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Foodborne Disease Outbreaks and Consumer Purchases

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Using a large product-level scanner data set from a national grocery chain, we examine how consumers in California reacted to three consecutive egg recalls during the 2010 Salmonella outbreak. We find a 9% significant reduction in egg sales. Given an overall price elasticity for eggs in U.S. households of around -0.1, this sales reduction is comparable to an almost 100% increase in price.

Also in this issue

When making purchasing decisions about products, consumers traditionally include factors such as price, quality, and availability of substitutes. It is less clear what happens when a very similar product is removed from the market for safety reasons. On the one hand, if a product with safety concerns is removed from the market and the remaining products experience additional safety checks, consumers may perceive the market as being at least as safe as before. On the other hand, if the removal of the unsafe product provides negative information about closely related products or the industry as a whole, consumers may respond by decreasing demand, even in the absence of safety concerns about the remaining products.

The empirical question is whether a recall of an unsafe product can have a direct impact on consumer purchases and preferences, even if the remaining products are safe. From a safety perspective, the question is relevant if firm incentives to invest in risk reduction and regulatory compliance in existing regulation depend, to some degree, on consumer responses to recalls.

The Egg Recalls

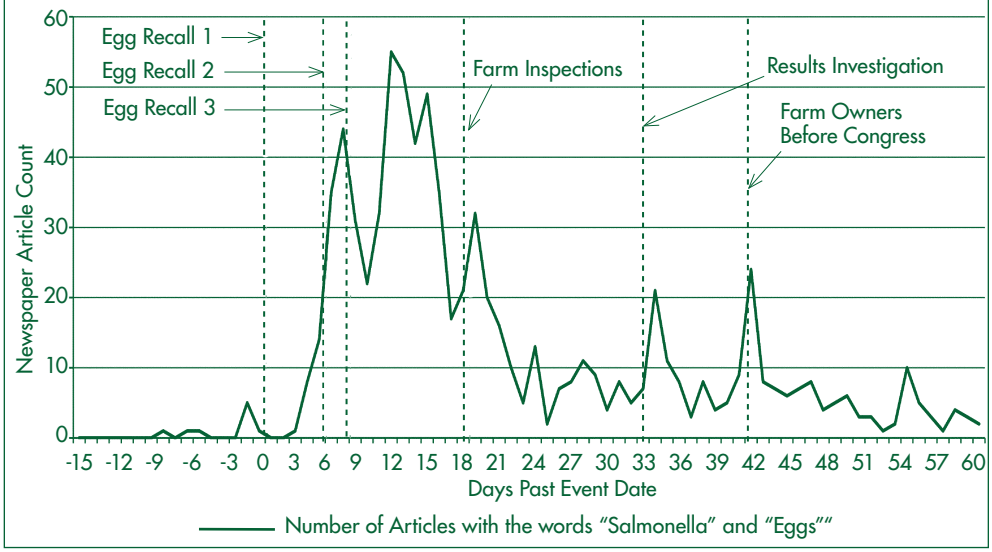
In early July 2010, the Center for Disease Control and Prevention (CDC) identified a nationwide, four-fold abnormal increase in the number of reported Salmonella infections. A month later, on August 13, 2010, a first egg farm, located in Iowa, conducted a nationwide voluntary recall of around 228 million eggs. By August 18, 2010, the same farm expanded its recall to around 152 million additional eggs. Within 48 hours, on August 20, 2010, a second egg farm, also located in Iowa, conducted another nationwide voluntary recall of around 170 million eggs.

In total, from August 13 to August 20, 2010, more than 500 million eggs were recalled, in what would be the largest egg recall in U.S. history (around 0.7% of production). Infected eggs from these two major egg producers were distributed in fourteen U.S. states, including California. Eggs were recalled using specific plant numbers and codes that allowed tracing back to the box level, leaving no infected eggs in stores. Consumers and stores could return infected eggs for a full refund.

The three egg recalls received extensive national and local media coverage on the television, radio, newspapers, and the Internet. To measure media coverage of the event, we conducted a Lexis-Nexis search, which gave us the daily count of newspaper articles that appeared on the 2010 Salmonella egg outbreak, starting 15 days before the event up to 60 days after the event.

Figure 1 shows the number of articles in major newspapers that include the words "Salmonella" and "Eggs" on a given day. Media interest persisted over a six-week period following the event,

Figure 1. Newspaper Coverage of the 2010 Salmonella Egg Outbreak



in particular covering farm inspections that found numerous violations and showed that the egg farms were infested with flies, maggots, rodents and overflowing manure pits, as well as both farm owners testifying before Congress.

The fact that there were three consecutive egg recalls within one week could have led consumers to think that this was a major outbreak, and not a regular food recall. Furthermore, given the information provided by the media coverage, some consumers may have obtained information or updated their beliefs on the egg industry as a whole.

If consumers were perfectly informed, did not update their beliefs, and expected no further recalls, we could anticipate no effect of the event on consumer purchases. However, if consumers did not have perfect information on the outbreak or the recall codes, updated their beliefs about the egg industry, or "overreacted" to the recalls, we could expect a drop in egg purchases following the event, at least temporarily. We find that the latter was true.

Empirical Strategy

Using a unique product-level scanner data set of a national grocery chain that has stores in both high and low income zip codes, we examine how consumers reacted to the three consecutive egg recalls. First, we test whether consumers changed their egg purchases in California following the recalls. We examine media coverage on the highly publicized outbreak and hypothesize that media coverage is the channel through which consumers became informed about the event.

Second, we study whether consumers substitute away from conventional eggs towards other types of specialty "greener" eggs that may be perceived as having a lower probability of Salmonella, such as organic or cage-free eggs. Eggs are currently produced under a variety of methods, but 95% of the national egg production in 2010 came from conventional battery cages. In our California and Washington sample, around 90% of eggs sold came from battery cages.

Table 1 summarizes some of the differences between conventional eggs and non-conventional eggs. It is unclear if consumers were aware of the debate in the United States about the link between the type of egg (e.g., from a battery cage, cage-free, organic) and the probabilities of Salmonella infection.

We hypothesize two possible results for purchases of unaffected eggs. On one hand, consumers might substitute away from conventional types of eggs to non-conventional specialty eggs (a substitution effect across egg classes). On the other hand, some consumers might choose to reduce all egg purchases, leading to a decline in purchases of all types of eggs.

Third, we investigate whether different socio-economic groups reacted differently to the egg recalls. In particular, we look at whether income and household size affect the response to the recalls. To do this, we use demographic data for the zip code where the store is located. Income may affect the response if wealthier consumers are able to substitute to greener alternatives, which can cost up to twice as much as traditional shell eggs.

Finally, we examine whether separate areas within California reacted differently to the egg recalls. Due to its distribution system, our national grocery chain had infected eggs only in Northern California. We use variation within California to test whether consumers in Southern California reduced egg purchases as well.

We use a technique known as differences-in-differences to estimate the effect of the three recalls on egg sales and use a control state that did not receive infected eggs, Washington. We are also able to control for seasonality (i.e., seasonal changes that could be occurring at the time of the event in California) by using data from previous years around the event date. The differences-in-differences approach consists in comparing changes in egg purchases in affected areas in California to changes of egg purchases in comparable but recall-unaffected areas in Washington.

If we were to focus only on the changes in California, we could not conclude that those changes were caused by the recalls. We could only show that they are correlated with the recalls. Indeed, other confounding factors, such as macroeconomic conditions, could be responsible

for changes in California egg purchases. We net out such factors by using changes for comparable stores in Washington as counterfactuals.

We use the fact that infected eggs could be traced to the box level to establish a clear definition of the treatment and follow a panel of over 600 stores during a four-year period. Further, given the geographical distribution of infected eggs, we are able to measure potential spillovers to unaffected areas of California.

Findings

We begin by plotting the evolution of daily sales around the "event week" (August 13–August 20, 2010) in California. Figure 2 plots changes in egg purchases (in quantities of egg boxes sold) for all shell eggs for stores in California only. The category all shell eggs includes 2 classes (all traditional or value-added specialty eggs) and 7 subclasses (traditional large, traditional extra-large, traditional jumbo, specialty brown, specialty organic, specialty cage-free and specialty nutrient-enhanced). The figure plots data starting 30 days before the "event day" (here defined as August 13, 2010, the day of the first egg recall) up to 35 days after the event day.

Changes in egg purchases take into account price, as well as factors that are constant across stores, aggregation levels and day of the week (e.g., sales are always higher on weekends). Egg sales show a large drop a few days after the first recall and a small increase between the second egg recall and the third recall. Sales reach their lowest level in the time period around 11 days after the first egg recall. This suggests that, if egg purchases decreased due to the egg recalls, there was a small (days) time-lag between the time the recalls were made and the time that the effect was reflected in lower purchases in stores.

Using our econometric model, we proceed to formally test the effect of the three egg recalls and find a 9% significant reduction in egg sales in California. Given an overall price elasticity for eggs in U.S. households of around -0.1, this sales reduction is comparable to an almost 100% increase in price. Consistent with a rather inelastic demand, the effect is very similar with and without prices.

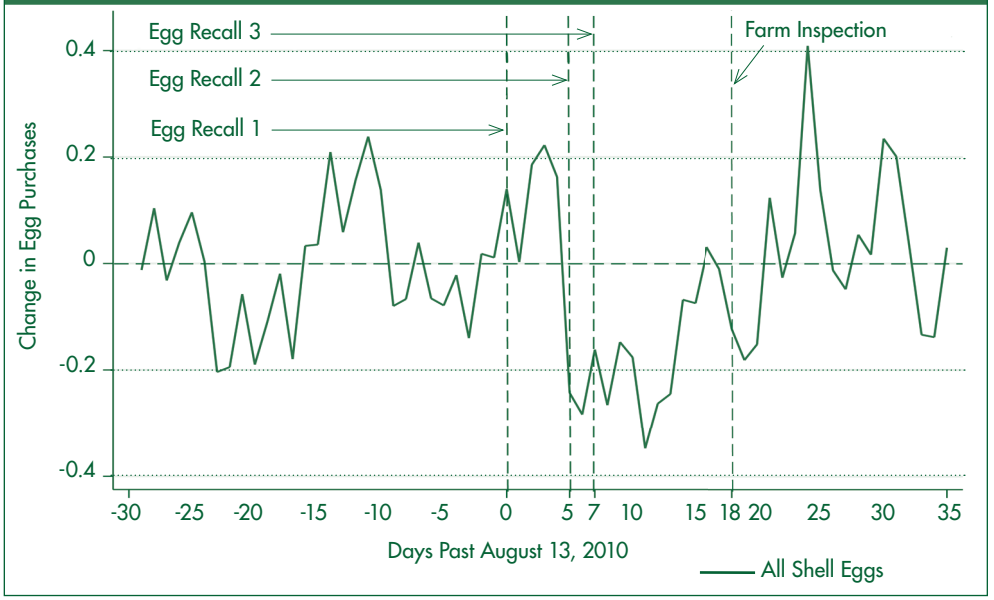
We find that the decrease in sales was driven by a drop in purchases of traditional large shell eggs and find no evidence of substitution toward other greener type of eggs, such as organic or cage-free eggs. More specifically, we find that purchases of large traditional shell eggs significantly decreased by 10% in California in the month following the event. Large traditional eggs had the largest market share of sales in our sample in 2009 (around 70%). Sales of the other types of eggs do not change significantly due to the recalls. For jumbo, brown, cage-free and nutrient-enhanced eggs (with very small 2009 baseline sales), we find no significant effects of the recalls. Sales for extra-large traditional shell eggs and for organic eggs seem higher but the recalls still have no significant effect.

Table Conventional and Non-Conventional Eggs

Conventional Eggs	Non-Conventional Eggs
• 95% of the egg production in 2010 came from conventional battery cages. • Conventional battery cages are stacks of cages that can be up to two stories high and keep about six hens to a cage. • Each hen gets on average 67 square inches of floor space (about ¾ of a sheet of a notebook paper). • Hens are unable to fully stretch their wings and have no access to natural light. • As many as 100,000 birds may be grouped together under a single roof (USDA).	• 5% of egg production comes from non-conventional production methods. • Methods are classified by: o how eggs are raised (e.g., cage-free, free-range, pasture-raised), and/or o by what birds are fed (e.g., organic, vegetarian-fed, no hormones, no antibiotics) • A single egg box usually contains more than one label (e.g., "Cage-Free, Kosher and Vegetarian-fed hens").

Sources: United Egg Producers (UEP) and USDA, ERS

Figure 2. Daily Changes in Egg Purchases Following the Egg Recalls



When matching each grocery store with the socio-economic characteristics of the zip code in which it is located, we are able to investigate heterogeneous effects of the recall. We study whether income and household size affect the response to the recalls, where income is the demeaned average income in the zip code in which the store is located (in 10,000 USD) and household size is the demeaned average household size in the zip code in which the store is located. Socio-economic data come from the 2000 U.S. Census. While we find no correlation with income, we do find that areas that had a larger than average household size decreased egg purchases significantly more.

A caveat to the results is that it is possible that more affluent customers diverted egg purchases to farmers' markets or high-end grocery stores after the egg recalls and thus the estimates would suffer from selection bias. The data allow only for the identification of effects with purchases undertaken at the national grocery chain.

We also find differentiated effects among Northern and Southern Californian stores. Although the national grocery chain had infected eggs only in Northern California, we find that Southern Californian stores had lower egg sales as well. The overall sales reduction in Southern California was half as large as the reduction in Northern California, and is consistent with media and reputation effects being significant determinants of demand, even in the absence of an actual food recall.

Studies on the effects of safety warnings on spinach (Arnade et al. 2009), beef (Schlenker and Villas-Boas 2009) or fish (Shimshack et al. 2007) have also found significant consumer responses. However, the persistence of the effect may vary depending on the type of good and availability of substitutes. For example, while the effect of a safety warning on spinach had a long-term effect, our results for eggs suggest that the effect was temporary.

To test the robustness of our findings, we perform several checks. First, we test the sensitivity of the baseline results to various assumptions about the seasonality parameters. We use only data for one year before the recall (2009) instead of using, as above, all previous years (2007, 2008, and 2009). This yields very similar drops in purchases as when we include all previous years.

Second, we test the sensitivity of the baseline results to using Washington as a control state by excluding data from Washington and using stores in Southern California as controls. The rationale is that we may assume that stores in Southern California have similar trends to stores in Northern California. Once again, using Southern California stores as counterfactuals for Northern California store patterns yields very similar estimates of the egg recalls.

Third, we test the sensitivity of the baseline results to using only one month after the event week. We obtain data on a second post-event month and include a total of eight weeks after the event week for all years. While this additional robustness check gives us similar results to the ones from the main specification, we find that the effect lasted more than one month.

Conclusion

Consistent with previous literature on the effects of foodborne disease outbreaks, food scares and government warnings, our results show that consumers do respond to outbreaks, at least temporarily. Moreover, not only did consumers reduce their purchases of affected products, they also did not switch to unaffected alternatives. As a result, overall egg purchases dropped. These findings have policy implications for consumers, producers, and policymakers. They show that consumers do respond to recalls and that these responses are an incentive for firms to invest in risk reduction and to comply with existing regulations. They also contribute to a discussion on the need for additional investments in food safety, product tracking, and the enforcement of existing regulations in order to improve the availability of safe products for consumers.

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For additional information, the authors recommend:

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Shimshack, J., M. Ward, and T. Beatty. "Mercury Advisories: Information, Education and Fish Consumption." *Journal of Environmental Economics and Management* 53(2) (2007): 158-179.