily stock returns from the Center for Research in Security Prices at the University of Chicago. They find that recall announcements generate negative abnormal returns that persist for roughly two months after the recall is publicized. The results suggest that the market perceived the recall announcement as adverse and unpredicted event. They also find evidence that in percentage terms, the stock prices of larger companies declined less than the stock prices of smaller companies[1] over the post recall period. In addition, they argue that the adverse stock price responses can be explained only partially by the direct cost of the recall. Chu, Lin, and Prather (2005) conduct a follow-up study to Pruitt and Peterson (1986) and add data from 1984 to

[1] The authors classified the companies by size, multiplying the outstanding shares by the price per share of each company. The size classifications were: over $1 billion for the largest firms, from $250 million to $1 billion for the median sized firms, and below $250 million for the smallest. The largest companies presented a mean abnormal return of -0.591 percent, whereas the smallest had -4.145 percent.

2003. They call attention to the significant increase in the number of recalls. As in Pruitt and Peterson (1986), these authors indicate that the product recall announcements have a negative effect for equity holders. Negative abnormal returns are observed on the day before and day of publication in the *Wall Street Journal*. However, the mean cumulative abnormal return is not statistically significant before or after the *Journal's* publication. Additionally, they show that firms with larger market value (more than US$1 billion) experienced a greater number of recall events. They analyzed datasets for each industry separately and found that stock prices of companies in drugs and cosmetics or toys and appliances were more sensitive to recall announcements.

Numerous recall studies have used automobile recalls as the research subject. I am largely avoiding these articles in this review because of the lack of similarity to meat and poultry. However, two of these studies warrant mention. Hartman (1987) provides insight on the consequences of new information about product safety and the presence of cross-product effects during recall events. Rupp (2001) addresses whether the effect of a recall depends on the entity initiating the recall. Hartman (1987) uses a hedonic model to access the impact of the new safety information on the resale price of 1980 model-year cars in the American resale market from 1981 to 1985. He chooses this particular model year because it was subject of safety recall, and it was also the launching period of General Motors' X cars, which were marketed as high quality cars and were of specific interest in Hartman's (1987) study. The car sample collected was 190 domestic and imported makes/models. He finds that a recall negatively affects the resale value of recalled cars; however it has no influence in the value of the manufacturer's non-recalled products (cross-product effect). The magnitude of the negative effect is different based on the class of the car, nature of the defect, and severity of the recall.

Specifically based on the X cars, which experienced two recalls due to brake defects, Hartman (1987) finds that the resale price dropped 14% after the recall. In addition, he affirms the market responded rapidly to the new quality information contained in the recalls.

Rupp (2001) used the word "initiator" to designate which entity first discovered the safety problem and compares the stock market response when the recall of an automobile was initiated by the government or by the company. The study assesses abnormal returns from 1973 to 1998 of major automobile companies in the US. He uses recall announcement data from the *Wall Street Journal Index* and compares them with data provided by the National Highway Traffic Safety Administration, which retains the industry's safety recall information. He also collects stock price data from the Center for Research in Security Prices at the University of Chicago (data on Japanese companies were available in the form of American Depository Receipts). From the 734 recalls published in the *Wall Street Journal Index*, the government initiated 208 and the companies initiated 526 recalls. The government initiated recalls tended to be larger in volume. Rupp (2001) discovers that government initiated automotive recalls did not lead to larger shareholder losses (equity loss) when compared to the manufacturer initiated recalls. This is contrary to his *a priori* hypothesis.

Because my research focus is on meat and poultry recalls, I looked for studies addressing the meat sector. Thomsen and McKenzie (2001) used an event study of the meat and poultry recalls from 1982 to 1998 and their impact on the stock prices of the recalling companies. Their recall data were gathered from FSIS and security price data were collected from the Center for Research in Security Prices at the University of Chicago. They find a negative abnormal returns for the most serious class I recalls (class I according to the FSIS classification) that persisted for at least a month after the recall announcement. This was fairly consistent with the findings of Pruitt and Peterson (1986). Other recalls classified as less severe threats to consumer health (class II and class III) showed no statistically significant effect on security price returns. Salin and Hooker (2001) and Wang et al. (2002) evaluated the stock return and the stock price volatility after food recall incidents for specific firms. Salin and Hooker (2001) assess recalls by Sara Lee, IBP, and Odwalla and include a total of four recall events in their study. The authors justify the selection of these companies because they vary in size, volume of product recalled and reports of illnesses or death related to recalled products, and the diversity of business. In addition, two of the recall events they analyzed prompted policy reforms. They find stock in Odwalla had a significant drop on the recall day, and abnormal returns were seen for 10 days after the event. For Sara Lee, no significant abnormal return was detected. Two IBP recalls were examined. The first recall generated a negative reaction in the stock market, with cumulative abnormal returns been noticed for at least the 40 days post-event. The second recall presented no statistically significant effect. In the riskiness of returns analyses, Sara Lee showed higher volatility in its returns after the recall. However, the capital asset pricing model presented no change in risk after the event. The IBP first recall generated an increase in volatility as well, with no change in risk. The second recall from IBP showed a decrease in volatility and a decline in risk. Odwalla also exhibited higher volatility after the recall and no change in nondiversifiable risk. Finally they assert that financial markets responded in different intensity to these food recalls events and that the stock price reaction after the recall could not be related to the severity of food contamination in the study.

Wang et al. (2002) conducted a similar study, focusing on recalls events of two specific companies due to bacterial contamination, albeit with a different econometric approach. They used a Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model to evaluate stock prices responses from Sara Lee and IBP after food recalls. A total of five recall events (three from IBP and two from Sara Lee) happened during their study period. The authors find that the first recall for both companies had a significant adverse effect on the stock returns around the recall announcement days. Also, the first recall amplified the recalling company's stock returns volatility and that of the other company. The results indicate the market had a lower reaction to subsequent recalls. The first recall from Sara Lee presented the largest correlation between the two companies' stocks. Finally, they assert that investors' response to the food recalls present incentives to the private sector to pursue food safety measures.

In summary, a product recall most likely will cause a negative impact in stock prices and an increase in volatility of returns. These have direct implications to shareholders and investors and might pressure publicly traded companies to pursue higher standards and invest in product quality and food safety. These market responses may also encourage companies to prepare for crisis management and crisis communications.

The majority of the meat and poultry recalls is associated with a specific company or brand, which is indicated in the FSIS's press release. This is useful information to consumers and enables them to identify the product being recalled. Thomsen, Shiptsova, and Hamm (2006) assess the impact on the product sales of the recalling firm. They examine frankfurter recalls due to the presence of the pathogen *Listeria monocytogenes* and assess the impact on the recalling brand's sales. They also evaluate the sales of other frankfurter brands not involved in a recall. In addition, they report on brand recovery patterns following the recall. The authors gathered the frankfurter retail sales data from Information Resources, Inc.'s InfoScan database from November 1998 to December 2000. The recall data were obtained from FSIS and matched by date, brand, and market with the retail sales data. They find that recalls had a negative impact on sales for the recalled brands. The sales drop was, on average, 22 percent during the period of the recall announcement and 4 weeks thereafter. However, there was no adverse impact on the sales of other brands which are not involved in the recall. Some of the competing brands actually had a slight increase in sales. Thus, consumers tended to view the recall as a brand-level problem that did not adversely affect other brands in the frankfurter category. They find that brand sales began to recover 8 to 12 weeks after the recall announcement and returned to pre-recall levels within 4 to 5 months.

Crisis Management and Communication

A product recall results from a product defect or contamination, which is considered a crisis for the producing company or distributor (Miller and Littlefield 2010). The negative impact of a recall incident to the company is the result of different aspects of the recall itself and the way the firm handles the problem, specifically its communication strategies. Miller and Littlefield (2010) examined the different communication strategies used by ConAgra in two different food recall events through a content analysis, and assess whether the company exhibited organizational learning in their handling of these crises. They collected data from major American newspaper and wire services, using the database Lexis Nexis, from September 2006 to September 2008 to access the coverage of a peanut butter and pot pie recall experienced by the company. They find evidence that the company exhibited different behavior across the two events before, during, and after the crisis periods. They give specific attention to the lack of organizational learning in between the first and second recall. They conclude that ConAgra did not show organizational learning on the second recall and did not apply the best practices with the same efficiency as the company had done in the first recall. In the earlier peanut butter recall, the company focused in the consumer safety, issuing a recall quickly, and making meaningful efforts to communicate information to consumers. According to the authors, the communication in the later pot pie recall seemed to target image restoration instead of consumer safety.

For consumers, safety is a basic attribute of a food product. Thus, when a food product is recalled, the product has failed. According to Greyser (2009), product failures are one cause of a corporate brand crisis. Other causes of corporate brand crises are: social responsibility gaps, corporate misbehavior, executive misbehavior, poor business results, spokesperson controversy or misbehavior, death of an individual symbolizing the company, loss of public support, and controversial ownership (Greyser 2009, p. 591). Cleary a product failure, if handled inappropriately can lead to other types of crises such as perceived social responsibility gaps, perceptions of corporate or executive misbehavior, and losses of public support. Greyser (2009) asserts that in crises events, the organization's behavior history plays a significant role in protecting and building reputation. In particular, effective organizational communication is very important. Greyser (2009) argues that the foundation of trust is usually the base for an effective communication and states that trust is a result of a company's "performance, behavior, and supportable communication, and is a foundation of authenticity and reputation" (Greyser 2009, p. 596).

In the case of an ongoing crisis, the firm's strategy for best managing the crisis should be admitting the problem, attempting to solve the issue, and using plausible behavior responses, always through reliable communication, according to Greyser (2009). As mentioned before, this was one of the failures of ConAgra during its pot pie recall (Miller and Littlefield 2010).

In addition, he emphasizes the larger interest of the media on the company's response when in a crisis situation.

One should expect, based on Greyser's (2009) assertions, that every meat or poultry recall, when classified as a high hazard to consumer health, would negatively impact the recalling company's reputation or the specific brand involved. However, the data I describe in the next chapter of this thesis suggest that this may not always be the case and it is questionable whether recall information is being broadly disseminated among consumers. In fact, my data show that only about 25 percent of meat and poultry recall cases from 1982 to 2008 were covered by the AP Newswire. This percentage varies substantially from year to year. Why are some of the recalls covered by the media whereas the majority is not? What are the peculiarities of a recall event that make them newsworthy? I will explore these questions further and address the possible reasons.

Jolly and Mowen (1985) assess consumer perceptions of recalling companies by examining three different communication factors within an experimental study. They investigate consumer response to source of information, type of media used, and the presence of social responsibility information. Their experimental scenario involved a defective hair dryer from the company Conair Corporation and was based on a real recall event. The experiment sample was drawn from undergraduate students enrolled in the Business College at a Midwestern university and from students in an introductory management and consumer behavior class. They find that, when the information emphasized the social responsibility aspects of the recall, either in recall information provided by the government or by the company itself, there was a positive reaction by consumers towards the recalling company. This somewhat corresponds to Mowen, Jolly, and Nickel's (1981) assertion that social responsibility is important to consumer preferences. This finding is important because it informs strategies that companies can use to improve their image after a crisis or to diminish consumers' negative response to adverse information that accompanies the crisis (Jolly and Mowen 1985). Based on Miller and Littlefield's (2010) description of the ConAgra peanut butter recall, it appears that the company pursued a social responsibility emphasis in their crisis communications and behavior towards the recall. Souiden and Pons (2009) show a similar result automobile recalls. They find that in cases where a firm disapproved of the recall, the there was a negative impact on its image, consumer loyalty, and consumer purchase intentions. However, when the recall was voluntary, there was a positive impact on each of these constructs. In addition, they assert that companies should opt for a proactive strategy during a recall crisis in order to diminish image damage.

Jolly and Mowen (1985) also find that information presented by the government was considered by consumers as a more reliable and objective than information presented by the company. Finally, the results show that the print media were evaluated by the consumers as more dependable and objective than radio media sources.

Hooker, Teratanavat, and Salin (2005) assess meat and poultry recalls from 1994 to 2002. They collected recall data from FSIS, and investigate the effectiveness of crisis management by examining the proportion of pounds recovered to the total pounds recalled (called recovery rate by the researchers), the duration in days of a recall case (completion time), and the ratio between recovery rate and completion time. They evaluate these measures using managerial and technical variables. The authors find that very small plants perform recalls more effectively than small plants[2], which goes against their hypothesis. Results also imply that

[2] According to the authors, large plants are the ones with more than 500 employees, small plants have between 10 and 500 employees, and very small plants consist of plants that employ less than 10 employees or have less than $2.5 million in annual sales.

small plants may be more effective than large plants in recovering recalled products in a timely fashion. In addition, they found that recalls of processed products were more effective (had higher recovery rates and ratios between recovery rate and completion time). Recall duration was longer for plants that belonged to a larger firm and for recalls of larger volume. Finally, the authors report that nature of the foodborne hazard or severity of health risk had no influence on recall effectiveness measures.

Recalls and Consumer Confidence

A major nationwide food recall increases consumer concerns about food safety in general. Stinson et al. (2008) measured consumer perceptions and attitudes towards food safety and food defense, which bears primary responsibility for these issues, and how funds should be allocated to ensure a safe and secure food supply. The researchers conducted three surveys, one in 2005 and two in 2007. One of the 2007 surveys was performed after a nationwide recall of spinach and lettuce. The other was performed after a large pet food recall. Their conclusions are that consumer confidence in food safety and food defense decreases after a major national recall event. They also found that concerns over food defense rose over the study period, along with perceptions of funding that should be allocated to preventing intentional food contamination. In addition, they assert that the public believes the government is principally responsible for food safety and food defense.

CHAPTER 3: DATA

Two sources of data were used in this thesis. First, I used records on meat and poultry recalls from the USDA's Food Safety and Inspection Service (FSIS) and developed a database from these records for the years 1982 through 2009. FSIS records contain an identification number for each recall and provide descriptive facts about meat and poultry recalls including the product being recalled, the name and location of the company producing the product, the reason for the recall, and the volume of product subject to recall. Secondly, I conducted a content analysis of Associated Press (AP) Newswire stories covering meat and poultry recalls for this same 1982 to 2009 period.

My rationale for choosing the AP Newswire as an indicator of coverage is that the AP is known by its broad distribution, credibility and accessibility. According to *Forbes*, the AP reports for more than 40 percent of the content of daily's newspapers (Hau 2008). The AP is a newsgathering cooperative organization. Information from smaller and less prominent newspapers around the country is likely to be reported and published by the AP. For this reason, the AP has an advantage as an indicator of coverage over one or more of the nation's leading newspapers such as *USA Today*, *The New York Times*, and *The Wall Street Journal*. In addition, AP serves newspapers and other media sources, which often use its news. The AP website asserts that "on any given day, more than half the world's population sees news from the AP (The Associated Press 2011)." In short, the AP was chosen because it provided the highest likelihood of identifying coverage of recall events. In addition, the adoption of a single, comprehensive, news source helped to simplify and optimize the process of story search and avoid duplicate articles when the same story appeared in multiple print outlets.

Searches of the AP newswire were performed using the Lexis Nexis Academic database, which is available through the University of Arkansas libraries. Identifying search terms involved a balancing act between finding a term that identified most meat or poultry recalls but did not return a large number of unrelated (false positive) stories. After several tries, the search strategy used was for the term "recall" within 15 or fewer words of the appearance of the terms "meat" or "beef" or "chicken" or "pork." The search was performed while restricting Lexis Nexis to look only within content from the AP. The search provided 1,450 stories from 1982 to 2009.

Each story was read and analyzed for content. Specifically, it was noted whether the story was primarily about product recalls and whether a specific meat or poultry recall event could be tied to the story. Stories never provided the FSIS recall identification number but they generally did provide enough information about the company recalling the product, the product being recalled, and the size of the recall to enable an easy match between stories and specific recall cases in the FSIS recall data. Figure 3.1 provides a flowchart illustrating the approach to coding stories. Outcomes of the coding exercise are summarized in figure 3.2.

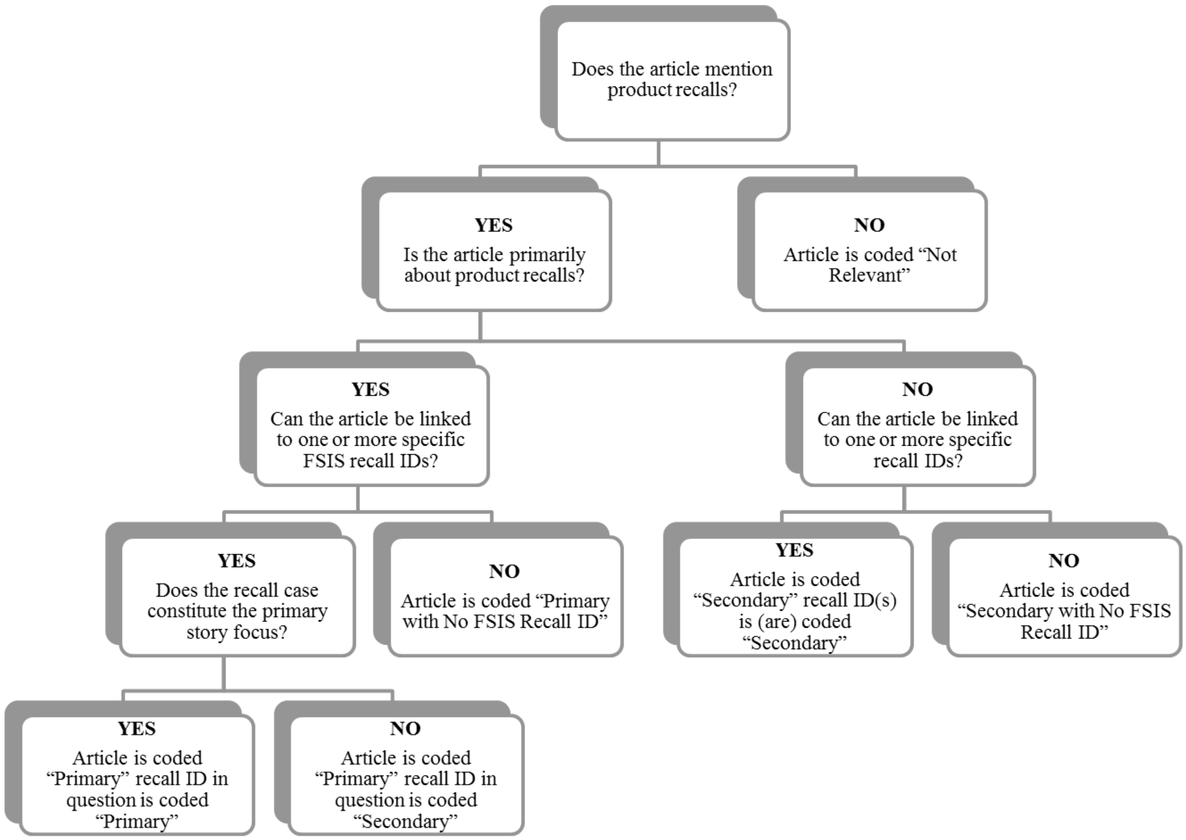

Figure 3.1. Flowchart for coding AP Newswire stories.

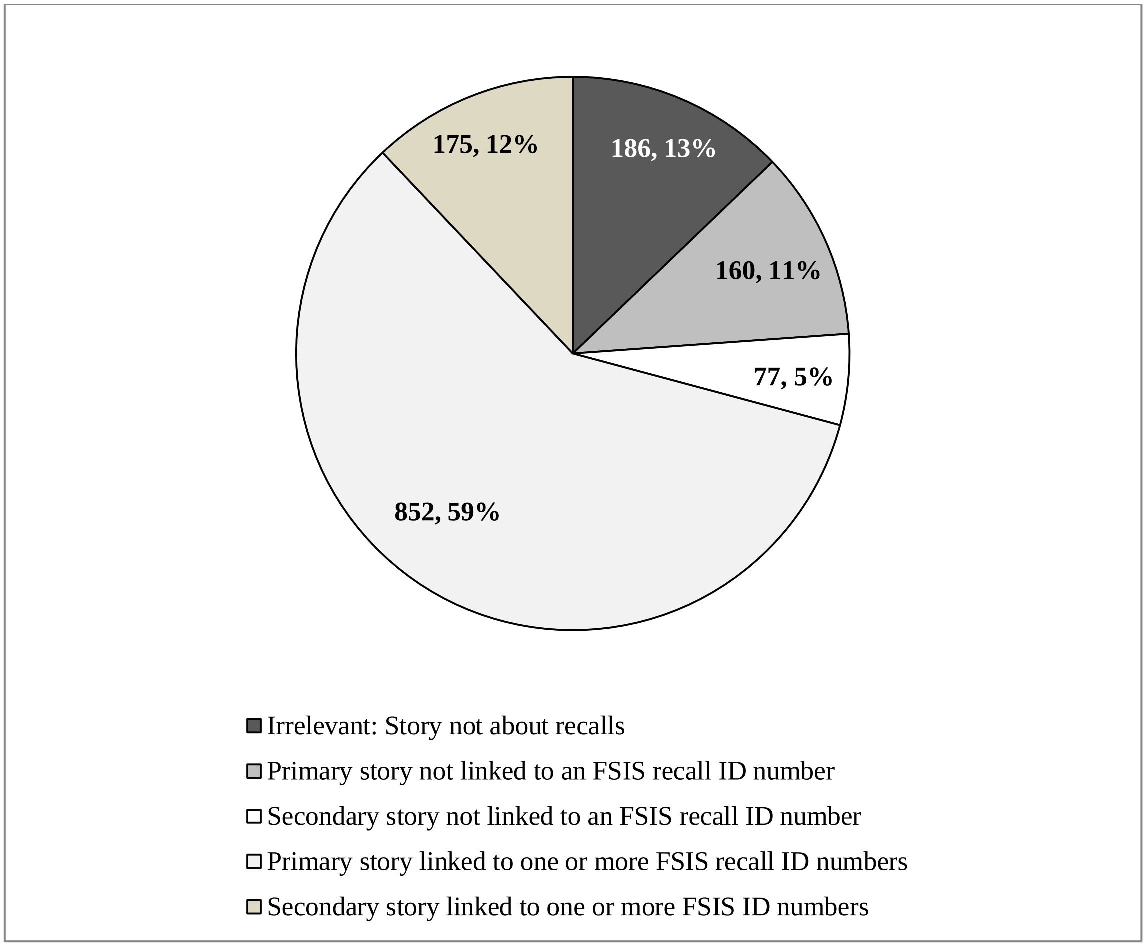

Figure 3.2. Coding outcomes (number of stories).

Irrelevant Stories

Despite the fairly narrow search terms used, there were a number of articles that met the search criteria but had no relevance to product recalls. For example, phrases such as “John Doe recalled his childhood spent raising chickens on his family’s farm” or “Pork barrel spending is worse today than anyone can recall” would each meet the search criteria outlined above but has nothing to do with product recalls. As shown in figure 3.2, 186 stories were coded as not being about product recalls. This amounts to 13 percent of all search results.

Primary Stories

An article was classified as primary when the major subject was product recalls, regardless of whether the product recall actually involved meat or poultry. While the search terms used in Lexis Nexis were specific to meat and poultry products, there were still some hits for articles covering recalls of toys, cars, drugs, and foods other than meat or poultry. These were still classified as primary articles within my coding framework, so long as the primary focus of the story was on product recalls.

Primary stories were matched, when possible, with one or more recall events in the USDA-FSIS recall database. As shown in figure 3.2, 59 percent of all search results were classified as primary stories and were matched to at least one recall event. It is important to emphasize that it is possible for more than one recall ID number to appear in a given story. Table 3.1 shows that in most cases, stories mentioned only one recall event. However, it was not a rare occurrence for a story to mention multiple events. Of the 852 primary stories linked to recall events (figure 3.2), table 3.1 (middle row) shows that 142 were linked to multiple events. In fact, one story mentioned 9 recall events in the FSIS records.

Table 3.1. Frequency (number of stories) linked to FSIS recall events by coding outcome

	Recall events linked to the Story						**Total**
Coding Outcome	**0**	**1**	**2**	**3**	**4**	**9**	**Stories**
Story was not about recalls	186	-	-	-	-	-	186
Primary story	160	709	101	35	6	1	1,012
Secondary story	77	161	12	2	-	-	252
Total Stories	423	870	113	37	6	1	1,450

Recall events, when linked to a story, were also coded as having received either primary or secondary coverage. Hence, it is possible within my coding scheme for a story to be coded as primary but for one or more recall cases mentioned within the story to be coded as having received secondary coverage. My guiding principle in coding was that stories were coded as primary whenever the main focus of the story was about product recalls. Similarly, specific recall events linked to a story were coded as primary whenever the primary focus of the recall was on the specific recall case in question.

To illustrate, each of the following examples provides a situation where recall cases were linked to a primary story but the recall case itself was coded as having received secondary coverage.

- On April 23, 1983 the major subject of an AP article was on the recall of salami products announced by FSIS the week before. However, the article mentioned an earlier recall event involving the same company. The primary focus of the article was on the latest recall event and so this latest event was coded as having received primary coverage. The earlier recall, which was mentioned tangentially, was coded as having received secondary coverage.
- On May 15, 2000 an article appeared on the Newswire that addressed the increase in recalls due to *Listeria* in meat products, which was an outcome of expanded government testing for this pathogen. Three specific recall events were mentioned in the story. However, because the primary focus of the story was on the trend in *Listeria* recalls and not these three events, each of these events was coded as having received secondary coverage.
- On January 15, 2000 an article described a new USDA policy of publicizing every meat and poultry recall, including the ones that involved minimal health risk. Again, this story was about recalls but not about any specific recall case. The article did mention two recalls, one in 1997 and one in 1999 that were the largest and smallest recalls which

had received press releases prior to the policy change. Both of these recall events were coded as having received secondary coverage.

Primary articles to which I could find no corresponding recall in the FSIS records were generally ones about non food products or food products other than meat and poultry that are not under the USDA jurisdiction, and therefore have no corresponding information in the FSIS database. In other cases, the primary focus of the article was meat or poultry recalls but the content of the article related to recall policies and practices, and did not refer to specific recall events. For sake of illustration, some examples of articles coded as primary but not matched to a recall ID are as follows:

- An article on July 3, 1999 addressed the question of the government's authority to order mandatory recalls and the arguments in the debate over whether mandatory recall authority should be extended to federal government agencies.
- On March 7, 2006 a story reported on a USDA proposal change the agency's disclosure policy by including the names of the retail outlets in recall announcements.
- On May 6, 2005 an article discussed the recall of frozen vegetarian food due to the potential presence of an undeclared allergen.
- On November 29, 2007 recalls of different brands of cars was reported by a story on the AP Newswire.

In each of these cases product recalls were the primary subject of the story and so each was coded as a primary story. The first two stories were about meat and poultry recalls but did not mention any specific recall case. The latter two stories mentioned specific recall cases but none that were under FSIS jurisdiction. Each of these stories was ultimately coded as a primary story not linked to an FSIS recall ID number. As shown in figure 3.2, there were 160 of these stories accounting for 11 percent of all search results.

Secondary Stories

Articles were classified as secondary when the main subject was something other than product recalls but when product recalls or specific recall events were mentioned within the story. As in the primary articles, a recall ID was associated to the article whenever possible. When the article received the secondary notation, every recall ID that could be connected to it was coded as having received secondary coverage as well, with no exceptions. Some articles are exemplified as follows.

- On July 4, 2000 a story -- designed to whet the appetite for 4th of July hamburgers -- focused on problems the beef industry faced with controlling the deadly *E. coli* pathogen along with the steps that one processor was taking to address these problems. The article mentioned beef recalls but no specific recall event.
- On April 26, 2000 the Newswire reported on quarterly financial reports of Sara Lee Corporation. A major recall the company faced in 1998 was cited as one of the reasons for its food unit's decline.
- On September 2, 2007 an article addressed the then recent and increasing practice of outsourcing production and sale of products from one plant under many different brands. It also discussed the consequences of this practice for food safety and traceability. Several prominent and large recalls of both meat and non-meat food products were cited in the article.

In the first example, the story was primarily about food safety (*E. coli* specifically) and not about product recalls. For this reason, the story was given a secondary designation. Similarly the second and third stories were primarily about financial performance and business practices, respectively, with recalls being mentioned tangentially. In these latter two cases, specific recall events could be identified within the FSIS records and, as explained above, these events were also coded as having received secondary coverage.

Other Coding Issues

In most cases, coverage of recall events mentioned the company somewhere in the story and this was used to link the story to a specific event in the FSIS records. However, in some cases the recall event was indicated implicitly. That is, when the company's name is absent. A recall described in a story can be tied to the FSIS records by any combination of information given, such as the date of the recall event, the product being recalled, the recall reason, the pounds recalled, the city and state where the plant and/or company is located, and the parent company's name. An example is provided by an article appearing on February 10, 1998 about an experimental vaccine created to protect people against *E. coli* infection. Since the focus was primarily on the vaccine, the article was classified as secondary coverage. It did mention the recall in 1997 of millions of pounds of ground beef for *E.coli* contamination but did not specifically mention a company name. In 1997 Hudson Foods recalled 25 million pounds of ground beef after an *E. coli* outbreak was linked to this company and so it was clear that the recall event described in the story was a reference to the Hudson Foods case. For these reasons, the article was coded as secondary coverage for the Hudson Foods recall event. In these types of situations, I did make a coding note indicating that the linkage between the story and the FSIS recall records was implicit.

Another issue that warrants mention is my handling of news summaries that appear on the Newswire. These summaries are similar to the highlights that often appear on the front page of daily newspapers. They consist of several synopses of leading stories in areas such as business news, domestic news, international news, sports, and so forth. Some of the recall events were mentioned within these news summaries. When coding these summaries, I looked at the main subject of the synopsis that mentioned product recall and made the coding decisions based on that synopsis alone, without regard to the multiple other synopses on various other topics. I indicated these news summaries in my coding notes.

Key Features of the Datasets

FSIS Recalls over Time

Table 3.2 shows the number and volume of FSIS recalls over the study period classified by severity. The recall events receive severity classifications by the FSIS based on the potential hazard the product can cause to the consumer's health (as mentioned before in chapter 1, p. 3). Table 3.2 is similar to that presented by Thomsen and McKenzie (2001), who report data from FSIS from 1982 to 1998.

Table 3.2. Number of recalls by class and pounds recalled.[1]

	Class I		Class II		Class III	
Year	**Number**	**Pounds**	**Number**	**Pounds**	**Number**	**Pounds**
1982	12	719,833	6	280,339		
1983	6	170,072	1	428,000	2	266,220
1984	5	436,512	1	93,600	4	2,004
1985	6	163,088	10	1,706,453	2	132,293
1986	5	711,706	8	1,670,111	2	465,591
1987	8	1,090,520	30	8,631,531	5	1,541,345
1988	4	237,326	13	5,205,813	4	292,604
1989	13	348,008	12	3,212,155	1	2,903
1990	18	2,138,838	8	606,367	2	79,521
1991	16	2,079,333	17	4,664,738	4	558,755
1992	18	2,561,856	15	623,693	3	3,047,950
1993	24	582,726	11	2,106,611	3	2,705,870
1994	28	1,401,908	18	3,257,845	2	115,300
1995	28	5,048,105	10	575,503		
1996	17	360,752	6	590,845	2	52,430
1997	16	27,005,998	11	1,143,991		
1998	30	43,136,101	12	2,884,755	2	18,623
1999	54	39,033,811	7	879,037	1	12,516
2000	75	21,206,054	7	1,544,500	3	12,920
2001	71	21,059,415	12	8,852,900	14	1,650,920
2002	93	56,379,833	15	1,082,400	17	379,230
2003	44	2,443,549	13	216,220	11	653,205
2004	41	2,462,711	4	153,050	4	274,410
2005	48	5,940,165	3	429,400	1	74,810
2006	26	4,703,669	6	1,136,964	2	25,300
2007	50	48,458,459	7	158,353	1	19,488
2008	42	9,816,427	12	144,910,236		
2009	44	5,518,290	21	782,565	4	3,089,258
Total	**842**	**305,215,065**	**296**	**197,827,975**	**96**	**15,473,466**

[1] There are 1,240 total recall IDs in the dataset. Six of them are missing the class categorization and so are not reported in table 3.2.

Coverage of FSIS Recalls

The total number of recall events reported in table 3.2 over the 1982 to 2009 period is 1,234[3]. Among them, 311 recall events, or around 25 percent, were covered at least once by the AP newswire. Trends in recalls and the proportion of recalls receiving coverage in the Newswire are presented in figure 3.3. By year, the percent covered by at least one Newswire story ranges from a low of around 8 percent in 1994 and 1996 to a high of 40 percent in 1984 and 2000. The overall pattern in FSIS recall events over time follows, to a certain extent, the pattern documented by Chun, Lin, and Prather (2005) for non-automotive product recalls appearing in the *Wall Street Journal Index*. Similar to my data, these authors find that product recalls for non-automotive consumer products were less frequent before the early 1990s, and they document a gradual increase in recalls through the late 1990s, reaching its peak in the year 2000. The peak among meat and poultry recalls appears slightly later, hitting the highest point in 2002. This increase in number of recalls issued by the FSIS is also due to policy and regulatory changes that were applied, especially in the late 80's and the 90's, such as an increase in sampling by the FSIS at the plant level and lower tolerance for presence of pathogens by the agency (Ollinger and Ballenger 2003; U.S. Department of Agriculture 2001; Brasher 2000a; Brasher 2000b). These changes also are noticed in the reasons for recalls, with a sharp rise in those due to presence of *E. coli* and *Listeria*.

[3] There are 1,240 total recall IDs in the dataset. Six of them are missing the class categorization and so are not reported in Table 3.2.

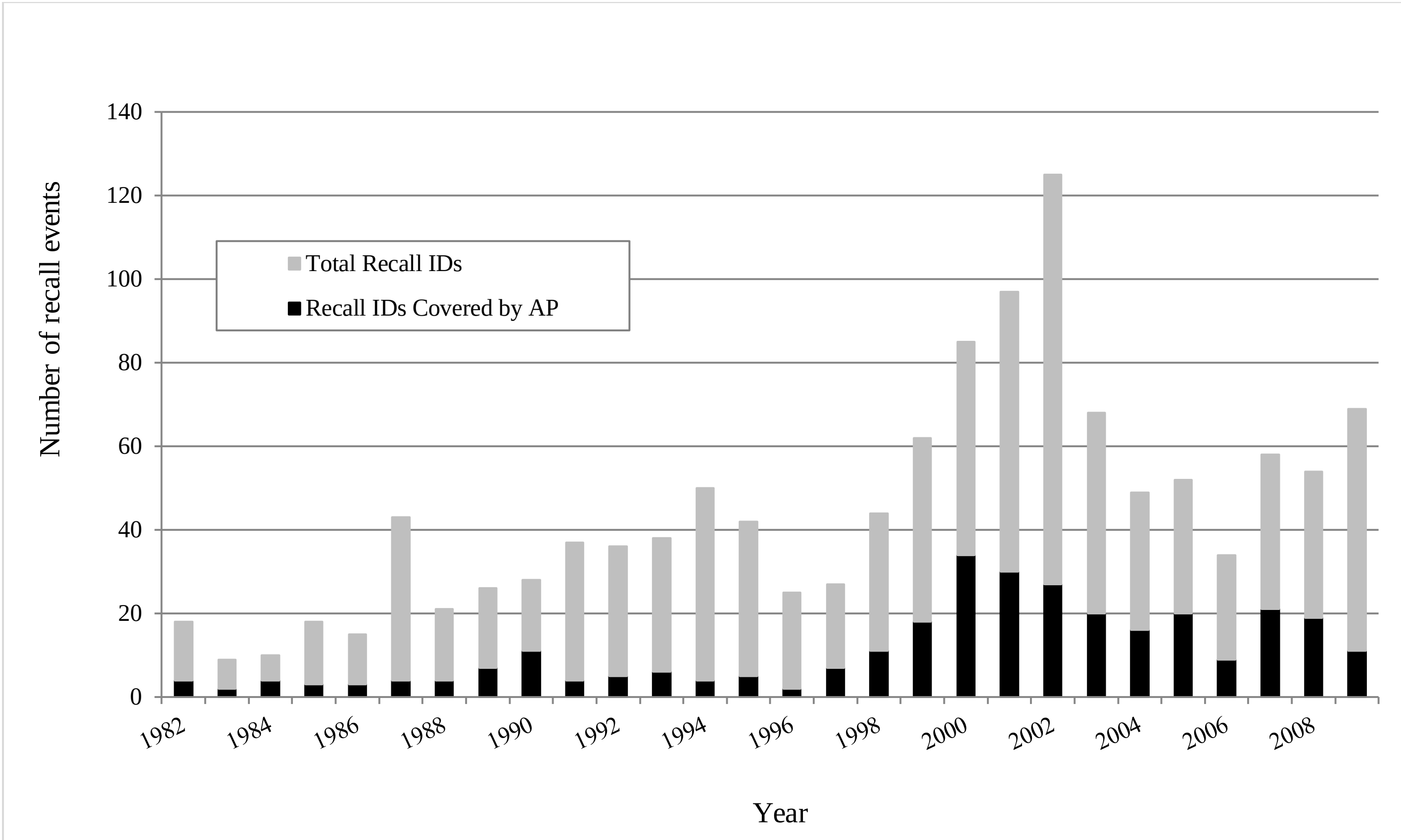

Figure 3.3. Total number of recall events and number with coverage by the AP Newswire from 1982 to 2009.

Reasons for Meat and Poultry Recalls

Information on the reason for the product recall is always mentioned in FSIS records and announcements. I assigned reasons for recalls to one of five categories. The total number of recalls assigned to each category is reported in table 3.3.

- *E. coli 0157:H7*: the reason cited was for contamination with this bacterial pathogen.
- *Listeria monocytogenes*: the reason cited was for contamination for this bacterial pathogen. In a handful of cases the reason given was for contamination for *Salmonella* along with *Listeria*. In these cases, I assigned *Listeria* as the primary reason.
- Mislabeled: includes recalls for which the reason given is mislabeling or formulation errors.
- Other: includes recalls for which the reason involves a variety of other violations including chemical contaminants; physical contaminants such as metal, bone fragments or glass; and other regulatory violations such as meat shipped without inspection or imported from an unapproved source.
- Other Microorganisms: includes recalls for other microbiological contaminants including *Salmonella* when listed alone without *Listeria*, a variety of other bacterial pathogens, and molds.

Table 3.3. Number of recalls by reason.

Reason	Recall IDs	Percent	Cumulative Percent
E. coli O157:H7	219	17.66	17.66
Listeria	319	25.73	43.39
Mislabeled	239	19.27	62.66
Other	368	29.68	92.34
Other Microorganism	95	7.66	100.00

Entity Discovering the Problem

Most of the recall announcements, especially the most recent ones, identify how the problem was discovered. I assigned problem discovery to three broad entities based on FSIS records or press releases. These are reported in table 3.4. I assigned discovery to the company whenever FSIS records indicate that the problem was identified by the company itself, by the company's final consumers, or by another business entity either upstream or downstream within the company's supply chain. I assigned discovery to FSIS whenever records indicate that FSIS identified the problem leading the product recall. Finally, I assigned discovery to other governmental entities whenever recall records indicate that the problem was identified by a local, state or federal body other than FSIS. These include state departments of health, the CDC, the US Food and Drug Administration, other agencies within USDA, US Customs, foreign governments, and several others. Often, but not always, these recalls appear to have been initiated after epidemiological evidence has linked an outbreak to specific product.

FSIS has changed their database structure over the years. Before 1998, many of the FSIS recall announcements were not accompanied by an automatic press release. The press release is a separate file that usually explains how the problem was discovered. In many cases before 1998, recall records indicate that there was a press release but the actual text of the press release is no longer available. Therefore, data from the earlier part of the sample has missing values for the entity discovering the problem. The total number of recall events with missing this information is 432.

Table 3.4. Number of recalls by discovering entity.[1]

Discovered	Recall IDs[1]	Percent	Cumulative Percent
Company	276	34.16	34.16
FSIS	436	53.96	88.12
Other Government Entity	96	11.88	100.00

[1]In 432 recall cases, FSIS records did not provide adequate information in order to assign problem discovery to one of these three entities.

Day of the Week

Table 3.5 shows proportion of recalls by discovering entity and day of the week. FSIS recalls occur most frequently on Tuesdays. Recalls discovered by other governmental entities are much less frequent on Monday and most frequent on Thursday. Interestingly, company discovered recalls are most likely to occur on Fridays. This may represent strategic behavior on part of companies to try to lessen the negative publicity generated by the recall announcement as news consumption patterns differ on weekends. I further explore whether Friday recalls are less likely to be covered in Newswire stories in my empirical models described below.

Table 3.5. Percent of recalls by discovering entity and day of the week.[1]

Discovered	Weekend	Monday	Tuesday	Wednesday	Thursday	Friday
FSIS	10.78	15.83	22.25	18.12	14.68	18.35
Other Government Entity	16.67	4.17	19.79	15.63	22.92	20.83
Company	6.16	11.23	16.67	17.39	21.38	27.17

[1] In 432 recall cases, FSIS records did not provide adequate information to assign problem discovery to one of these three entities.

Large Recalls and Coverage

Table 3.6 summarizes the ten largest recall events during the period of study. With the exception of the Hallmark/Westland recall, each of these recalls was given the most serious class I severity designation. Table 3.7 shows the eleven recall events with the most coverage (either primary or secondary) in the AP Newswire. A comparison of table 3.6 with 3.7 indicates that size of the recall, in terms of total volume matters. In fact, eight of the companies with the largest recalls listed in table 3.6 also appear among those receiving the greatest number of Newswire stories in table 3.7.

Table 3.6. Ten largest recalls during the study period.

Company	Year	Class	Cause	Initiated	Pounds
Hallmark/Westland Meat Packing	2008	II	Other	FSIS	143,383,823
Bil Mar Foods	1998	I	*Listeria*	Other Gov. Entity	35,000,000
Thorn Apple Valley	1999	I	*Listeria*	FSIS	35,000,000
Pilgrim's Pride Corporation	2002	I	*Listeria*	FSIS	27,400,000
Hudson Foods	1997	I	*E. coli*	Other Gov. Entity	25,000,000
Topps Meat Company, LLC	2007	I	*E. coli*	Other Gov. Entity	21,700,000
ConAgra Beef Company	2002	I	*E. coli*	FSIS	19,000,000
Cargill Turkey Products	2000	I	*Listeria*	Company	16,895,000
Bar-S Foods Co	2001	I	*Listeria*	FSIS	14,500,000
Castleberry's Food Company	2007	I	Other Micro	Other Gov. Entity	11,172,478

Table 3.7. Ten most covered recalls by the AP Newswire.

Company	Year	Class	Cause	Initiated	Total Coverage[1, 2]
Hudson Foods	1997	I	*E. coli*	Other Gov. Entity	208
Hallmark/Westland Meat Packing	2008	II	Other	FSIS	98
Bil Mar Foods	1998	I	*Listeria*	Other Gov. Entity	78
ConAgra Beef Company	2002	I	*E. coli*	FSIS	61
Pilgrim's Pride Corporation	2002	I	*Listeria*	FSIS	43
Topps Meat Company, LLC	2007	I	*E. coli*	Other Gov. Entity	38
Verns Moses Lake Meats	2003	II	Other	Other Gov. Entity	37
Beef America Operation Co. Inc.	1997	I	*E. coli*		23
Thorn Apple Valley	1999	I	*Listeria*	FSIS	17
ConAgra Foods	2007	I	Other Micro	Other Gov. Entity	17
Castleberry's Food Company	2007	I	Other Micro	Other Gov. Entity	17

[1]Total coverage ranges from pre-recall announcement to after twenty six weeks of recall announcement.
[2]Number of articles that were assigned to the recall ID number in any classification (primary or secondary).

CHAPTER 4: METHODS

Regression Analysis for Count Data

Count data models were used to model coverage of recall events. In these models the unit of analysis is the recall case. The dependent variable is coverage and was measured two ways. The first way was the number of primary coverage articles linked to the recall case during the first week of the recall. The second way was the total number of primary coverage articles linked to the recall case from the time of the recall through the end of the study period (through the end of 2009). Tables 4.1 and table 4.2 show the frequency of article counts for each of the dependent variables. As evident in both tables, the number of zero counts is large for each measure of coverage. Zero counts can come from two possible sources. First, it is possible that some recall cases never receives coverage in the AP Newswire due to the combination of one or more of their characteristics. In fact, I expect that recalls involving small volumes of product will likely not be considered for a story by the AP. The results of the zero (probit) model in chapter 5 will point to these specific characteristics. In other words, the probit model will distinguish between the recall events that will never receive an AP story and those that might. When the recall presents characteristics that make it likely to have at least one AP story, then the count models (negative binomial and the Poisson) will apply. However, it is possible that some of these recalls will still receive no coverage by the AP. This is the second possible source of zeros in my data.

Table 4.1. Primarily coverage within the first week of the recall announcement.

Coverage (Number of Articles)	Frequency (Recall Cases)	Percent	Cumulative Percent
0	553	70.90	70.90
1	151	19.36	90.26
2	50	6.41	96.67
3	13	1.67	98.33
4	5	0.64	98.97
5	1	0.13	99.10
6	2	0.26	99.36
7	2	0.26	99.62
12	2	0.26	99.87
14	1	0.13	100.00

Table 4.2. Total primary coverage.

Coverage (Number of Articles)[1]	Frequency (Recall Cases)	Percent	Cumulative Percent
0	546	70.00	70.00
1	142	18.21	88.21
2	55	7.05	95.26
3	14	1.79	97.05
4	4	0.51	97.56
5	8	1.03	98.59
6	1	0.13	98.72
7	3	0.38	99.10
10	1	0.13	99.23
15	1	0.13	99.36
25	1	0.13	99.49
26	1	0.13	99.62
31	1	0.13	99.74
42	1	0.13	99.87
97	1	0.13	100.00

[1]Number of articles primarily covering one or more recall IDs for the entire period is a count variable.

The summary literature on count data models (see Long 1997 and Cameron and Trivedi 1998 as examples) recommends that when excessive zeros arise from two possible sources, the zero-inflated count model should be used. Bilgic, Florkowski, and Akbay (2010) also assert that the zero inflated models permit the relaxation of the Poisson model's restriction that the conditional mean must be equal to the conditional variance, and thus are considered alternative models for count data. For this reason, I implemented the Zero-Inflated Poisson (ZIP) and Zero-Inflated Negative Binomial (ZINB) in this study. In each model, I use a probit model to estimate the probability of zero counts.

Explanatory variables include total volume subject to recall (measured as the logarithm of pounds to avoid scale effects), binary variables measuring the reason for the recall, binary variables indicating who discovered the problem leading to the recall, and binary variables indicating the day of the week on which the recall was announced. Table 4.3 provides descriptive statistics for the final samples used in the count data models. As noted earlier, the entity discovering the recall was not reported in FSIS records during the early part of the data, typically before 1998. Consequently, I am reporting descriptive statistics for the total sample and for the subsample that contains non-missing observations on recall discovery.

Table 4.3. Descriptive statistics for samples used in the zero-inflated count data models.

	Unit of Measurement	Total sample (n=1,192)				Sample with values for discovered (n = 780)			
		Mean	Std. Dev.	Min.	Max.	Mean	Std. Dev.	Min.	Max.
Dependent Variables									
Prim. Coverage Week of Recall	Number of Stories	0.389	1.052	0	14	0.486	1.157	0	14
Prim. Coverage Total	Number of Stories	0.628	3.514	0	97	0.799	4.269	0	97
Explanatory Variables									
Volume recalled	Pounds	314,722	2,146,556	1	35,000,000	399,109	2,627,134	1	35,000,000
Log (volume recalled)	Log of pounds	9.022	2.828	0	17.371	8.795	2.981	0	17.371
Reason *E. coli 0157:H7*	Binary	0.179	0.383	0	1	0.253	0.435	0	1
Reason *L. monocytogenes*	Binary	0.266	0.442	0	1	0.303	0.46	0	1
Reason Other	Binary	0.294	0.456	0	1	0.187	0.39	0	1
Reason Other Microbiological	Binary	0.076	0.266	0	1	0.045	0.207	0	1
Reason Mislabeled[1]	Binary	0.185	0.388	0	1	0.213	0.41	0	1
Discovered FSIS	Binary					0.538	0.499	0	1
Discovered Other Govt. Entity	Binary					0.113	0.317	0	1
Discovered Company[1]	Binary					0.349	0.477	0	1
Monday Recall	Binary	0.138	0.345	0	1	0.127	0.333	0	1
Tuesday Recall	Binary	0.196	0.397	0	1	0.204	0.403	0	1
Wednesday Recall	Binary	0.172	0.378	0	1	0.172	0.377	0	1
Thursday Recall	Binary	0.191	0.393	0	1	0.182	0.386	0	1
Friday Recall[1]	Binary	0.235	0.424	0	1	0.217	0.412	0	1
Saturday Recall	Binary	0.068	0.252	0	1	0.099	0.298	0	1

[1] Omitted category in all model specifications.

Before estimating the model, two recalls were excluded from the dataset because they were atypical. Both received an abnormally high number of article counts. One recall was due to possible Bovine Spongiform Encephalopathy (BSE) contamination by Verns Moses Lake Meats in 2003. The other recall was in 2008 by Hallmark/Westland Meat Packing and was due to the slaughter and processing of a non-ambulatory or "downer" cow, which increases the risk of contamination with BSE. I also excluded 46 recall cases because they were missing information for volume (total pounds) subject to recall. After removing these observations, I was left with 1,192 observations in the full sample and 780 observations in the subsample with non-missing observations on recall discovery.

Empirical Implementation

I used the COUNTREG procedure in SAS® version 9.2 to estimate three specifications of both the ZIP and ZINB models (see table 4.4). Explanatory variables listed in table 4.4 were included in both the count and excess zero equations. To provide evidence on robustness, specification 1 was estimated using both the full sample of 1,192 observations and the subsample of 780 observations. I did face convergence issues mostly in estimating the excess zero equations within the ZINB model and convergence depended on choice of optimization algorithm within the SAS software. My rationale for the use of the normal distribution (probit) link for the zero model was that it lessened convergence problems. The estimation method for the covariance matrix was quasi-maximum likelihood (QML) (SAS 2011) since this also helped to facilitate convergence.

Table 4.4. Dependent and independent variables of the count data model.

Dependent Variable	Explanatory Variables		
	Specification 1	Specification 2	Specification 3
Measure 1: Primary coverage for the recall event during the first week of the recall (number of articles) Measure 2: Total primary coverage for the recall event (number of articles)	Logarithm of pounds subject to recall Binary variables indicating reason for recall	Logarithm of pounds subject to recall Binary variables indicating reason for recall Binary variables indicating how the recall was discovered	Logarithm of pounds subject to recall Binary variables indicating reason for recall Binary variables indicating how the recall was discovered Binary variables indicating day of the week

Hypotheses

Hypothesized relationships based on the literature review and earlier descriptive analyses of the data presented in earlier chapters are as follows. First, I expect a positive relationship between the size of the recall (logarithm of pounds recalled) and article counts. In the zero (probit) equation, the dependent variable is considered a "certain zero", which means the model include the recall IDs that did not get primary covered by the AP and thus have a zero count of stories. In other words, the zero model is estimating the probability of an outcome of zero. For this reason, I expect a negative relationship between the volume of recalled product and the probability of having a zero count of articles published on the specific recall event. Second, I hypothesize that meat and poultry products recalled due to presence of *E. coli*, *Listeria*, or other microbiological problems will have a larger number of article counts. Analogously, I expect a negative coefficient on binary variables for these reasons in the zero equation. Third, I anticipate that variables indicating problem discovery by FSIS or another governmental entity will have a positive coefficients in the count data equation and negative coefficients in the zero equation. Finally, to the extent that weekend news cycles differ from weekdays, it is reasonable to expect Friday announcements to receive fewer article counts as they can be expected to receive less initial exposure.

CHAPTER 5: RESULTS

Primary Coverage During the Week of the Recall

Tables 5.1 and 5.2 show the results of the zero-inflated negative binomial (ZINB) and zero-inflated Poisson (ZIP) models, respectively, for article counts of primary coverage during the first week after the recall announcement. Results for specifications 1 and 2, with and without binary controls for entity discovering the problem, are presented in these tables.

Table 5.1 shows that estimates are robust to sample size and specification. This is especially true for estimates in the count equation which addresses factors affecting the number of primary articles published. In each count equation, the signs and statistical significance of the coefficients are quite similar. The coefficient of the estimate for recall volume (logarithm of pounds recalled) is remarkably similar across the different regressions. The magnitudes of estimates for binary variables indicating the reason for a recall are also similar between specification 1 and specification 2 in the subsample of 780 observations. However, comparing specification 1 across the two different samples indicates that estimates for these binary variables are smaller in the subsample than in the full sample (n=1,192).

The regression coefficients in the count equation can be used to determine the impact, in terms of the number of articles, of a change in the explanatory variable. Specifically, given a one unit increase in an explanatory variable, this impact is given by a function of the estimate provided all the other variables in the model are kept constant (UCLA: Academic Technology Services, Statistical Consulting Group 2011). For all the specifications in table 5.1, these coefficients suggest that an increase in the volume of product recalled will increase the number of articles published in the AP. For the binary variables the positive estimates for reasons *E.*

coli contamination, *Listeria* contamination, other microbiological contamination, or other problems indicate that recalls for these reasons are expected to have a higher number of primary articles than recalls that are the result of mislabeling, the omitted category. *E. coli* and *Listeria* contamination represent serious health risks to consumers and may be linked to an outbreak so it is expected that recalls for these reasons would receive more coverage.

Specification 2 also includes binary indicator variables for the entity discovering the problem leading to a recall. These results suggest that recalls initiated by FSIS have more articles than those that were initiated by the company (omitted category). Recalls initiated by other government entities would also be expected to receive more coverage since many of these recalls are related to outbreaks of foodborne illness. The estimated coefficient, however, is not statistically significant.

Table 5.1. Zero-inflated negative binomial models for primary article counts in the first week of the recall.

	Full Sample n=1192		Sample with non-missing discovery measures n=780			
	Specification 1		Specification 1		Specification 2	
Parameter	**Estimate**	**t ratio**	**Estimate**	**t ratio**	**Estimate**	**t ratio**
Count Equation						
Intercept	-4.202***	-5.230	-3.856***	-8.770	-4.038***	-11.190
Logarithm of pounds	0.254***	3.660	0.251***	7.160	0.258***	9.100
Reason – *E.coli*	1.465***	5.660	1.103***	6.210	0.908***	4.830
Reason – *Listeria*	1.380***	6.460	1.074***	5.400	0.874***	4.630
Reason – Other	1.166***	3.680	0.368*	1.730	0.571***	2.610
Reason – Other Micro	1.946***	7.350	1.794***	4.900	1.113**	2.370
Discovered – FSIS					0.420***	2.730
Discovered – Other Gov.					0.233	1.480
Zero Equation						
Intercept	-1.075	-0.300	1.718*	1.660	-1.895	-1.050
Logarithm of pounds	-0.158	-1.540	-0.326***	-4.440	-0.361***	-4.550
Reason – *E.coli*	1.923	0.860	0.589	1.000	-0.321	-0.530
Reason – *Listeria*	1.996	0.810	0.293	0.460	-0.768	-1.240
Reason – Other	3.021	1.110	-0.289	-0.270	1.643**	2.320
Reason – Other Micro	3.416	1.350	2.011***	2.670	0.960	0.890
Discovered – FSIS					5.012***	3.480
Discovered – Other Gov.					-0.652	-0.400
Alpha	0.264***	2.630	0.172*	1.940	0.208***	2.700
AIC		1634		1190		1183
SBC		1700		1251		1262
Log likelihood		-803.815		-582.068		-574.356
Optimization method		Newton-Raphson		Double Dogleg		Double Dogleg

* significance at 10% level, ** at 5% level, and *** at 1% level.

Coefficient estimate magnitudes in the zero equation of the ZINB model vary depending on sample size and specification. Most of these coefficients are not statistically significant. In fact, in the full sample none of the coefficients in the zero equation are significant. Cameron and Trivedi (1998) note that when most of the variables in the zero section of the model are insignificant, it implies that the independent variables have the majority of their explanatory power through their influence on the "positive counts." The interpretation for the predictors whose estimates are not significant is that the odds of being a "certain zero" do not change when a continuous variable changes (logarithm of pounds) or does not change relative to the omitted category for the binary variables (UCLA: Academic Technology Services, Statistical Consulting Group 2011). For the subsample, both specifications 1 and 2 present negative and significant estimates for the logarithm of pounds recalled. Because the zero model is based on a probit model, this means that for a unit increase in the logarithm of pounds, the odds of a recall event having zero coverage by the AP decreases. This means that as the volume of product involved in a recall case increases it is less likely to observe a zero count and is consistent with findings above that large recalls receive more coverage. In the zero equation for specification 2, positive and statistically significant coefficients are observed for binary variables indicating the other reason category and the problem discovered by FSIS. This latter finding is not consistent with findings in the count equation discussed above. However, this finding may be reasonable if we consider that the number of recalls initiated by the FSIS is proportionally higher than the ones initiated by the company. Although the estimates for binary variables indicating reasons *E. coli* and *Listeria* are not significant, the negative signs are expected since recalls for these reasons are more likely to be covered, as mentioned before, when compared with recalls for mislabeling.

According to Cameron and Trivedi (1998), the goodness of fit of the count data model is considered by comparing the Akaike Information Criterion (AIC) values, with a lower value of AIC indicating a better fit. For the subsample, the fit of the model is similar for specification1 and 2. The AIC value is slightly smaller in specification 2. However Schwartz's Bayesian information criterion (SBC) is slightly smaller in specification 1. Thus there is no conclusive evidence about the superiority of specification 1 over specification 2.

It is worth pointing out that the dispersion parameters (alpha) in table 5.1 are significant. According to the UCLA Academic Technology Services, Statistical Consulting Group (2011), an alpha value of zero indicates that the Poisson model is appropriate. This also means that the ZINB is nested within the ZIP (Bilgic, Florkowski, and Akbay 2010). In my models the alpha values are significantly different than zero which suggests that the ZINB is the appropriate model. For that reason, marginal effects are shown only for the ZINB model (as seen in table 5.3 and table 5.6). However, I provide the analysis for ZIP as well in table 5.2 for comparison purposes and to assess the robustness of my findings.

Table 5.2. Zero-inflated Poisson models for primary article counts in the first week of the recall.

	Full Sample n=1192		Sample with non-missing discovery measures n=780			
	Specification 1		Specification 1		Specification 2	
Parameter	**Estimate**	**t ratio**	**Estimate**	**t ratio**	**Estimate**	**t ratio**
Count Equation						
Intercept	-4.153***	-7.530	-3.922***	-8.300	-4.066***	-10.270
Logarithm of pounds	0.250***	5.470	0.257***	6.870	0.259***	8.290
Reason – *E.coli*	1.572***	7.270	1.144***	6.130	0.847***	4.290
Reason – *Listeria*	1.489***	6.830	1.094***	4.950	0.825***	4.130
Reason – Other	1.308***	5.400	0.360*	1.640	0.583***	2.620
Reason – Other Micro	2.115***	8.840	1.948***	7.740	1.501***	3.940
Discovered – FSIS					0.514***	3.040
Discovered – Other Gov.					0.397**	2.420
Zero Equation						
Intercept	-0.901	-0.390	1.446	1.320	-3.081	-0.930
Logarithm of pounds	-0.151***	-2.830	-0.297***	-3.990	-0.288***	-5.390
Reason – *E.coli*	1.929	1.080	0.717	1.120	-0.279	-0.520
Reason – *Listeria*	1.975	1.050	0.414	0.570	-0.658	-1.190
Reason – Other	2.936	1.520	-0.22	-0.180	1.268**	2.040
Reason – Other Micro	3.271*	1.740	2.083***	2.950	1.406*	1.830
Discovered – FSIS					5.650*	1.870
Discovered – Other Gov.					4.59	1.520
AIC		1645		1196		1190
SBC		1706		1252		1265
Log likelihood		-810.624		-585.978		-579.052
Optimization Method		Newton-Raphson		Newton-Raphson		Newton-Raphson

* significance at 10% level, ** at 5% level, and *** at 1% level.

Table 5.3 displays the marginal effects for the ZINB model for article counts of primary coverage during the first week after the recall announcement. With the exception of the full sample, the marginal effects are positive, which indicates that an increase in the explanatory variable increases the likelihood of having more articles published by the AP, keeping all other values constant. The marginal effects were computed in two different ways. For the continuous variable, which in this study is the volume of product recalled, the following formula was used:

$$(1 - \Phi[x\gamma])\beta_i e^{x\beta} - \phi[x\gamma]\gamma_i e^{x\beta}$$

Where γ is a column vector of coefficients from the zero model (probit equation), Φ is the normal CDF, β is a column vector of coefficients from the count data model (negative binomial), ϕ is the normal PDF, and x is a row vector of regressors evaluated at the sample mean. For the binary independent variables, the marginal effects were calculated using the following formula:

$$(1 - \Phi[x_1\gamma])e^{x_1\beta} - (1 - \Phi[x_0\gamma])e^{x_0\beta}$$

Where x_1 has the binary variable in question held at a value of 1 and each other variable set at the sample mean and x_0 has the binary variable in question held at a value of zero and each other element set to the sample mean.

Table 5.3. Marginal effects for primary article counts in the first week of the recall.

	Full Sample n=1192	Sample with non-missing discovery measures n=780		
	Specification 1	Specification 1	Specification 2	Specification 3
Parameter	**Marginal Effect**	**Marginal Effect**	**Marginal Effect**	**Marginal Effect**
Logarithm of pounds	0.104	0.12	0.0201	0.121
Reason – *E.coli*	-0.074	0.362	-0.0047	0.425
Reason – *Listeria*	-0.064	0.402	0.0098	0.422
Reason – Other	-0.244	0.175	0.0286	0.133
Reason – Other Micro	-0.291	0.021	-0.0232	0.725
Discovered – FSIS			-0.4052	-0.231
Discovered – Other Gov.			0.2293	0.068
Monday				0.107
Tuesday				0.026
Wednesday				0.043
Thursday				-0.077
Weekend				-0.062

Estimates for the ZIP model in table 5.2 are similar to estimates for the ZINB model in terms of their signs and magnitudes. There are, however, some observable differences. In the zero equation for the full sample, the logarithm of pounds and indicator variable for recalls caused by contamination with other microorganisms are statistically significant, even though the estimate values do not differ meaningfully in magnitude. Similarly, in specification 2, the binary variable for recalls discovered by other government entities in the count equation and binary variable for recalls caused by other microorganism in the zero equation are both statistically significant. The intercept values of the zero equation of specification 1 in the subsample (n=780) loses its significance in the ZIP as opposed to the ZINB. Overall model fit statistics are also similar between tables 5.1 and 5.2. AIC and SBC values, however, are smaller in the ZINB models which indicates that ZINB models provide a better fit. This is to be expected because of the significant dispersion parameters that suggest the negative binomial is the more appropriate model.

Total Primary Coverage

Tables 5.4 and 5.5 estimates for specifications 1 and 2 for the ZINB and ZIP models respectively when the dependent variable is total primary coverage article counts. Again, the majority, if not all, of the estimates in the count equations show statistical significance while only a few estimates are significant in the zero equation.

In the count equations presented in table 5.4 all estimates are positive, except for the intercepts. With exception of the indicator variable for other microorganisms in specification 2 all estimates are statistically significant as well. The interpretation of these estimates is analogous to that described above. For example, the results suggest that recalls for *E. coli*, *Listeria*, and other microorganism receive more coverage than recalls for mislabeling (the base category). In the zero equation, the logarithm of pounds exhibits a consistent negative sign across samples and specifications, and as explained above this is as would be expected if larger recalls are more likely to be covered by the Newswire. For all the specifications, the dispersion parameter is significantly different than zero, which favors the ZINB over the ZIP. This implication can also be noticed when comparing the values of the AIC between tables 5.4 and 5.5 (for the reasons earlier described).

Table 5.4. Zero-inflated negative binomial models for total primary article counts.

	Full Sample n=1192		Sample with non-missing discovery measures n=780			
	Specification 1		Specification 1		Specification 2	
Parameter	**Estimate**	**t ratio**	**Estimate**	**t ratio**	**Estimate**	**t ratio**
Count Equation						
Intercept	-4.730***	-9.390	-5.003***	-9.550	-5.027***	-10.900
Logarithm of pounds	0.305***	6.950	0.353***	7.840	0.346***	9.060
Reason – *E.coli*	1.704***	7.770	1.338***	6.460	1.066***	4.730
Reason – *Listeria*	1.577***	7.800	1.369***	6.820	1.139***	5.400
Reason – Other	0.658**	2.050	0.578***	2.670	0.765***	3.250
Reason – Other Micro	0.945**	2.270	0.940**	2.170	0.775	1.450
Discovered – FSIS					0.398**	2.040
Discovered – Other Gov.					0.492**	2.340
Zero Equation						
Intercept	0.908	0.430	1.808	1.310	-3.859	-1.000
Logarithm of pounds	-0.352**	-2.030	-0.417***	-4.000	-0.341***	-3.410
Reason – *E.coli*	1.283	1.120	0.741	0.790	-0.384	-0.450
Reason – *Listeria*	1.328	1.240	0.512	0.600	-0.643	-0.800
Reason – Other	1.635	1.080	-0.491	-0.420	1.931**	2.360
Reason – Other Micro	0.978	0.320	0.876	0.640	0.697	0.480
Discovered – FSIS					6.473**	1.990
Discovered – Other Gov.					3.477	0.620
Alpha	1.199***	4.460	0.744***	4.440	0.654***	4.040
AIC		1878		1343		1333
SBC		1944		1404		1412
Log likelihood		-925.95		-658.68		-649.35
Optimization method		Double Dogleg		Newton-Raphson		Newton-Raphson

* significance at 10% level, ** at 5% level, and *** at 1% level.

Table 5.5. Zero-inflated Poisson models for total primary article counts.

	Full Sample n=1192		Sample with non-missing discovery measures n=780			
	Specification 1		Specification 1		Specification 2	
Parameter	**Estimate**	**t ratio**	**Estimate**	**t ratio**	**Estimate**	**t ratio**
Count Equation						
Intercept	-6.379***	-10.750	-6.553***	-10.080	-6.445***	-10.720
Logarithm of pounds	0.471***	9.080	0.489***	8.570	0.462***	9.770
Reason – *E.coli*	1.602***	5.070	1.442***	4.250	1.059***	3.620
Reason – *Listeria*	1.211***	3.920	1.139***	3.490	0.937***	2.980
Reason – Other	1.025***	3.140	0.825**	2.480	0.931***	2.790
Reason – Other Micro	1.210***	3.430	1.341***	3.630	0.776*	1.650
Discovered – FSIS					0.442**	1.960
Discovered – Other Gov.					0.913***	3.580
Zero Equation						
Intercept	-1.806**	-2.510	-3.066**	-2.220	-3.21	-1.100
Logarithm of pounds	0.092	1.320	0.124	0.760	0.039	0.320
Reason – *E.coli*	-0.141	-0.250	0.242	0.140	0.271	0.110
Reason – *Listeria*	-5.354***	-8.180	-4.673**	-2.480	-4.452*	-1.950
Reason – Other	0.894*	1.860	1.059	0.820	1.807	0.750
Reason – Other Micro	0.696	1.260	1.529	1.050	1.502	0.590
Discovered – FSIS					1.383**	2.310
Discovered – Other Gov.					1.248*	1.950
AIC		2125		1561		1518
SBC		2186		1617		1593
N		1192		780		780
Log likelihood		-1050		-768.566		-743.181
Optimization method		Newton-Raphson		Newton-Raphson		Newton-Raphson

* significance at 10% level, ** at 5% level, and *** at 1% level.

In table 5.5, findings are not much different than those presented earlier for coverage during the first week of the recall. However, two findings warrant mention. The first is the estimates in the zero equation for the logarithm of pounds. These are not significant in the ZIP models but are in the ZINB models. The second outcome is the coefficient for the indicator variable for *Listeria*, also in the zero equation. In all the specifications in table 5.5, the estimates are negative and significant, and display a large magnitude in comparison to result presented in table 5.4 and earlier for coverage during the first week of the recall.

Table 5.6 presents the marginal effect for the ZINB model. Specification 3 did not converge, and therefore the marginal effects listed are for specification 1 and 2. The values were calculated following the same above formulae for continuous and binary variables.

Table 5.6. Marginal effects for total primary article counts.

	Full Sample n=1192	Sample with non-missing discovery measures n=780	
	Specification 1	Specification 1	Specification 2
Parameter	**Marginal Effect**	**Marginal Effect**	**Marginal Effect**
Logarithm of pounds	0.126	0.141	0.1387
Reason – *E.coli*	0.549	0.596	0.5799
Reason – *Listeria*	0.436	0.618	0.6008
Reason – Other	0.000	0.269	0.3266
Reason – Other Micro	0.218	0.361	0.4403
Discovered – FSIS			-0.1366
Discovered – Other Gov.			0.2192

Models Adding the Day of the Week Variable

Results for the models in which the day of the week variables were included (specification 3) are shown in tables 5.7 and 5.8. Table 5.7 presents results when the dependent variable is the number of primary coverage articles within the first week of recall announcement. Table 5.8 presents results for models in which the dependent variable is total primary coverage article counts, however only the ZIP model is presented due to convergence issues experienced with the ZINB[4], as mentioned before. For all of the models, the omitted variable for the day of the week was Friday to make it easier to assess the possible evidence of strategically using Friday announcements to limit negative publicity.

As shown in table 5.7, we find no evidence that Friday announcements provide any advantage as none of the day of the week variables are significantly different from Friday in either the count or zero equations of the model. Other coefficient estimates are similar to those reported earlier for specification 2 of tables 5.1 and table 5.2.

In table 5.8, estimates for Wednesday in the count equation and Tuesday in the zero equation are statistically significant. These indicate that Wednesday recalls receive more coverage relative to Friday recalls and that Tuesday recalls are less likely than Friday recalls to receive zero article counts. However, when combining these findings with the ones shown in table 5.7, the coefficient estimates for the day of the week present weak evidence. For this reason, conclusions based on this finding may be speculative due to the longer-run nature of this particular dependent variable. When comparing the results in table 5.8 with those presented earlier in table 5.5 for specification 2, the estimates are quite different in both

[4] When the number of total primary coverage articles was used as the dependent variable, results could not be obtained for the ZINB model due to convergence problems such as the "the Hessian matrix is singular." Each available optimization method within the COUNTREG procedure was unsuccessful.

magnitude and statistical significance for both the count and zero equations. This, coupled with the significant dispersion parameters reported earlier suggests further that findings based on the ZIP model of table 5.8 should be viewed with caution.

Table 5.7. Models for primary article counts during the first week of the recall including controls for day of the week (specification 3).

	Sample with non-missing discovery measures n=780			
	ZIP		**ZINB**	
Parameter	**Estimate**	**t ratio**	**Estimate**	**t ratio**
Count Equation				
Intercept	-4.163***	-9.420	-4.044***	-10.580
Logarithm of pounds	0.273***	7.300	0.262***	8.500
Reason – *E.coli*	0.802***	3.420	0.784***	3.190
Reason – *Listeria*	0.757***	3.220	0.778***	3.410
Reason – Other	0.542**	2.220	0.524***	2.260
Reason – Other Micro	1.702***	4.940	1.373***	2.650
Discovered – FSIS	0.431**	2.360	0.490***	3.120
Discovered – Other Gov.	0.353**	1.990	0.395**	2.000
Monday	0.212	0.930	0.236	1.070
Tuesday	0.091	0.400	0.061	0.260
Wednesday	0.289	1.190	0.1	0.460
Thursday	-0.217	-1.080	-0.197	-0.900
Weekend	-0.15	-0.720	-0.161	-0.800
Zero Equation				
Intercept	0.152	0.160	-1.842	-0.760
Logarithm of pounds	-0.263***	-3.480	-0.307***	-4.440
Reason – *E.coli*	-0.405	-0.530	-0.369	-0.450
Reason – *Listeria*	-1.003	-1.300	-0.94	-1.300
Reason – Other	1.051*	1.880	1.216*	1.940
Reason – Other Micro	1.522*	1.880	1.303	1.520
Discovered – FSIS	2.269***	3.040	4.753**	2.170
Discovered – Other Gov.	1.055	1.100	3.5	1.340
Monday	-0.173	-0.270	-0.264	-0.430
Tuesday	0.144	0.240	0.08	0.120
Wednesday	0.674	1.170	0.311	0.600
Thursday	-0.119	-0.150	-0.173	-0.210
Weekend	-0.594	-1.130	-0.769	-1.470
Alpha			0.139*	1.850
AIC		1199		1196
SBC		1320		1322
Log likelihood		-573.571		-571.019
Optimization method		Newton-Raphson		Newton-Raphson Ridge

* significance at 10% level, ** at 5% level, and *** at 1% level.

Table 5.8. A zero-inflated Poisson model total primary coverage article counts including controls for day of the week (specification 3).

	Sample with non-missing discovery measures n=780	
Parameter	**Estimate**	t **ratio**
Count Equation		
Intercept	-6.242***	-4.220
Logarithm of pounds	0.456***	2.650
Reason – *E.coli*	0.598	1.390
Reason – *Listeria*	0.49	0.640
Reason – Other	0.521	0.900
Reason – Other Micro	0.961	1.450
Discovered – FSIS	0.467	0.600
Discovered – Other Gov.	0.635***	1.850
Monday	0.312	1.050
Tuesday	1.003	1.470
Wednesday	0.636***	2.880
Thursday	-0.283	-1.100
Weekend	0.124	0.540
Zero Equation		
Intercept	-2.559	-0.200
Logarithm of pounds	0.048	0.040
Reason – *E.coli*	-1.86	-0.460
Reason – *Listeria*	-2.085	-0.230
Reason – Other	0.359	0.510
Reason – Other Micro	0.015	0.010
Discovered – FSIS	1.778**	2.320
Discovered – Other Gov.	1.058	1.480
Monday	0.326	0.180
Tuesday	1.49**	2.230
Wednesday	1.411	1.010
Thursday	-0.983	-0.310
Weekend	-5.48***	-2.750
AIC		1440
SBC		1561
Log likelihood		-693.891
Optimization method		Newton-Raphson

* significance at 10% level, ** at 5% level, and *** at 1% level.

CHAPTER 6: CONCLUSIONS AND IMPLICATIONS

In this thesis, I used recall information from the USDA Food Safety and Inspection Service (FSIS) and combined it with articles appearing in the Associated Press (AP) Newswire to arrive at article counts resulting from meat and poultry recalls from 1982 and 2009. My overall objective was to assess the characteristics that make a meat and/or poultry recall event more likely to receive coverage in the news media.

My results were based on count data models, specifically the zero-inflated negative binomial model and the zero-inflated Poisson model. These results suggest that recalls involving larger volumes are more likely to be covered by the AP and also receive more coverage. This finding is consistent with my *a priori* hypothesis. There is also evidence that product recalls due to serious microbial pathogens are more likely to be covered as well. This is also consistent with the hypothesized relationship. I find little evidence that the day of the week on which the recall was issued affects either the likelihood or amount of coverage. Thus it is unlikely that recalling companies can strategically time recall announcements to correspond to slower periods in the weekly news cycle.

Given the FSIS records, I could not consistently identify recalls that were linked to outbreaks of illnesses due to consumption of meat or poultry products contaminated with pathogens. Thus outbreak is not considered as an explanatory variable in the models. However there is some evidence that outbreaks lead to increased media coverage. When recalls are for *E. coli*, *Listeria* or contamination with other microbiological hazards article counts were higher and outbreaks are generally linked to recalls for these causes. While I did not systematically record outbreak content contained in the AP stories, mention of outbreaks was frequent, which also suggests that outbreaks lead to increased coverage. The results also imply that recalls discovered by FSIS, when covered, generally receive more coverage than recalls discovered by the company or other governmental entities. My suspicion is that number of outbreaks and the magnitude and severity of illnesses are important variables in predicting the intensity of media coverage. In the regression context this means the list of explanatory variables is incomplete for the models I estimated in this thesis. This implies that the results herein are intermediate estimates and that the conclusions drawn are certainly not definitive but awaits further investigation. Such investigation needs additional exploration of data from the FSIS and/or CDC on outbreak intensity and severity.

The study has some additional limitations. First, although the AP is a comprehensive newsgathering organization, it is not a comprehensive indicator of coverage. In addition, as media consumption habits change, the AP Newswire may have become a less comprehensive indicator of coverage over time. My study period overlapped growth in cable news programming and the advent and growth of internet news sources but these other sources may depend on the AP Newswire to some degree.

The combined dataset used in this research included AP articles coded as primarily or secondarily covering a recall event. However, the models were estimated solely using the primary covered articles. Although primary coverage is probably the most important and interesting information in terms of media coverage and public accessibility, a different coding system, which would include all the articles that mention a recall event, may present some different results because they would be analyzing different aspects of recalls.

Additional future research should emphasize the limitations listed above. If consumer safety is the major point of any product recall then research evaluating in which contexts consumers are most likely to receive recall announcements would be important in terms of regulations and food safety policies.

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