Examining the Effect of Food Recalls on Demand: The Case of Ground Beef in the U.S.

Samane Zare*, Yuqing Zheng**, Steven Buck***

Selected Paper prepared for presentation at the Southern Agricultural Economics Association's 2017 Annual Meeting, Mobile, AL, February 4-7, 2017

Working Paper

Abstract

Using Nielson retail scanner dataset and applying difference-in-difference approach and synthetic control method, we test whether consumers in Utah reduced beef purchases after 2009 Salmonella outbreak of ground beef products. The result of DID approach indicates that the Salmonella event reduced ground beef purchases in Utah by 17% in four weeks after the recall. Price elasticity of demand is also estimated to be -2.04; therefore, the reduction in ground beef purchases as a result of recall is comparable to almost 8.3% increase in the price of this product. Using the synthetic control method that allows us to use all of the control states to produce synthetic Utah, we found the effect of this event very small.

Key words: Recall, Salmonella, Treatment effect, Synthetic control

*University of Kentucky, email: samane.zare@uky.edu
**University of Kentucky, email: yuqing.zheng@uky.edu
***University of Kentucky, email: steven.buck@uky.edu

Introduction

In 2015 approximately, 25 million pounds of beef were consumed. However, beef consumption has decreased over the last several years as consumers have switched to other meats or increased vegetable consumption. For example, per capita beef consumption in the U.S. decreased from 67.8 pounds in 2002 to 53.9 pounds in 2015. The main part of this reduction can be explained by increasing beef prices since the nominal price of beef had almost 100% growth from 2002 to 2015. While there are campaigns including "Beef. It's What's For Dinner" and "Powerful Beefscapes" advertising the benefits of beef, there are frequent health warnings related to beef consumption.

The number of food recalls reported by U.S. Department of Agriculture’s Food Safety and Inspection Service (USDA/FSIS) has increased over the past 16 years. In 2005, there were 53 FSIS recalls. This number increased to 150 recalls in 2015. Correspondingly, the number of beef recalls increased from 12 in 2005 to 41 in 2015. Lusk and Schroeder (2002), posit that an increase in public concern over food safety has led to closer regulatory vigilance. Pathogens like *E. coli*, *Listeria*, and *Salmonella* are the main reasons for the recalls; however, the number of recalls because of E. coli and Listeria have decreased over the last several years, and the number of recalls because of Salmonella have increased. For example, the average number of recalls because of Salmonella was less than two during the years 2005-2009, and the average increased to 5 during the years 2010-2015. During the preceding 11 years, beef was consistently the commodity most commonly associated with outbreaks. Around 33% of food recalls are associated with beef products. During 2006-2015, over 247 million tons of beef products were recalled (USDA/FSIS).

The annual healthcare costs and other losses due to foodborne illness are estimated to be over $150 billion in the U.S. (Scharff 2010). Recalls can cause significant financial loss to manufacturers exceeding 30 million dollars on average (Grocery Manufacturers Association 2011). Retailers also experienced a significant loss from recalls. For example, the BSE announcement in December 2003 resulted in a decline of more than $11 billion in domestic retail beef revenues in the post-BSE period (Crowley and Shimazaki 2005).

In July and August of 2009, the Colorado Department of Public Health and Environment (CDPHE) identified 21 cases of drug-resistant Salmonella among Newport, Colorado residents.

CDPHE notified the USDA/FSIS of the situation, and on August 6, 2009, FSIS announced a recall of more than 0.8 million pounds of potentially Salmonella-tainted ground beef products to retail distribution centers in Arizona, California, Colorado, and Utah. These products were repackaged into consumer-size packages and sold under different retail brand names. Therefore, consumers were advised through the FSIS web page to consult local retailers to determine if the products that purchased were part of the recall. They could return contaminated ground beef products for a full refund. The Centers for Disease Control and Prevention (CDC) reported 68 illnesses and four hospitalizations as a result of this outbreak.

The media did not specify the brands of recalled product; therefore, if consumers were informed of the recall, they were more likely to reduce their demand for all ground beef products. We would anticipate no effect of the recall on uninformed consumers. Using the Nielsen Retail Scanner dataset, we examine how consumers reacted to the 2009 ground beef Salmonella outbreak. Specifically, we test whether consumers changed their ground beef product purchases in Utah after the recall.

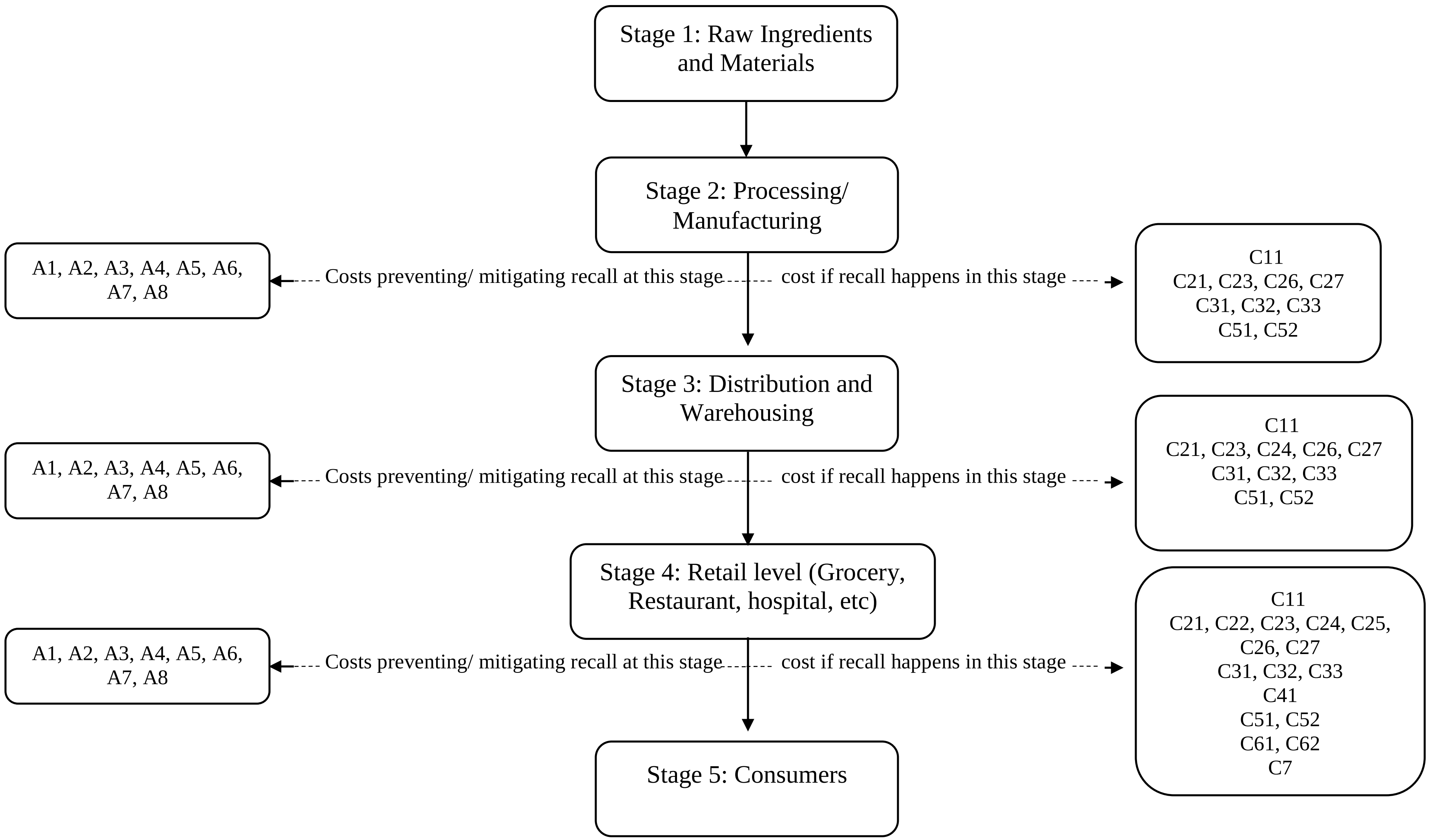
We perform a difference-in-differences analysis of the recalls and use a control state that did not receive contaminated ground beef products: Nevada. The result of our preferred specification indicates that the Salmonella event reduced ground beef purchases in Utah by 7% in four weeks after the recall. Price elasticity of demand is also estimated to be -1.55%; therefore, the reduction in ground beef purchases as a result of recall is comparable to almost 4.5% increase in the price of this product. This result is consistent with the previous literature. Using the synthetic control method that allows us to use all of the control states to produce synthetic Utah, we found the effect of this event very small.

Salmonella

Salmonella is the name of a group of bacteria and one of the most common causes of food poisoning in the United States. Salmonella causes diarrhea, fever, vomiting and abdominal cramps. Usually, symptoms last 4-7 days and most people get better without treatment. But diarrhea and dehydration may be so severe that it is necessary to go to the hospital and in people with weaker immune systems, or in young children and the elderly, it can be fatal.

Every year, approximately 40,000 cases of salmonellosis are reported in the United States. Because many milder cases are not diagnosed or reported, the actual number of infections may be thirty or more times greater. The CDC estimates around 1.2 million illnesses and 450 deaths due to Salmonella annually in the United States (Scallan et al. 2011). Evidence shows that Salmonella spreads through livestock (especially when kept in large numbers in confined spaces), runoff from livestock pastures, and leaky or piled up waste lagoons at industrial farming sites.

A Conceptual Model of Costs of Voluntary Product Recalls



List of costs preventing or mitigating recall:

A1: QA/QC procedures, preventative controls

A2: Recall insurance

A3: Recall planning

A4: Voluntary or required tracking system for units

A5: Supplier inspections, engage redundant suppliers

A6: Investigating consumer complaints

A7: Conducting mock recalls to identify gaps in the recall process

A8: Adopting technology-enabled prevention such as implementing an integration and control system with scanning technology which matches barcode on labels with container codes.

List of costs if a recall occurs:

C1: Issue Identification

C11—Identifying issues, escalating and triggering product recall

C2: Recall notification and communication cost

C21—Manufacturers notifying regulatory agencies (FDA, USDA, and state/ local authorities)

C22—Manufacturers notifying consumers (e.g., press release, hotline, through retailer loyalty cards database)

C23—Manufacturers notifying distributors and retailers (e.g., using Rapid Recall Exchange)

C24—Retailers notifying stores

C25—Retailers notifying consumers

C26—Manufacturers issuing a reverse recall to all parties involved in the initial recall after receiving verification that the product is safe

C27—Brand management (communication with public and costumers)

C3: Product removal and destruction (most expensive step in the recall process)

C31—Returning products to manufacturer (or third party used by the manufacturer for destruction)

C32—Retailers or distributors destroying recalled products on site

C33—Cleaning, repairing, and replacing equipment

C4: Product replacement

C41—replacing the recalled products on the shelf with a new product, brand, or SKU

C5: Lost product or company values

C51—potential loss of future product sales from damage to the reputation

C52—Negative impact on company's market value (for listed companies)

C6: Health costs

C61—negative health impact (pain, suffering from illness, death) on consumers

C62—medical expenses

C7: Legal costs from lawsuits from consumers

Literature Review

Freedman, Kearny, and Lederman (2012) examine the effect of toy recalls due to a high level of lead content on the consumer demand. They find spillover effects of product recalls to non-recalled toys and manufacturers. Cawley and Rizzo (2008) find non-recalled therapeutic drug brand do not benefit from the recalls, and instead they experienced negative spillover effects. Reilly and Hoffer (1983) also find spillover effects in a case of automobile recalls.

In a food related setting, Brown (1969) investigates the effect of possible health hazards of pesticide residue on the demand of cranberries. One of the concerns of this study is the spillover effect on unsprayed bogs; the author finds a temporary decrease in the number of households purchasing cranberries. However, the author does not find a significant change in the elasticity of demand for processed cranberries. Peake, Detre, and Carlson (2009) found that recall concern reduces consumption in both specific branded and unbranded products. Arnade, Calvin, and Kuchler (2007) report that before the 2006 spinach recall, spinach sales were rapidly increasing. However, during the 68 week period after the recall, retail sales for bagged spinach declined 20%. Bakhtavoryan, Capps, and Salin (2012) find the Peter Pan peanut butter recall created a structural change in consumer demand for peanut butter brands since the own-price, cross-price, and expenditure elasticities increased after the recall. They also find spillover effects for the leading national brand and negative spillover effect for the rest of the brands.

Bakhtavoryan, Capps, and Salin (2012) find that consumers responded to the foodborne illness outbreak of peanut butter brand within three weeks. They observe that one brand does not necessarily harm rivals within the category.

In meat related settings, Lusk and Schroeder (2002) find that meat recalls have a short-run effect on future prices using the event study method. The authors find that the recalls do not have a direct impact on the daily lean hog or live cattle prices. However, Mckenzie and Thomsen (2001) using the same methodology find that recalls due to E. Coli OIS:H7 adversely affect wholesale beef prices in the short-run but do not effect live cattle prices.

Schlenker and Villas-Boas (2009), examine how consumers responded to two highly publicized warnings related to mad cow disease in the United States. They find an approximately 20% decrease in beef and an increase in pork and chicken consumption following the warnings. Dahlgran and Fairchild (2002) find that consumers tend to forget about adverse publicity concerning meat safety, and eventually return to established patterns of meat consumption. However, the study of Crowley and Shimazaki (2005) shows a significant disruption of beef sales after BSE announcement. The disruption has had a persistent level effect that shifted beef sales to a lower level in the post-BSE period.

Thomsen, Shiptsova, and Hamm (2006) examine the effect of a Listeria recall of Frankfurters ready-to-eat products. The authors find that the sales of the recalled brand declined about 22% after the recall. Nonetheless, two or three months later, brand recovery began. Kinnucan, Xiao, Hsia, and Jackson (1997) find that adverse health information has a strong negative influence on beef demand and a slightly negative influence on the demand for pork. Our research provides new evidence based on detailed retail scanner data and using difference-in- differences (DID) model and synthetic control method.

Data

Recall data such as date, geographic distribution area, and pathogens are collected from The USDA/FSIS. Also, we use Niesen retail scanner data to estimate the impact of the beef recall on consumer purchasing decisions. The dataset contains weekly pricing, volume, and store environment information generated by point-of-sale systems. The raw dataset includes all fresh ground beef sale transactions during the study period in 209 stores in Utah and Nevada. Of these

209 stores, 75 stores are in Utah, one of the four states that had contaminated beef, and 134 stores are in Nevada, one of the states that did not have contaminated beef. Our dataset includes weekly data for UPCs of fresh ground beef products along with a description, brand, size, as well as Nielsen codes for the department, product group, and product module. For each UPC code, participating stores report units, price, price multiplier, baseline units, baseline price, feature indicator, and display indicator weekly. Store demographics including store chain code, channel type, and area location are also available in this database.

Table 1 shows summary statistics for the quantity and price of beef at the store-level from the scanner dataset. Summary statistics are based on the four weeks before and four weeks after the event and the event week is excluded from the analysis. The average quantity of beef products sold in this period in each store of Utah is 895 pounds and 631 pounds for each store in Nevada. Prices per pound in both states are very similar ($3.36 in Utah and $3.38 in Nevada).

Empirical Model

In the difference-in-differences (DID) approach, we consider a "treatment" state, Utah, which had infected beef distributed in its stores, and a "control" state, Nevada which did not have infected beef distributed in its stores. The model is:

$$Y_{ist} = \alpha_1 . recall_{it} + \alpha_2 . P_{it} + \gamma_i + \eta_t + \varepsilon_{ist} \qquad (1)$$

Y_{ist} is the log of sales of ground beef products for each store *i* in state *s*, in week *t*, the variable of interest is $recall_{st}$which denotes whether a store observation is in the treatment group during the post period in which the recall happened, P_{it} is the average price of ground beef products in store *i* in week *t*. We also include store fixed effects (μ_i) and week fixed effects (η_t) in our preferred specification in DID; ε_{ist} captures all unobservables which affect the dependent variable.

In addition to DID model, the synthetic control method is employed to capture the causal effect of the beef recall on the sale. The basic idea behind synthetic control is that a combination of units often provides a better comparison for the unit exposed to the intervention than any single unit alone. This method searches for the set of weights that generate the best fitting convex combination of the control units[1].

Utah is exposed to the recall and all of the non-effected states as a potential control group. The synthetic control method reweights the control group such that the synthetic control unit matches the sale per capita of beef in Utah. By using this method, we can find the optimal weights of states; some states receive more weight, and some receive no weights. Once we have estimated weights and constructed the synthetic control unit, we can estimate a DID model in which we compare the treated unit to the synthetic control unit.

Empirical Result

In this section, we examine how consumers reacted to the Salmonella ground beef recall. We begin by exploring whether there are any differences in weekly ground beef products sales by comparing the treatment state (Utah) and the control state (Nevada). Table 2 provides the basic double difference result in levels ([purchase in treatment post event - purchase in control post event] - [purchase in treatment pre-event - purchase in control pre-event]). The result in this table indicates that ground beef products purchase in treated state was reduced by 13% during four weeks after the recall.

Further investigation of the pre-trends between control and treatment groups is analyzed using graphical analysis. Figure 1 shows the evolution of total monthly sales (lb) by the state for ground beef with no controls. Months denotes one pre-event month and one post-event month for each year (2006, 2007, 2008, 2009). Months across years are not continuous in time. This figure provides evidence that pre-trend of beef sale is parallel in the treatment and control states. Having evidence of pre-treatment parallel trends between treatment and control groups is a pre-requisite to use the DID method.

Figure 2 provides more detailed information about the difference between these two states regarding ground beef sales. This figure demonstrates percent difference in average weekly purchases between two states across the sample for four weeks prior and after the event week. We observe a significant decrease in the difference in the average weekly purchase as a percent between the pre-event (here four weeks before the recall), and the post-event (here four

[1] For more information about the synthetic control model see: Abadie, Diamond, and Hainmueller (2012).

weeks after the recall). The dashed line represents the average percent difference in the pre- and post-event. The ground beef product purchases in Utah in the pre-event is approximately 32% less than the ground beef product purchases in Nevada. While, in the post-event, purchase in Utah is 46% less than Nevada.

Next, we implement the DID model using data four weeks before the event and four weeks post event. Also, we exclude the event week from this analysis. Table 3 shows the results of the DID model using aggregated observations at the store by week. The dependent variable is the log of ground beef purchases in week t in store i in state s. The four-week period following August 6 is labeled "Post-Event". The coefficient of "Salmonella" is our coefficient of interest, i.e., the additional abnormal change in Utah one week after the recall. The price elasticity is given by "Log of Price" coefficient, where price is the average price of the corresponding aggregation level. Also, robust standard errors are reported in parenthesis.

Column 1 in this table shows that the Salmonella effect on ground beef purchases is not significant. However, average treatment effect point estimates using this specification is likely biased because of omitting time-invariant fixed effects such as store fixed effects. To avoid this concern, we add store fixed effects to the model. Results for this specification are reported in Column 2 of the same table. As specified in this table, Salmonella reduced weekly beef purchases by 20%. Store fixed effects control for the time-invariant unobservable such as store location or store upstream chain characteristics. Omitting such variables can cause bias of the treatment effect. Also, results in this column indicate that price elasticity of demand is -2.01.

Additionally, we control for the month fixed effects. Omitting month fixed effects can introduce bias in the point estimate of treatment effect because of the seasonality nature of the ground beef market. Results of the estimation with month and store fixed effect is reported in column 3 of table 3. Average treatment point estimate indicates that the Salmonella event reduced ground beef purchases in Utah by 17%. Price elasticity of demand is also estimated to be -2.04%. This model is our preferred specification.

One potential concern with average treatment estimation by DID method is using only Nevada as a control state. To address this concern, we used the synthetic control method to produce a synthetic control state for Utah. We used weekly and state-level per capita sales to produce a synthetic state. Figure 3 plots the log of ground beef sale in Utah. We used several features such as ground beef price, per capita sales in the in 4 weeks, three weeks, two weeks, and one week before the Salmonella event, and the number of stores per capita in each state as features to produce synthetic Utah. Table 4 shows the features are balanced in the Utah and synthetic Utah. For example, price per lb is 3.42 in Utah and 3.27 in synthetic Utah. Table 5 displays the weights of each control state in the synthetic Utah. We exclude California, Colorado, and Arizona before producing synthetic Utah because the Salmonella outbreak occurred in these states at the same time it happened in Utah. Based on the weights of control states we observe that Connecticut and New Hampshire get non-zero weights in which New Hampshire gets almost 90% of the weights.

Using synthetic Utah, we generate figure 4 which shows the per capita sales four weeks before and after the event. This figure displays that sales in Utah and sales in synthetic Utah move very closely except for the week before the event. The synthetic Utah provides a reasonable approximation of the log of sales in Utah. Synthetic Utah includes a weighted average of New Hampshire and Connecticut with weights of 0.895 and 0.105, respectively. We used differences between Utah and synthetic Utah to show the effect of Salmonella on ground beef sales in Utah. As displayed in figure 5 Salmonella reduced ground beef sales by 0.8% following the event and this effect disappears after one month. This result may suggest that the even announcement does not affect sales in the long-run but is has a negative effect in the short-run. This effect seems more pronounced in the second and third weeks after the event.

New Hampshire and Connecticut seems unlikely to represent Utah. Therefore, I consider three western time zone states and regenerate a new synthetic Utah. The synthetic Utah is a combination of Oklahoma, Wyoming, and North Dakota with weights 0.527, 0.379, and 0.093. This combination of states is more reasonable to serve as control states for Utah. But, the gap between synthetic and control group before the event should be close to zero which is not happening in this case. Figure 6 and figure 7 indicate that the per capita sales four weeks before to the event at Utah and synthetic Utah 2 do not move closely. Continued work on this paper will explore synthetic control method in greater detail. Further analysis that we aim to investigate are additional predictors such as chicken and pork sales per capita to estimate more accurate synthetic Utah.

Conclusions

Using Nielsen Retail Scanner dataset that includes detailed purchasing records, this paper studied how consumer purchases reacted after the ground beef Salmonella outbreak in August 2009. To estimate average treatment effect first, we used DID method where Utah is the treatment state and Nevada is the control state. Results indicate 17% reduction in beef sale following the week after the Salmonella event. This effect is estimated using four weeks of data before and four weeks of data after this event. Given the estimated price elasticity for ground beef products (-2.04) the sale reduction as a result of recall is comparable to almost 8.3% increase in prices. Using the synthetic control method that allows us to use all of the control states to produce synthetic Utah, we found the effect of this event small.

Consistent with the previous literature on the effects of recalls, food scares and government warnings, our results show that consumers responded to the Salmonella recall, at least temporarily. Consumers' reactions to recalls motivate firms to invest in risk reduction and to satisfy food safety.

Reference

Abadie, A., Diamond, A., and Hainmueller, J. 2012. “Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California’s Tobacco Control Program.” Journal of the American Statistical Association. 105(490), pages 493-505.

Arnade, C., Calvin, L., and F. Kuchler. 2007. “Consumer Response to a Food Safety Shock: the 2006 Food-Borne Illness Outbreak of E. coli 0157: H7 Linked to Spinach.” Applied Economic Perspectives and Policy 31(4):734–750.

Bakhtavoryan, R., Capps Jr, O. and Salin, V., 2012. “Impact of Food Contamination on Brands: a Demand Systems Estimation of Peanut Butter.” Agricultural and Resource Economics Review 41(3): 327.

Bakhtavoryan, R., Capps Jr, O. and Salin, V., 2014. “The Impact of Food Safety Incidents across Brands: The Case of the Peter Pan Peanut Butter Recall.” Journal of Agricultural and Applied Economics 46(4), p.559.

Bertrand, M., E. Duflo, and S. Mullainathan. 2004. “How Much Should We Trust Differences-in- Differences Estimates?” Q*uarterly Journal of Economics* 119(1):249-275.

Brown, J.D., 1969. “Effect of a Health Hazard “Scare” on Consumer Demand.” *American Journal of Agricultural Economics 51*(3):676-678.

Cawley, J. and Rizzo, J.A., 2008. “Spillover Effects of Prescription Drug Withdrawals.” *Advances in Health Economics and Health Services Research 19*:119-144.

Crowley, C.S., and Shimazaki, Y., 2005. “Measuring the Impact of a BSE Announcement on US Retail Beef Sales: A Time-series Analysis.” *Journal of Agribusiness 23*(1):19-40.

Dahlgren, RA and DG Fairchild. 2002. “The Demand Impacts of Chicken Contamination Publicity – A Case Study.” *Agribusiness* 18(4): 459-474.

Freedman, S., Kearney, M. and Lederman, M., 2012. “Product Recalls, Imperfect Information, and Spillover Effects: Lessons from the Consumer Response to the 2007 Toy Recalls.” *Review of Economics and Statistics 94*(2):499-516.

Grocery Manufacturers Association. 2011. *"Capturing Recall Costs: Measuring and Recovering the Losses.",* Available at: <http://www.gmaonline.org/file-manager/images/gmapublications/

Lusk, J.L., and Schroeder, T.C., 2002. "Effects of Meat Recalls on Futures Market Prices." *Agricultural and Resource Economics Review 31*(1):47.

Kinnucan, H.W., Xiao, H., Hsia, C.J. and Jackson, J.D., 1997. "Effects of Health Information and Generic Advertising on US Meat Demand." *American Journal of Agricultural Economics 79*(1):13-23.

McKenzie, A.M. and Thomsen, M.R., 2001. "The Effect of" E. Coli" O157: H7 on Beef Prices." *Journal of Agricultural and Resource Economics* 1:431-44

Peake, W.O., Detre, J.D. and C.C. Carlson. 2014. "One Bad Apple Spoils the Bunch? An Exploration of Broad Consumption Changes in Response to Food Recalls." *Food Policy* 49:13-22.

Reilly, R.J., and Hoffer, G.E., 1983. "Will Retarding the Information Flow on Automobile Recalls Affect Consumer Demand?." *Economic Inquiry 21*(3):444-447.

Scharff, R.L., 2012. "Economic Burden from Health Losses Due to Foodborne Illness in the United States." *Journal of Food Protection* 75(1):123-131.

The U.S. Department of Agriculture (USDA), The Food Safety and Inspection Service, 2005-2015, "Recall Case Archive." Available at: < *http://www.fsis.usda.gov/wps/portal/fsis/topics/recalls-and-public-health-alerts/recall-case-archive*

Thomsen, M.R., Shiptsova, R. and Hamm, S.J., 2006. "Sales Responses to Recalls for Listeria Monocytogenes: Evidence from Branded Ready-to-Eat Meats." *Review of Agricultural Economics 28*(4):482-493.

Scallan E, et. al. 2011. "Foodborne Illness Acquired in the United States- Major Pathogens" *Emerging Infectious Diseases* 17(1):7-15.

Figures and Tables

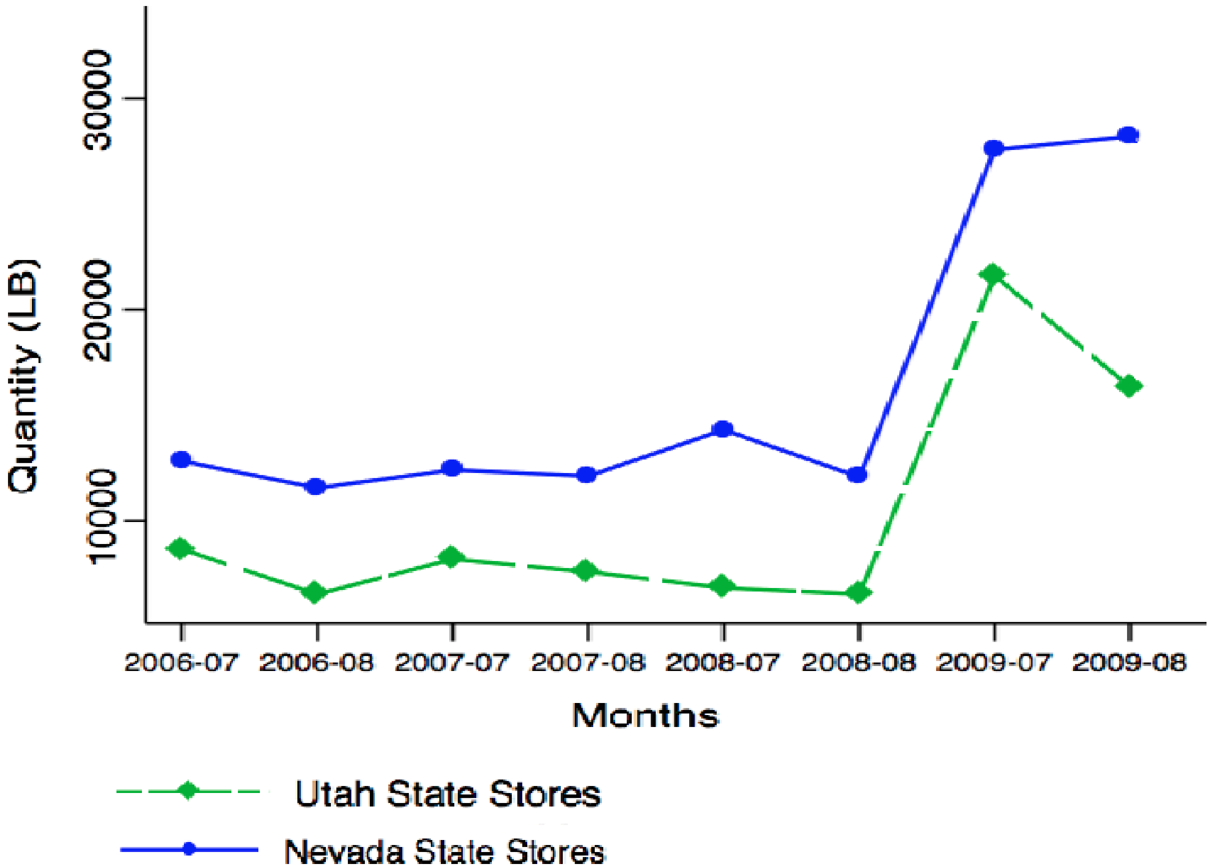


Figure 1: Comparing evolution of total monthly ground beef sales in Utah and Nevada.

Notes: Figure shows the evolution of total monthly sales (lb) by state for ground beef with no controls. Months denotes one pre-event month and one post-event month for each year (2006, 2007, 2008, 2009, 2010). Months across years are not continuous in time.

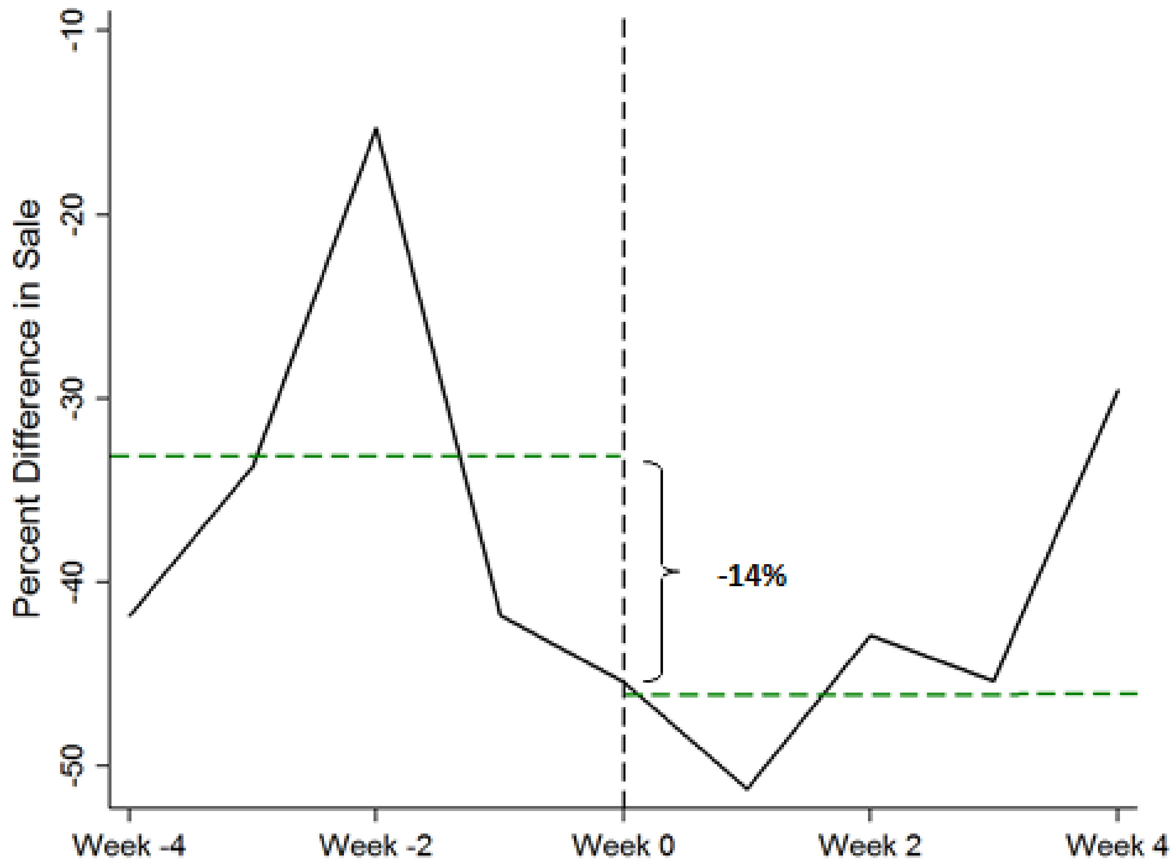


Figure 2: Percent difference in average weekly purchase by treatment statues. Vertical dashed line indicates recall event, and horizontal dashed lines indicate average differences using aggregated state level data.

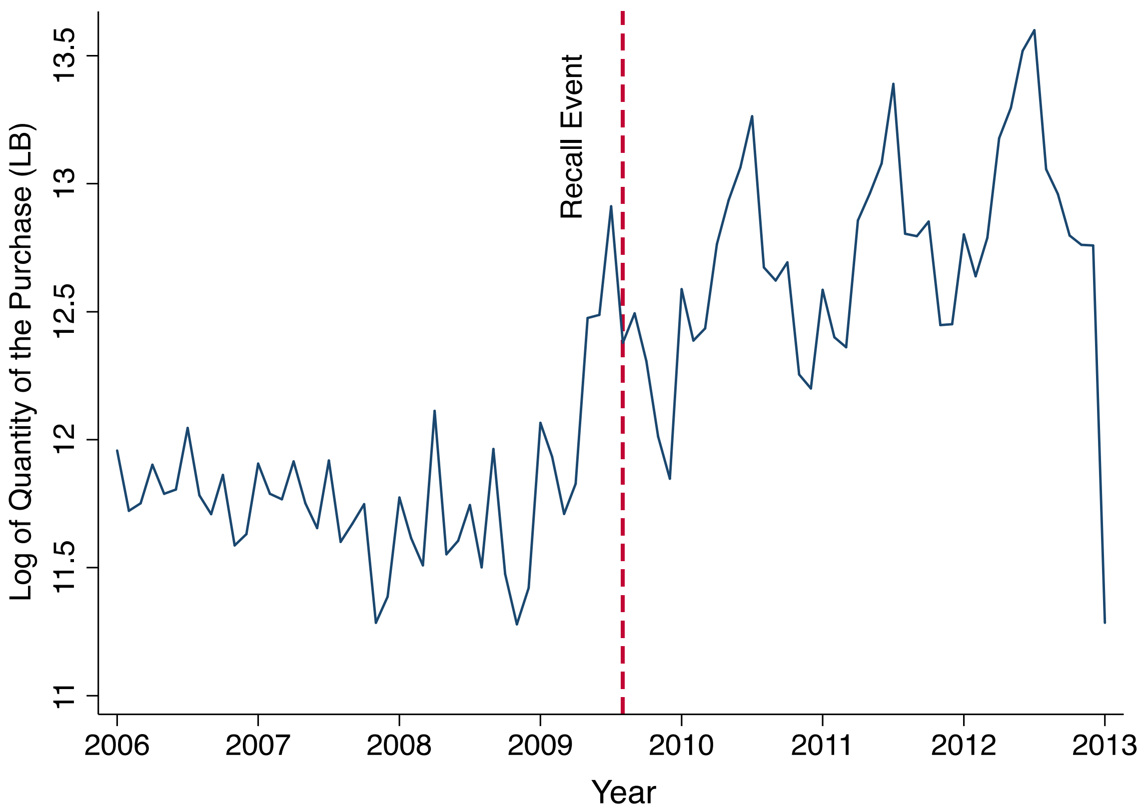


Figure 3. Trends in total monthly log of sales (lb) in Utah

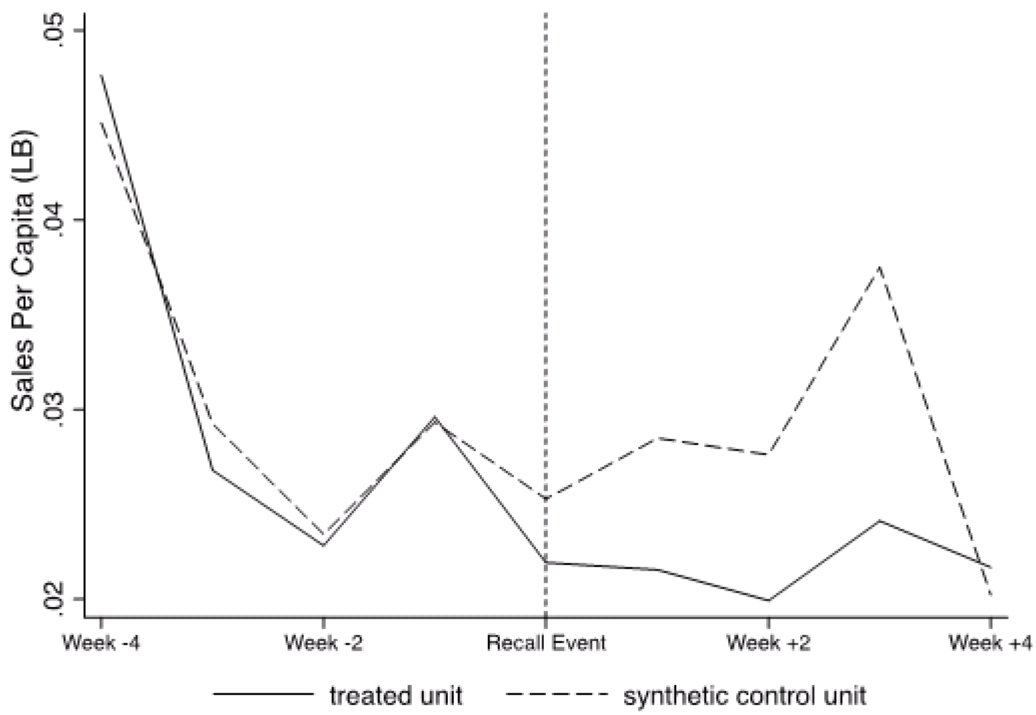


Figure 4. Trends in total weekly sales per capita of ground beef products (lb): Utah vs. synthetic Utah.

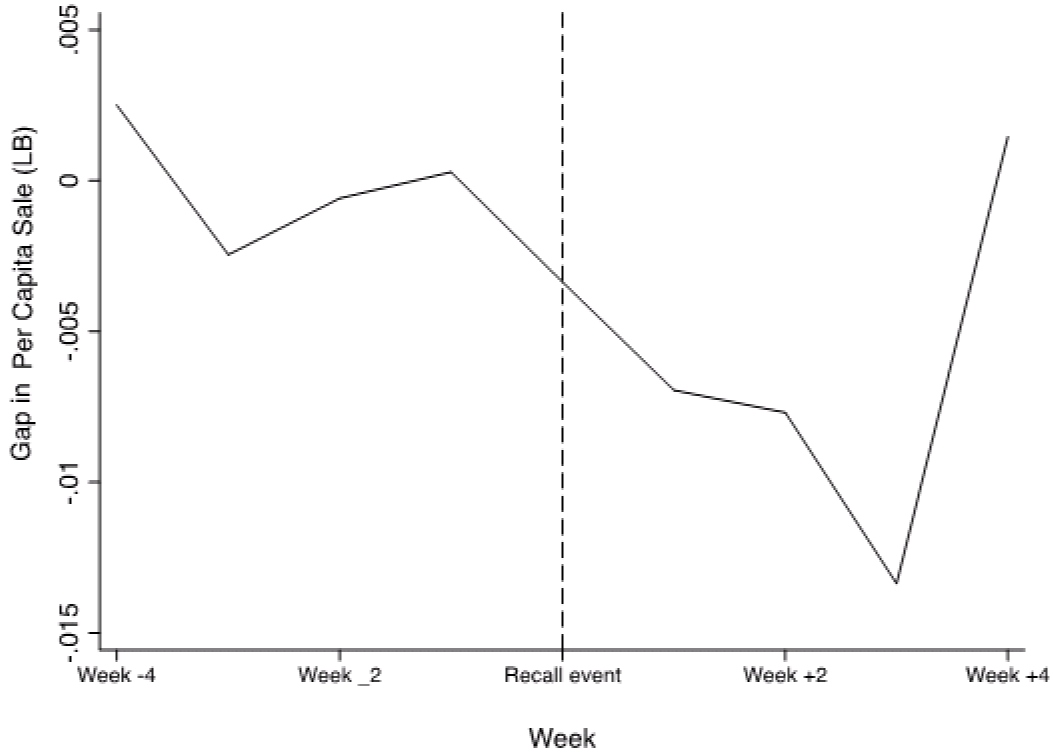


Figure 5. Log of weekly per capita sales gap between Utah and synthetic Utah.

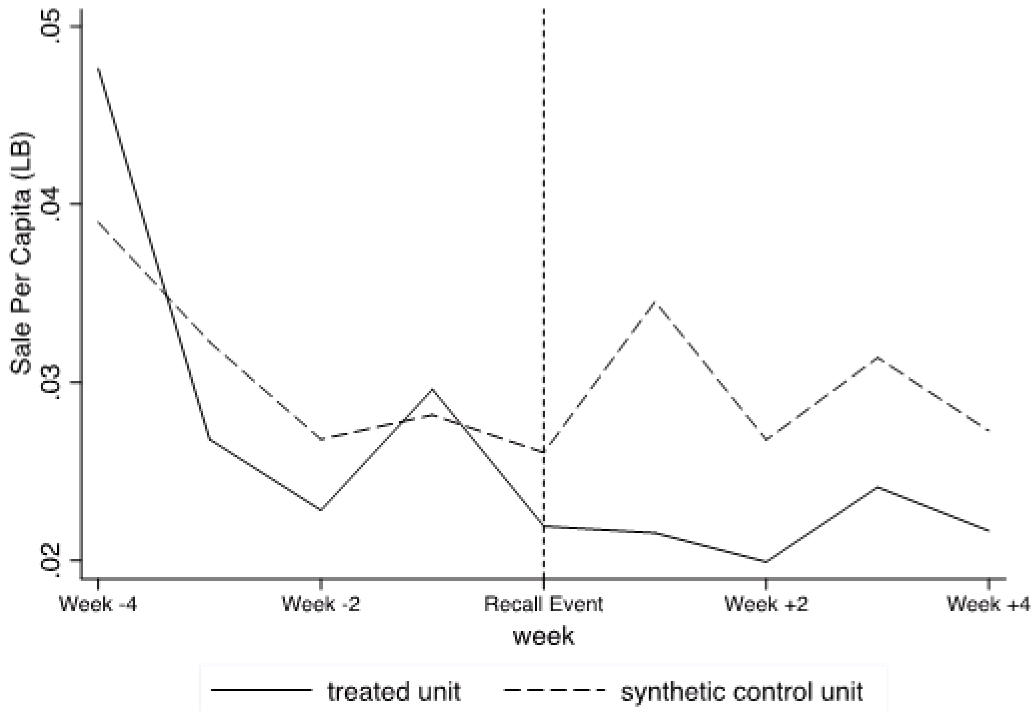


Figure 6. Trends in total weekly sales per capita of ground beef products (lb): Utah vs. synthetic Utah (Eastern Time Zone states are excluded).

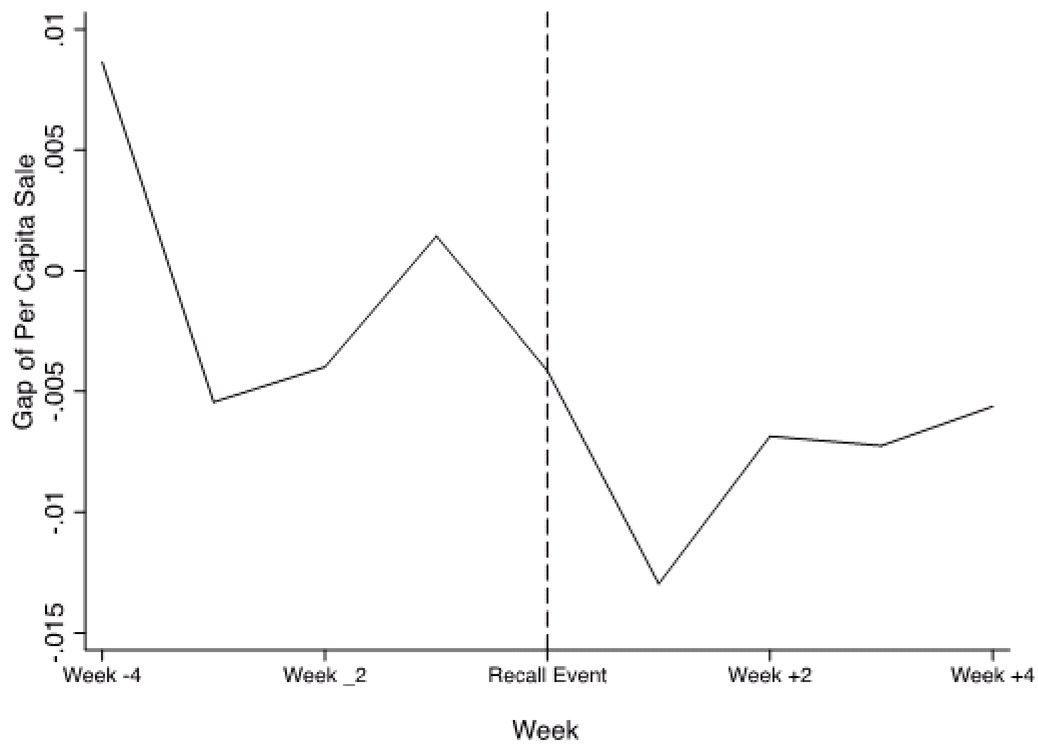


Figure 7. Log of weekly per capita sales gap between Utah and synthetic Utah (Eastern Time Zone states are excluded).

Table1: Store level descriptive statistics during four weeks prior and after the recall. (unit=lb)

		Obs.	Mean	Std. Dev.	Min	Max
Panel A: Utah Stores	Quantity (lb)	760	865	893	170	10640
	Price(/lb)		3.36	0.95	1.11	5.99
Panel B: Nevada Stores	Quantity (lb)		631	536	170	5328
	Price(/lb)	1,471	3.38	0.76	1.06	5.99

Table 2: State level aggregated average purchase of treated and control states for four weeks prior and after recall (unit=lb).

	Pre-Event	Post-Event	Difference
Nevada	11.55	11.63	0.085
Utah	11.13	11.07	-0.058
Difference	-0.41	-0. 56	**-0.14**

Table 3: regression result for 4 weeks before and 4 weeks after event (log of sale as a dependent variable) (unit=lb)

	Store level		
	(1)	(2)	(3)
Log of Price	-1.93***	-2.01***	-2.04***
	(0.01)	(0.05)	(0.05)
Salmonella Effect	-0.04	-0.20***	-0.17*
	(0.06)	(0.05)	(0.05)
Store Fixed Effects	No	Yes	Yes
Month Fixed Effects	No	No	Yes
Observations	2,827	2,827	2,827
R-squared	0.33	0.26	0.27
Number of Stores	-	156	156

Notes: Robust standard errors in parentheses. *** p<0.01, * p<0.1

Table 4: ground beef sales predictor means

	Treated	Synthetic Utah1	Synthetic Utah2
Price per lb	3.42	3.27	3.83
Sales per capita 1 week before event	0.027	0.028	0.039
Sales per capita 2 weeks before event	0.023	0.023	0.022
Sales per capita 3 weeks before event	0.030	0.029	0.027
Sales per capita 4 weeks before event	0.022	0.025	0.028
Number of stores per capita	0.013	0.022	0.010

Table 5: Sate weights in the synthetic Utah

State	weight		State	weight	
	Synthetic Utah1	Synthetic Utah2		Synthetic Utah1	Synthetic Utah2
Alabama	0	0	Nebraska	0	0
Alaska	0	0	Nevada	0	0
Arkansas	0	0	New Hampshire	0.895	0
Connecticut	0.105	0	New Jersey	0	0
Delaware	0	0	New Mexico	0	0
Florida	0	0	New York	0	0
Georgia	0	0	North Carolina	0	0
Hawaii	0	0	North Dakota	0	0.093
Idaho	0	0	Ohio	0	0
Illinois	0	0	Oklahoma	0	0.527
Indiana	0	0	Oregon	0	0
Iowa	0	0	Pennsylvania	0	0
Kansas	0	0	Rhode Island	0	0
Kentucky	0	0	South Carolina	0	0
Louisiana	0	0	South Dakota	0	0
Maine	0	0	Tennessee	0	0
Maryland	0	0	Texas	0	0
Massachusetts	0	0	Utah	0	0
Michigan	0	0	Vermont	0	0
Minnesota	0	0	Virginia	0	0
Mississippi	0	0	Washington	0	0
Missouri	0	0	West Virginia	0	0
Montana	0	0	Wisconsin	0	0
			Wyoming	0	0.379