Journal of Food Distribution Research
Volume 45 Issue 2

Dynamics of Consumer Response to Food Contamination: The 2007 Peanut Butter Recall

Rafael Bakhtavoryan[a], Oral Capps[ⓘb], and Victoria Salin[c]

[a]*Former Post-Doctorate Research Associate, Department of Agricultural Economics, Agribusiness, Food, and Consumer Economics Research Center, Texas A&M University, 600 John Kimbrough Blvd., College Station, Texas, 77845, USA.*

[b]*Executive Professor and Regents Professor, Department of Agricultural Economics, Agribusiness, Food, and Consumer Economics Research Center, Texas A&M University, 600 John Kimbrough Blvd., College Station, Texas, 77845, USA. Email: ocapps@tamu.edu*

[c]*Associate Professor, Department of Agricultural Economics, Agribusiness, Food, and Consumer Economics Research Center, Texas A&M University, 600 John Kimbrough Blvd., College Station, Texas, 77845, USA.*

Abstract

We investigate the foodborne illness outbreak affecting a national brand of peanut butter to determine how demand for the product category was affected. The illness outbreak coincided with growth in the quantity demanded for the peanut butter category. The negative impact on the category associated with the initiation of the product recall was significant and dissipated over time. The recovery of the product category after the recall indicates that the information was correctly targeted and actions of the companies in the market overcame the initial food scare.

Keywords: Food safety, food recall, peanut butter, polynomial distributed lag

ⓘCorresponding author

Introduction

The release of negative information by federal agencies or individual companies concerning a product that might cause human health problems may entail a lagged response from consumers due to psychological, technological, and institutional reasons (Griliches 1967). The consideration of lagged response by consumers to negative information has important implications for policymakers, who could use the time span resulting from the lagged response to push for timely food safety warnings and recalls. This consideration, in turn, could lead to a decrease in health risks and associated health care costs, which usually are a top priority for policymakers. Also, lagged response by consumers to negative information allows for some time for the affected firms to bounce back and strengthen the reputation of their implicated brands through marketing campaigns. This situation was the case with ConAgra, whose peanut butter brand of Peter Pan was involved in a food safety incident resulting in a recall. From competitors' perspective, the time span resulting from the lagged response to negative information serves as a window of opportunity to possibly increase their market shares by improving the consumer perceptions of safety with respect to their own brands in relation to the implicated brand. With respect to food contamination, the timing is particularly complex because the science of attribution is time consuming and difficult. The difficulties with timely and precise attribution of foodborne illness to a particular product are illustrated in the 2007 peanut butter case.

The 2007 peanut butter recall is an excellent case study to illustrate points related to the importance of incorporating the dynamics of negative information dissemination and the resulting delayed response on part of consumers when dealing with the product category. Reporting by the U.S. Centers for Disease Control and Prevention (CDC) indicated that information on the peanut butter case emerged sporadically as the illness outbreak evolved. Foodborne illness numbers spiked beginning in October 2006. To support this contention, PulseNet showed 30 cases of the outbreak strain of *Salmonella* serotype Tennessee, whereas in a typical month, there were one to five cases per month (CDC 2007). So, in October 2006, public health authorities were on alert. However, there had not yet been a connection made between the illness outbreak and a particular food source. It would take another 3 months to finalize the information and announce a health alert for the brand. The official attribution to the food product source occurred after the case-control study was completed, during February 5-13, 2007 (CDC 2007). On February 13, 2007, CDC reported its data to the Food and Drug Administration (FDA), and the FDA issued its health alert the next day. On that same day, a nationwide recall of a national peanut butter brand (Peter Pan) and a private label brand (Great Value) manufactured by ConAgra took place.

In the retrospective studies, the public health authorities looked at production from as far back in time as August 2006. It turned out that the outbreak event was defined over the period August 1, 2006 to April 23, 2007, the date of the onset of the last case associated with the peanut butter *Salmonella* Tennessee infection. Ultimately, 628 illnesses in 47 states were linked with the contamination (CDC 2007).

ConAgra remedied the contamination source and began a marketing campaign while returning Peter Pan to store shelves on August 22, 2007 (NewsInferno 2007). The brand was absent from the market for about 27 weeks (February 14, 2007, through August 21, 2007). As the brand returned to stores, the company issued two million coupons for free peanut butter, offered dollar-off coupons, and updated the design of the product labels (Dorfman 2007). Clearly ConAgra was concerned with trying to get its brand to emerge from the food safety crisis unharmed, along with repairing its reputation to the extent and as quickly as possible.

Did these efforts by ConAgra to rejuvenate the brand also mitigate any potential harm to the product category as a whole? In order to answer this question, we need to examine the consumption of peanut butter as a food category. If consumers attribute food scares of a specific product to all of the competitors in that category, then there is an incentive for rivals to invest more in the safety of their brands.

These management incentives for action are contingent on consumers receiving the negative information, absorbing it, and acting upon it. Actions may well vary across consumers. Consumers who are aware of the problem may associate the food safety risk with only the affected brand, and switch to consumption of unaffected rival brands when they restock. According to Figure 1, restocking appears to be a plausible scenario in this outbreak and product recall incident. Households increased average weekly consumption of competing brands during the recall period when Peter Pan was not available for purchase. It does not appear that consumers who became aware of the problem generalized the risk to other brands within the product category and consumed less of the product in total. In addition to the possible brand-specific effects and category effects, some consumers might not become aware of the problem at all. Or, if consumers are aware of the recall, they may choose to consume the product. Given the variety of possible consumer impacts, a detailed study of information dispersion over time and its impact on the product category is needed to understand the market incentives provided to management for undertaking successful counter measures to offset the possible adverse effects of the outbreak.

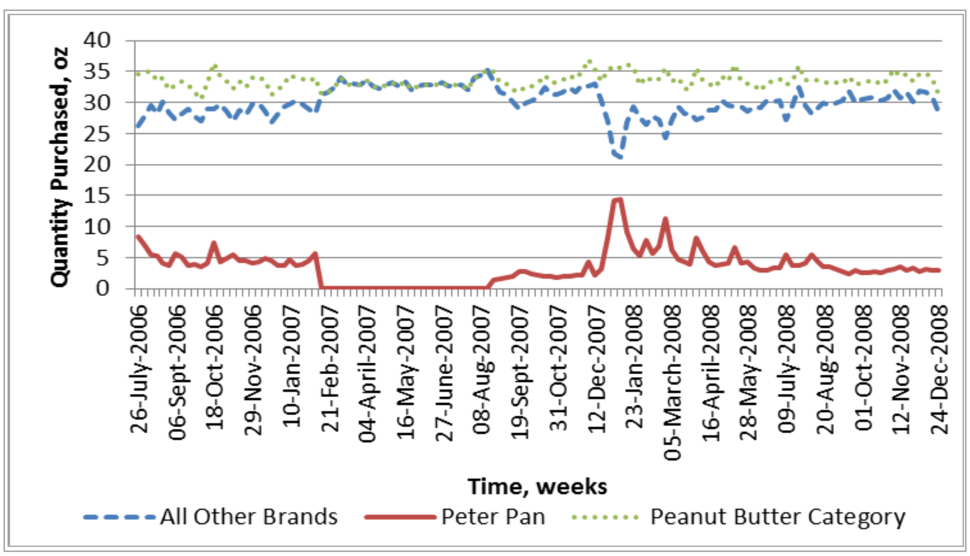

Figure 1. Quantity of Peanut Butter Purchased per Household.
[a]**Source:** Nielsen Homescan panel data for household purchases of peanut butter, 2006, 2007, and 2008.

This research provides a detailed analysis which traces the provision of information about illness incidence and aggregate demand for peanut butter within the context of the 2007 food safety event. We apply a polynomial distributed lag (PDL) specification to estimate the dynamics of the outbreak incident. The foodborne illness outbreak and subsequent product recall are associated with an initial growth in demand after the recall announcement and a downward shift in demand in the post-recall period. The category level demand recovered relatively soon after the re-introduction of the affected brand.

The paper is organized as follows. First, a review of relevant literature is presented. Then, the theoretical framework is discussed, and the model is presented. Subsequently, data are described followed by the discussion of the construction of variables. Next, the estimation results are presented and discussed. The conclusions and discussion comprise the final section.

Literature Review

The question for economic modeling of the market is how to utilize public health information in a model of consumer demand. Previous research relates consumer demand to indicators of the severity of a foodborne illness outbreak. In a study by Capps, Castillo, and Hernandez (2013), the influence of Food Safety Inspection Service (FSIS) recalls and BSE outbreaks on the marketing margins at the farm-to-wholesale and wholesale-to-retail levels in the U.S. beef and pork industries was studied allowing for delayed effects by applying the second-degree and three-lag polynomial distributed lag technique to the food safety incident variables. To account for the severity of the food safety incidents, the following classifications of the FSIS recalls were used: “1. recalls due to pathogenic bacteria or class I bacterial; 2. the rest of class I recalls that originate, for example, due to allergenic ingredients or under processing; and 3. national recalls that are effective in all of the states in the United States and are not necessarily a class I recall.” In this analysis, three BSE events in the U.S. and 13 in Canada were considered. Data on prices, consumption, and marketing cost indices ranging from January 1986 through December 2008 were used to estimate a system of marketing margin equations for beef and pork applying the seemingly unrelated regression procedure. The FSIS recalls and BSE outbreaks were incorporated into the analysis as dummy variables. The estimation results showed that different types of the FSIS recalls and BSE outbreak had varying (in terms of direction and magnitude) statistically significant effects on the marketing margins at the farm-to-wholesale and wholesale-to-retail levels for the beef and pork industries.

Instead of focusing on aspects of the illnesses or the outbreaks, previous research relates consumer response to the intensity of media coverage. While media indices may not necessarily reflect the extent of the illness outbreak associated with a contamination, they are widely used approaches to measuring the information set that consumers use in making their choices (Burton and Young 1996; Verbeke and Ward 2001; Marsh, Schroeder, and Mintert 2004; Piggott and Marsh 2004; Pritchett et al. 2007; Swartz and Strand 1981; Smith, van Ravenswaay, and Thompson 1988; van Ravenswaay and Hoehn 1991).

The issue of consumer responsiveness to negative public health information available through various media has been examined extensively in prior research with several different econometric techniques. Demand systems that include both the affected good and substitutes are a primary modeling choice (Burton and Young 1996; Verbeke and Ward 2001; Marsh, Schroeder, and Mintert 2004; Piggott and Marsh 2004; Pritchett et al. 2007). Other researchers use single-equation econometric models (Swartz and Strand 1981; Smith, van Ravenswaay, and Thompson 1988; van Ravenswaay and Hoehn 1991). All the aforementioned studies provide empirical evidence that food safety crises had a negative influence on the demand for those products.

The polynomial distributed lag method (Almon 1965) frequently has been used to study the timing of response to negative information, such as recalls and food safety announcements (Swartz and Strand 1981; Smith, van Ravenswaay, and Thompson 1988; van Ravenswaay and Hoehn 1991). Swartz and Strand (1981) studied the influence of information about oyster contamination with kepone (a compound used as an insecticide) on the demand for shucked oysters in Baltimore (1973-76) using a second-degree and four-lag PDL model. Media indices were developed using articles from the four major Baltimore and Washington newspapers. The PDL parameter estimates were statistically significant and were linked with reductions in consumption.

Smith, van Ravenswaay, and Thompson (1988) used a second-degree PDL specification with lag length of three months to evaluate the response of fluid milk sales to the negative newspaper coverage of heptachlor contamination (an insecticide) of fresh fluid milk in Oahu, Hawaii (January 1977 to June 1983). The coefficients associated with current and lagged media variables constructed based on newspaper articles concerning the incident from two major Honolulu newspapers were negative and significantly different from zero.

Van Ravenswaay and Hoehn (1991) estimated a PDL model with three lags (monthly) to evaluate the effect of Alar (a chemical sprayed on fruit later determined to be carcinogenic) on apple demand (January 1980 to July 1989). The risk information variable was developed using the total monthly number of articles in *New York Times.* The parameter estimates for the current and lagged risk information variables were all negative in sign with only the first-lag and the third-lag being statistically significant.

In sum, the literature on food contamination incidents that focuses on the dynamics of consumer reaction suggests in part immediate impacts without much delay of news media reports of contamination. However, persistent impacts were found as well, up to lags of three months (Smith, van Ravenswaay, and Thompson 1988; van Ravenswaay and Hoehn 1991). The fact that longer lags are significantly associated with demand implies that some consumers do not hear the initial messaging, or they do not act on it until the problem persists. When longer lags associated with information variable are found to be statistically significant, that means consumers took longer to respond. The statistically significant longer lags help us ascertain the time (given the time scale that the information variable is based upon) that consumers took to respond to the negative information. If only the contemporaneous lag of the negative information is statistically significant, that means consumers have not only responded immediately but also the impact of the negative information is felt all at once.

The literature on product harm crises largely is silent on the impact on the category when one brand is affected. Most researchers study the category level because attribution to a brand has not been made. See for example, Arnade, Calvin and Kuchler (2009) and Fahs, Mittelhammer, and McCluskey (2009) in which the contamination of leafy greens in the United States was analyzed. In that incident, multiple brands were supplied by a number of growers/shippers. The study by Arnade, Calvin, and Kuchler (2009) showed that at the aggregate level of demand for all leafy greens and all other fresh vegetables, consumers temporarily substituted leafy greens with other vegetables. Also, the long-run influence was reflected by consumers switching among leafy green vegetables without lasting changes in the consumption of the aggregate leafy greens. At the individual leafy green commodity level, both temporary and permanent effects were detected. The findings from the study by Fahs, Mittelhammer, and McCluskey (2009) revealed that lettuce and cabbage were substitutes for spinach. In addition, the demand for spinach was negatively affected by a subsequent outbreak attributed to lettuce, indicative of cumulative negative market effects.

Consumers can be influenced by a food scare to turn away from a product, or they may be resilient in the desire to consume the product. Hallman, Cuite, and Hooker (2009) demonstrated the variation in the responses that consumers reported after the 2008 food safety incident involving chili peppers, where tomatoes were suspected initially and an alert was issued and later turned out to be incorrect. About one-third of the respondents discarded the food, about one-in-ten returned the implicated food to the store, and 12% of the respondents admitted knowingly eating a food under an alert. The proportion of consumers who ignored negative health news was relatively small, which is consistent with the typical finding that food safety news is associated with reduced consumer demand for the implicated product.

The peanut butter food safety event has been analyzed by a couple of studies. Bakhtavoryan, Capps and Salin (2012) investigated spillover effects, competition, and possible structural change in peanut butter demand in the light of the Peter Pan recall. The issue of delayed consumer response was not addressed directly in the demand system approach. The authors inferred on the basis of a comparison of the pre-recall period to the post-recall period that the recall contributed to structural change in consumer demand for peanut butter brands (generally increasing the own-price, cross-price, and expenditure elasticities) and that there were both negative and positive spillover effects among the leading national peanut butter brands. The leading national brand, Jif, was found to have benefitted from this recall.

In another study by Bakhtavoryan, Capps and Salin (2014), spillover effects were considered among peanut butter brands in the presence of the Peter Pan peanut butter recall. Barten's synthetic model was used with a PDL specification applied to the variable measuring the impact of the recall. The findings showed that the Peter Pan recall resulted in negative effects on the demand for Peter Pan and positive spillover effects for a major competing brand (Jif). The conflicting effects on brands leaves open the question of how the product category overall was affected.

Our study is similar to the aforementioned articles in analyzing the impact of a recall on demand while taking into account the potentially delayed response of consumers to the incident. However, in contrast to the studies that used newspaper articles to develop the negative information variable, in our study, the information set is measured with a variable constructed from the weekly number of confirmed cases associated with illnesses attributed to *Salmonella*

Tennessee. Figure 2 exhibits the extent of the outbreak as represented by the cumulative sum of illness counts over time.

According to the Public Health Agency of Canada, increasing case count, which is exhibited in Figure 2, is indicative of the severity and scope of the identified foodborne illness outbreak (Public Health Agency of Canada 2014). The count also precedes the official public health news and includes the period of industry actions to recover from the initial negative news. In light of all these information variables, it is important to determine how the product category fares.

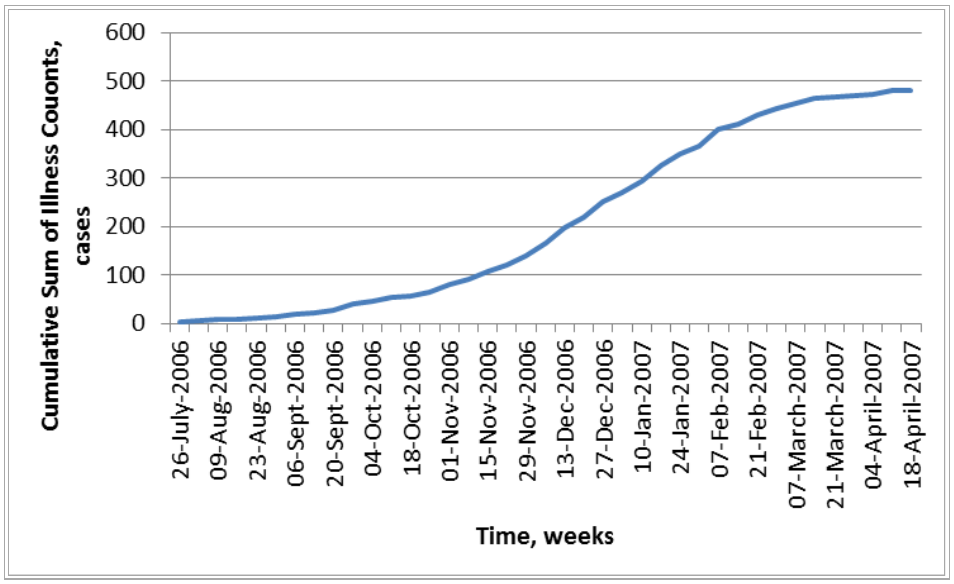

Figure 2. Cumulative Sum of Illness Counts Over Time.
[a]**Source:** Nielsen Homescan panel data for household purchases of peanut butter, 2006, 2007, and 2008.

Theoretical Framework

The impact of a food recall event on demand can be analyzed within the theoretical framework developed by Basmann (1956). In this framework, a consumer's utility function is represented by

$$(1) \quad U_t = U(q_t, \theta(r_t))$$

where q_t is the vector of the product consumed, $\theta(r_t)$ denotes the perception of quality of a product consumed in time period t, and r_t stands for a vector of perceived characteristics or attributes (for example, quality, safety) of a product in q_t. By assumption, changes in the product attributes lead to changes in the consumer's consumption decisions regarding q_t, which in turn results in changes in the parameters of the utility function. Assuming a quasi-concave and twice differentiable utility function for a rational consumer, the solution of the first-order conditions of the utility maximization with respect to q_t, given r_t, and subject to a budget constraint, gives the Marshallian demands $q_t = q_t(y, p, \theta(r_t))$, where y is total consumption budget and p is the vector of prices.

This theoretical framework is quite amenable for analyzing the effects of both negative food safety information and advertising (Capps and Schmitz 1991). Particularly, regarding negative food safety information, the focus of our study, by assumption consumer utility depends not only on quantities of goods consumed, but also on $\theta(r_t)$, which in turn is dependent on the perceived attribute (safety) of goods consumed, r_t. Demand decreases in response to the number of cases of illnesses reported and the resulting negative publicity.

Model

The single-equation model that dealt with the analysis of peanut butter as a category was specified as follows:

$$(2)\quad lnQPB_t=f(lnPPB_t, lnPJ_t, lnCOUPPB_t, lnINC_t, WKSFRRECALL_t, Q1, Q2, Q3, SQRTCDCCASE_t,...SQRTCDCCASEt_{t-j}\ DUMMY_t)+v_t$$

where $lnQPB_t$ is the natural logarithm of quantity purchased of peanut butter per household in time period t; $lnPPB_t$ is the natural logarithm of the real unit value of peanut butter in time period t; $lnPJ_t$ is the natural logarithm of the real unit value of jelly in time period t; $lnCOUPPB_t$ is the natural logarithm of values of coupons per household used in time period t when purchasing peanut butter; $lnINC_t$ is the natural logarithm of real disposable personal income of households in time period t; $WKSFRRECALL_t$ counts number of weeks from the recall announcement in time period t; *Q1*, *Q2*, and *Q3* are dummy variables designed to handle seasonality; $SQRTCDCCASEt_{t-j}$ is the square root of the number of confirmed foodborne illness cases in time period t-j, j= 0,1,2…m, with m representing the optimal length of the lag. A square root transformation, rather than the logarithmic transformation, was used for the explicit purpose of handling zero observations of confirmed cases while still capturing diminishing marginal returns. $DUMMY_t$ is the dummy variable associated with the timing of the recall announcement and v_t is the disturbance term in time period t.

Equation (2) was estimated using a second-degree PDL specification with length of lag three. Head and tail endpoint restrictions were imposed and this specification was supported through statistical tests. Various combinations of both models were estimated using alternative lag lengths and degrees of polynomial. However, based on the Schwarz Information Criterion (SIC), the specification with lag length of three weeks and a second-degree polynomial was chosen as the best. Additionally, in the final estimation, the $SQRTCDCCASEt_{t-j}$ variable was lagged eight weeks to accommodate the time period health authorities needed to attribute the foodborne illness outbreak to peanut butter. In fact, alternative lags were tried for this variable, but based on the Schwarz criterion, eight lags were eventually selected. SAS 9.2 was the statistical software package used to estimate the model. Additionally, the model was estimated without the intercept to circumvent degrading collinearity problems with the income variable. Finally, no evidence of serial correlation was found.

Data

For our analysis, the data regarding the quantities purchased, prices, and coupons used of peanut butter were derived from the Nielsen Homescan Panel for calendar years 2006, 2007 and 2008.

The time-series data set spans 127 consecutive weeks, from July 26, 2006 to December 30, 2008 and includes weekly totals of quantities purchased across all households, prices (unit values), and value of coupons. The data set also was supplemented with a measure of weekly income and a set of information variables. Descriptive statistics of the continuous variables incorporated in the model are presented in Table 1.

Construction of Variables

Quantity variables were constructed as follows. The household quantity purchased of peanut butter was constructed by aggregating weekly total ounces of all peanut butter brands across households and then dividing this measure by the number of unique households that purchased peanut butter in the given week. For each week, unit values for peanut butter (*lnPPB*) and a complement good (jelly) (*lnPJ*) were calculated by dividing total expenditures by total ounces. The coupon variable for peanut butter (*lnCOUPPB*) was developed first by aggregating weekly values of coupons used and then dividing it by the number of unique households to express the variable on a per household basis. Real disposable personal income (*lnINC*) was reported on a monthly basis (U.S. Department of Commerce 2010); however, weekly interpolations of these data were used. Income variable was taken from the Department of Commerce (2010), since in the Nielsen data this variable is not amenable to our analysis. However, it is expected that this income variable will serve as a proxy to the Nielsen data income variable in reflecting household characteristics.

Table 1. Descriptive Statistics of the Variables Used in the Analysis of Peanut Butter at the Category Level[a].

Variables	Variable Description	Units	N	Mean	Std Dev	Min	Max
QPB	Quantity of peanut butter	oz	127	33.54	1.15	30.60	36.97
PPB	Unit value of peanut butter	cents/oz	127	5.01	0.25	4.39	5.65
PJ	Unit value of jelly	cents/oz	127	3.21	0.24	2.76	3.96
COUPPB	Coupon of peanut butter	cents	127	5.42	2.91	0.81	18.96
INC	Income	dollars	127	614.18	8.46	595.88	624.69
CDCCASE	number of confirmed cases by CDC	cases	127	3.79	7.92	0.00	36.00

Notes: [a]Derived from Nielsen Homescan panels for calendar years 2006, 2007, and 2008.
*The reported summary statistics is on a per household basis.
*The average weekly number of households that purchased peanut butter across the study period was 3,321 in our sample.

The product harm event was represented with three different variables that were included in the model at the same time. The outbreak variable (*SQRTCDCCASE*) was developed based on information from the CDC that showed the weekly number of newly confirmed cases of *Salmonella* Tennessee infection associated with consumption of peanut butter (CDC 2007). This measure allows for tracking the scope of the illness outbreak. The first 39 weekly observations of this variable corresponded to the actual number of confirmed cases, and the rest of the weekly observations running from 40 through 127 were all zeros.

To test the hypothesis that with the passage of time after the initial release of the recall announcement, consumers gradually increase their consumption of peanut butter, a variable that counts the weeks from the recall was created (*WKSFRRECALL*). The first 29 observations of this variable were zeros, the 30th observation was assigned a value of 1 (the week following the recall announcement), and the last observation was assigned a value of 98, with intermediate observations running chronologically.

A possible permanent shift in the demand for peanut butter was modeled as a dummy variable taking on a value of 0 before the issuance of the recall and a value of 1 afterwards (*DUMMY*). This permanent shift corresponds to an abrupt structural change attributed to the initiation of the recall announcement.

To assess the effects of seasonality on peanut butter demand, the weekly observations were partitioned into four 13-week periods (*Q1, Q2, Q3, Q4*). Using the 4th 13-week period as a reference period, three dummy variables were used in the actual estimation to circumvent the dummy variable trap. Unit values, coupon, and income variables were deflated using the consumer price index with 1982-84=100 reported by the Bureau of Labor Statistics (2011).

According to the law of demand, there is a negative relationship between price and quantity demanded. As such, the coefficient associated with the own real unit value of peanut butter was expected to be negative. Theory suggests a negative relationship between the price of a complement good and the demand for the good in question. Hence, it was expected that the coefficient associated with the unit value of jelly would be negative. Based on theory and the good in question (peanut butter), the income effects were hypothesized to be positive, suggesting that peanut butter is a normal good rather than an inferior good. Theory suggests a positive relationship between coupons (price reduction) and the demand for the good in question. Hence, the coefficient estimate associated with the coupon variable was anticipated to be positive. The parameter estimate for the variable that counts weeks from recall was expected to be positive implying that as more and more weeks passed from the announcement of the recall, consumers would increase their consumption of peanut butter.

According to theory, the issuance of recalls likely results in a consumer response that ultimately leads to a decrease in the demand for the affected good. However, theory does not reveal any information regarding the magnitude and duration of this negative consumer response, which largely depends on consumer perceptions of the health risks and extent of knowledge about the outbreak and product recall events. As such, a negative sign was anticipated on all the coefficients associated with current and lagged outbreak variables, as well as the parameter estimate for the dummy variable associated with the beginning of the recall. However, depending on the economic behavior of rival brands and the purchasing behavior of consumers as well as their perceptions of the safety related to peanut butter, the consumption of peanut butter at the category level could rise. For example, in the wake of the recall of Peter Pan, Jif and Skippy may choose to invest in the safety of their brands leading consumers to further disassociate their brands from Peter Pan. As a result, consumers may discard Peter Pan and replace it with the other brands, Jif and Skippy.

Estimation Results

The estimated coefficients, which also are the elasticities, as well as the associated standard errors from the single-equation specification, are reported in Table 2. The significance of coefficient estimates is indicated with asterisks. The significance level chosen for this analysis was 0.05.

According to Table 2, the R^2 for the model concerning the peanut butter category was 0.57 meaning that 57% of variation in the dependent variable was explained by the model. Standard economic variables took on the expected signs and significance suggested by theory. As expected, the parameter estimate for the unit value of peanut butter (representing price) was negative and statistically significant. In addition, the demand for peanut butter was inelastic such that a 10% decline in peanut butter unit value led to 7.8% increase in the quantity of peanut butter demanded, holding all other factors constant. The parameter estimate for the unit value of jelly was negative, as hypothesized; however, it was statistically insignificant.

Table 2. Peanut Butter Demand Estimation Results.

Variables	**Variable Description**	**Estimate**	**Std Error**
lnPPB	(Unit value of peanut butter)	-0.778*	0.097
lnPJ	(Unit value of jelly)	-0.072	0.048
lnCOUPPB	(Coupons for peanut butter)	0.006	0.005
lnINC	(Income)	0.424*	0.014
WKSFRRECALL	(Weeks from recall)	0.001*	0.0002
Q1	(Seasonality in quarter 1)	-0.024*	0.008
Q2	(Seasonality in quarter 2)	-0.007	0.005
Q3	(Seasonality in quarter 3)	-0.006*	0.003
DUMMY	(Binary=1 in all weeks after recall)	-0.026*	0.008
SQRTCDCCASE(0)	(CDC cases 0 lags)	0.001*	0.001
SQRTCDCCASE(1)	(CDC cases 1 lag)	0.002*	0.001
SQRTCDCCASE(2)	(CDC cases 2 lags)	0.002*	0.001
SQRTCDCCASE(3)	(CDC cases 3 lags)	0.001*	0.001
R^2		0.57	
Durbin-Watson		1.59	

Note: * Statistically significant at the 5% level.

As expected, the parameter estimate for the coupon was positive albeit statistically insignificant. The parameter estimate associated with income was positive and significantly different from zero implying that peanut butter is a normal good and a 10% increase in income led to 4.2% increase in the demand for peanut butter, controlling for all other factors. As indicated by the seasonal dummy variables, the demand for peanut butter was significantly lower in the first and the third quarters relative to that in the fourth quarter. Demand in the second quarter was not significantly different than that in the fourth quarter.

The food safety event variables present a complicated picture of the peanut butter category in the time surrounding the illness outbreak and the product recall. First, consider the *DUMMY* variable, which controls for the potential structural shift in the demand for peanut butter in the weeks following the recall. This binary variable took on a negative and statistically significant coefficient, indicating a reduction in the consumption of peanut butter on average in the post-recall period compared to the pre-recall period. While there was an overall reduction in consumption apparent from the binary shift variable, the effects tended to dissipate over time. Specifically, the coefficient on the count variable of the number of weeks since the product recall was positive and statistically significant, as hypothesized, implying that consumers increased their purchases of peanut butter with the passage of time after the recall.

In addition to event indicators associated with the recall of products from distribution, the results demonstrate the association of product purchases with the number of cases of illness. All of the estimated coefficients associated with the outbreak variable were positive and statistically significant suggesting growth in household purchases of peanut butter. This atypical result may be explained by the restocking behavior on part of the households, where the contaminated peanut butter jars were replaced by other brands thus contributing to an overall increase in the purchases of peanut butter. The pattern of the predicted peanut butter purchased over time (in weeks after the recall) is illustrated in Figure 3. As shown, the quantity of peanut butter purchased declined around the time of the recall and shortly thereafter. However, when Peter Pan returned to the shelves, the quantity purchased of peanut butter increased rather dramatically. Then, it declined with seasonal movement reaching approximately its pre-recall level.

The specific results are best expressed with elasticities that represent both short-run and long-run effects. Letting w_s stand for the weight for lag period s, the short-run response in the quantity purchased of peanut butter for a unit change in outbreak variable, evaluated at the sample means, is computed by $\frac{\sum w_0}{2} CDCCASE^{-0.5} QPB$ and the short-run elasticity associated with the outbreak variable is calculated by $\frac{\sum w_0}{2} CDCCASE^{0.5}$. In addition, the long-run response in the quantity purchased of peanut butter given a one unit change in outbreak variable, at the sample means, is given by $\frac{\sum w_s}{2} CDCCASE^{-0.5} QPB$ and the long-run elasticity associated with the outbreak variable, at the sample means, is given by $\frac{\sum w_s}{2} CDCCASE^{0.5}$.In the peanut butter category, the short-run response was 0.011 indicating that each successive unit increase in the outbreak variable was associated with a rise in the short-run quantity purchased of peanut butter by 0.011 ounces, *ceteris paribus*. The elasticity was 0.001 indicating that as the outbreak variable went up by 10%, the short-run quantity purchased of peanut butter increased by 0.01%, *ceteris paribus*.

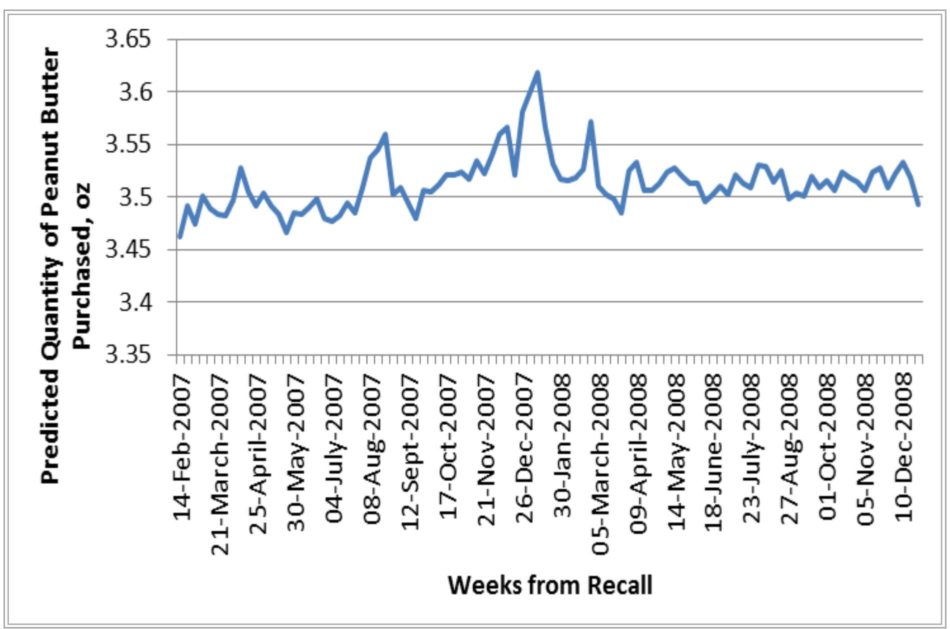

Figure 3. Predicted Quantity of Peanut Butter Purchased per Household vs. Weeks from Recall.
[a]**Source:** Authors' calculations based on parameters estimated from Nielsen Homescan panel data for household purchases of peanut butter, 2006, 2007, and 2008.

The long-run response was also modest but larger, with an increase in 0.056 ounces purchased for an incremental case of illness as reported by the CDC, everything else held constant. Upon conversion to percentages, the long-run elasticity associated with the outbreak variable was 0.006 meaning that, in the long-run, a 10% increase in illnesses was associated with a 0.06% increase in the quantity purchased of peanut butter, other factors held constant.

The connection between demand and the illness outbreak over defined periods of time also was explored. Three lags on the outbreak variable were statistically significant (and positive), suggesting that responses made by consumers to incremental cases of the foodborne illness occurred within three weeks cumulatively. The mean lag defined as $\frac{\sum s w_s}{\sum w_s}$, where w_s is the coefficient associated with lag period s, may be interpreted as the average length of time for unit changes in the outbreak variable to be transferred to changes in quantity of peanut butter purchased. The estimated mean lag was one and a half weeks.

Conclusions and Discussion

The impact of a foodborne illness outbreak on the demand for peanut butter was analyzed by estimating a second-degree distributed lag model with a lag length of three weeks and endpoint restrictions imposed. The estimation results showed that the food safety incident had various effects on the demand for the peanut butter category, depending on whether the incident was measured by outbreak variables ($SQRTCDCCASE_{t-j}$) or by product recall variables ($WKSFRRECALL_t$, $DUMMY_t$).

After negative news reached the market, through public health alerts and a company-issued product recall, consumer demand for peanut butter fell immediately following the recall as measured by a dummy variable. This structural shift in demand is consistent with the finding by Bakhtavoryan, Capps, and Salin (2012), where a similar structural change in demand for peanut butter brought about by the recall was ascertained at the brand level. This general negative reaction is consistent with intuition that consumers associate risk to an entire product category and that a product can be damaged by lapses in safety due to a single company. At the same time, the estimation results show that, in this incident involving nationally branded goods, consumers did not entirely abandon the product category. There are positive market responses in the post-recall period that demonstrate that this public health alert was not a category killer. In particular, demand increased with the passage of time after the recall. This finding implies that after the recall consumers updated their perceptions regarding the safety of peanut butter in the presence of marketing actions taken by ConAgra, the manufacturer of the affected brands. In addition, consumer forgetfulness and dissipating fear may have also contributed to this market response. As for the outbreak variable, the illness cases were associated with increasing quantity purchased, which could be attributed to restocking behavior of the households. The households may have replaced the jars of recalled peanut butter brands with other peanut butter brands that were perceived to be safer actually purchasing more peanut butter in the end. In addition, the recovery of the category may well be due to the careful attribution of the outbreak to one brand in the health alert messages. This situation underscores the importance of public health officials' efforts to document outbreaks and link them to the food source as quickly as possible.

Using the 2007 peanut butter recall as a case study, this empirical study has implications for policymakers when dealing with food safety issues for brands of food products. This piece shows the importance of using a polynomial lag structure applied to the outbreak variable thus allowing for the dynamics of the dissemination of negative information and the potentially delayed consumer response to the negative information when considering the entire product category. Accurate information regarding the time period between the release of the negative information and consumer response can be used by policymakers to advocate for timely food safety warnings and recalls. This will result in the reduction of both potential risks associated with food safety crises and health care costs which are a major focus for many public policy interventions. Also, this piece demonstrates the importance of using number of confirmed cases associated with specific illnesses as an alternative source (besides media) at the disposal of policymakers when communicating food safety information to general public. Finally, in terms of policy relevance, it needs to be noted that the willingness of consumers to return to purchasing an implicated good means that public health officials should not hesitate to provide risk messages when the scientific evidence supports it, because there is precedent for the category to recover in relatively short time.

Acknowledgement

The support for this research was made possible under Cooperative Agreement No. 58-4000-9-0058 with the Economic Research Service, U.S. Department of Agriculture and is gratefully acknowledged.

References

Almon, S. 1965. "The Distributed Lag between Capital Appropriations and Expenditures." *Econometrica* 33:178-196.

Arnade, C., L. Calvin, and F. Kuchler. 2009. "Consumer Response to a Food Safety Shock: The 2006 Food-Borne Illness Outbreak of E.coli O157:h7 Linked to Spinach." *Review of Agricultural Economics* 31:734-750.

Bakhtavoryan, R. G., O. Capps, and V. Salin. 2012. "Impact of Food Contamination on Brands: A Demand Systems Estimation of Peanut Butter." *Agricultural and Resource Economics Review* 41:327–339.

Bakhtavoryan, R. G., O. Capps, and V. Salin. 2014. "The Impact of Food Safety Incidents Across Brands: The Case of the Peter Pan Peanut Butter Recall." *Journal of Agricultural and Applied Economics*, forthcoming.

Basmann, R. L. 1956. "A Theory of Demand with Variable Consumer Preferences." *Econometrica* 24:47-58.

Bureau of Labor Statistics. 2011. "Consumer Price Index: Average Price Data." Bureau of Labor Statistics, U.S. Department of Labor, Washington, D.C. http://data.bls.gov/PDQ/servlet/ SurveyOutputServlet?series_id=APU0000716141&data_tool=XGtable [Accessed October 13, 2010].

Burton, M., and T. Young. 1996. "The Impact of BSE on the Demand for Beef and Other Meats in Great Britain." *Applied Economics* 28:687- 693.

Capps, O., Jr., and J. D. Schmitz. 1991. "Effect of Generic Advertising on the Demand for Fluid Milk: The Case of the Texas Market Order." *Southern Journal of Agricultural Economics* 23:131-140.

Capps, O., Jr., S. Colin-Castillo, and M.A. Hernandez. 2013. "Do Marketing Margins Change with Food Scares? Examining the Effects of Food Recalls and Disease Outbreaks in the U.S. Red Meat Industry." *Agribusiness: An International Journal* 29:426 - 454.

Centers for Disease Control and Prevention. 2007. "Multistate Outbreak of *Salmonella* Serotype Tennessee Infections Associated with Peanut Butter - United States, 2006-2007." *Morbidity and Mortality Weekly Report* 56:521-524. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5621a1.htm. [Accessed September 10, 2010].

Dorfman, B. 2007. "ConAgra Sets Peter Pan Re-launch." *Reuters*. http://www.reuters.com/ article/2007/08/08/us-conagra-peterpan-idUSN0724255020070808.

Fahs, F., R. Mittelhammer, and J. McCluskey. 2009. "E. Coli Outbreaks Affect Demand for Salad Vegetables." *Choices*. http://www.choicesmagazine.org/magazine/article. php?article=72.

Griliches, Z. 1967. "Distributed Lags: A Survey." *Econometrica* 35:16-49.

Hallman, W. K., C. L. Cuite, and N. H. Hooker. 2009. "Consumer Responses to Food Recalls: 2008 National Survey Report." Publication number RR-0109-018, New Brunswick, New Jersey: Rutgers, the State University of New Jersey, Food Policy Institute.

Marsh, T. L., T. C. Schroeder, and J. Mintert. 2004. "Impacts of Meat Product Recalls on Consumer Demand in the USA." *Applied Economics* 36:897-909.

NewsInferno. 2007. "Peter Pan Peanut Butter Back in Stores Following *Salmonella* Recall." http://www.newsinferno.com/legal-news/peter-pan-peanut-butter-backin-stores-following-salmonella-recall/1762.

Piggott, N. E., and T. Marsh. 2004. "Does Food Safety Information Impact US Meat Demand?" *American Journal of Agricultural Economics* 86:154-174.

Pritchett, J., K. Johnson, D. Thilmany, and W. Hahn. 2007. "Consumer Responses to Recent BSE Events." *Journal of Food Distribution Research* 38:57-68.

Public Health Agency of Canada. "Canada's Food-borne Illness Outbreak Response Protocol (FIORP) 2010: To guide a multi-jurisdictional response." http://www.phac-aspc.gc.ca/zoono/ fiorp-mitioa/index-eng.php [Accessed February 18, 2014]

Smith, M. E., E. O. van Ravenswaay, and S. R. Thompson. 1988. "Sales Loss Determination in Food Contamination Incidents: An Application to Milk Bans in Hawaii." *American Journal of Agricultural Economics* 70:513-520.

Swartz, D. G., and I. E. Strand. 1981. "Avoidance Costs Associated with Imperfect Information: The Case of Kepone." *Land Economics* 57:139-150.

U.S. Department of Commerce-Bureau of Economic Analysis. "Personal Income and Its Disposition." http://www.bea.gov/newsreleases/national/pi/pinewsrelease.htm [Accessed October 28, 2010]

Van Ravenswaay, E. O., and J. P. Hoehn. 1991. "The Impact of Health Risk Information on Food Demand: A Case Study of Alar and Apples." *Economics of Food Safety* 155-172.

Verbeke, W., and R. Ward. 2001. "A Fresh Meat Almost Ideal Demand System Incorporating Negative TV Press and Advertising Impact." *Agricultural Economics* 25:359-374.