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EFFECT OF THE 2007 PEANUT BUTTER RECALL ON CONSUMERS' BRAND CHOICES

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ABSTRACT OF THE THESIS

EFFECT OF THE 2007 PEANUT BUTTER RECALL ON CONSUMERS' BRAND CHOICES

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This research evaluated the effects of peanut butter recall event in 2007 on the U.S peanut butter market and consumers' brand preferences. With Nielsen Homescan data from July 2006 till March 2008 covering all the purchasing trips by U.S. households, we apply discrete choice model to detect and measure the impacts of the food recall event happening in U.S. peanut butter market initiated in February 2007. To set the stage for estimation, we also examine the effects separately by three periods: pre-, during- and post-recall periods. The objectives of this study are twofold: (a) investigate whether the peanut butter recall event has great impact on customer preferences and purchasing declines for some brands or in the scale of whole market; (b) with the rich information of demographic characteristics in our data, we want to detect any association between changes of purchasing behavior and demographic variables.

The findings suggest that due to the recall event, customers changed their purchasing behavior and brand preference among national, store and especially the recalled brands. Purchasing of recalled brand has declined due to food safety alert during the event, yet it recovered to a lower level to pre-event after the recall period. It was also observed that

positive spill-over effects existed for non-recalled brands. National brands benefits more than store brands. After the event, store brands suffer from some loss in market share compared with national brands.

Results of my study suggest food safety issue has drawn great attention from customers backwards to manufactures along the supply chain. It is very important to inform customers about potential hazards and safety issue in food products. It is also important to monitoring food producing and processing procedures from the manufacture side with a well-developed hygiene monitoring system. Asymmetric spill-over effect exists between non-recalled national and store brands, thus different marketing strategies are necessary for strong and weak brands to maintain and regain market share. Additionally, recalled brands could regain customer confidence. It is quite useful to identify various customer groups by their demographic characteristics, then to apply corresponding marketing strategies to restore consumers' confidence towards recalled brands. In all, it is highly recommended to prevent food safety hazards from happening before they come out of the plants and to keep information clear to customer once recall happens.

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CHAPTER 1: INTRODUCTION

Product-crisis incidents are becoming prevalent due to increasing complexity of products, closer scrutiny of manufacturers and tighter regulations, and higher demand of product safety by consumers (Dawar and Pillutla, 2000, Van Heerde, et al., 2007). Product-crisis incidents receive significant media coverage (Ahluwalia, et al., 2000). Product recalls are one of the most effective ways through which government is able to regulate and improve product safety by removing unsafe products out of the supply chain (Cason, 2013). Product-crisis incidents receive significant media coverage (Ahluwalia, et al., 2000). They impact the sales and reputation of infected products and product lines of the same manufacturer as well as substitute and complementary products of other manufactures (Freedman, et al., 2012, Van Heerde, et al., 2007, Zhao, et al., 2011). The spillover effect within a company of the infected product and between companies producing the similar products can significantly change market shares and production position. The effect is found to be more significant in the short term (Marsh, et al., 2004, Van Heerde, et al., 2007) and for weak brands (Zhao, et al., 2011).

This study focuses on the 2007 peanut butter recalls. On February 14, 2007, the US Food and Drug Administration (FDA) issued a recall of two peanut butter brands, Peter Pan and Great Value, both manufactured by ConAgra Foods, as they were found to be contaminated with *Salmonella* bacteria. The FDA extended the recall to three other peanut butter brands manufactured by ConAgra Foods on March 1st and to all ConAgra's peanut butter products on March 9th. The recalled amount totaled 326 million pounds (more than 10,000 cases) (Mulvenon, 2010) and decreased sales of Peter Pan and Great Value brands by 63 percent in 2007 (Nash, 2007). The estimated total value of peanut butter dropped due to

the contamination risk was as high as one billion dollars and the recall cost was estimated at more than 78 million dollars (Nash, 2007).

1.1 Research Objective:

The objective of this study is to estimate the brand preference and its changes resulting from the recall employing a mixed logit model based on the Nielsen Homescan data[1]. The household based scanner panel data allows us to explicitly estimate the change of brand preference while controlling for brand attributes and individual characteristics. Since the purchasing data consists both national and store brands, we can examine the heterogeneous effects resulting from the product-harm crisis on strong and weak brands. Furthermore, the linkage between socio-demographic profiles of consumers and their brand preferences allows us to examine when facing food safety issue who are more likely to change their brand preference, which will help responses/mitigation strategies taken by the affected firms/industries.

1.2 Outline of the Thesis

Following Chapter 1 which gives a snapshot of food safety and product crisis, a literature review in Chapter 2 provides an overview of food safety issues and recall events in the history of U.S. food market. Then it drills down to U.S. peanut butter market to provide us an overall looking at the market performance. This chapter also looks back at the previous study on product-crisis incidents from both industrial and methodology aspects along with some of my perspectives on the study trends, which is critical to this study in peanut butter market.

[1] Nielsen Homescan Data is about household food purchases, covering a wide variety of retailers and national coverage of households.

Chapter 3 presents the theoretical background and the methodology we used for this analysis. An overview of discrete choice model is given in this section. Based on that, we first adopt conditional logit model and finally choose the mixed logit model comprising a mimicked choice set for each household, while identifying brand dummies interacting period dummies as random effects.

Chapter 4 provides an introduction of the data used for the study including product attributes and demographic characteristics from Nielsen Homescan data. A summary of market share by brands and periods, descriptive statistics of product attributes and household characteristics are presented in this section.

Chapter 5 gives the empirical results. First a conditional logit model was employed assuming brand dummies as fixed product attributes. Then a mixed logit model was conducted to compare the impacts on brand preferences before, during and after the recall event. Based on the estimation results, we compared the brand preferences and market shares by periods. Recalled brand had a recession period during the recall event, and non-recalled brands benefit from positive spill-over effect. The effect is stronger on national brands. Yet after the recall ends, store brands suffer from some loss of market share. We also present household preference in product attributes, as well as household characteristics which are statistically significant in choosing national brands. Chapter 6 provides the implications and conclusions based on the results.

CHAPTER 2: 2007 PEANUT BUTTER RECALL EVENT

On February 14, 2007, the US Food and Drug Administration (FDA) found two brands of peanut butter, Peter Pan (national brand) and Great Value (Wal-Mart store brand) manufactured by ConAgra Foods in its Georgia plant, to have the potential risk of Salmonella contamination. This discovery led to a recall of certain jars of Peter Pan and Great Value peanut butter in the market with product code prefixed by 2111. If the product code was unclear on the jars, discarding them was strongly advised by the FDA (Herndon, 2007). Customers returning those products to ConAgra were reimbursed (Funk, 2007). In the following month, the FDA updated the recall twice. First update issued on March 1st, 2007 extended to the other three brands of peanut butter toppings that were also manufactured by ConAgra Foods containing the suspicious ingredient (FDA, 2007). On March 9th, 2007, FDA issued the second update on the recall. This time all ConAgra's products with product code started with 2111 were involved (FDA, 2007). The amount of peanut butter recalled during the course of the recall totaled up to 326 million pounds in weight, and cumulatively more than 10,000 cases of peanut butter toppings were affected (Mulvenon, 2010).

This is the first time that peanut butter was recalled due to salmonella outbreak in the United States (Bakhtavoryan, Salin, and Capps Jr, 2011). From August 1st, 2006 to May 22nd, 2007, the total confirmed cases of Salmonella infection associated with consumption of the adulated peanut butter products totaled 628 in 47 states (CDC, 2007). Among the 481 patients with available clinical information, 20 percent were hospitalized (Funk, 2007). Approximately 300 people become infected and sick in 39 states (Funk, 2007) and the most reported cases were from New York, Pennsylvania, Tennessee and Missouri (Funk, 2007). No deaths were incurred due to this infection as the CDC report (Funk, 2007).

Since as early as 2005, ConAgra Foods Inc. had been suspected of the potential risk of contamination with Salmonella in their peanut butter products, but they refused to accept the investigation request from the FDA until 2007, when emerged the first diagnosed Salmonella disease which was identified that their peanut butter product as a potential cause (Mulvenon, 2010). Since November 2006, there had been increasing number of Salmonella contaminated disease related to peanut butter being reported by CDC and state health departments. Among the patients who showed Salmonella contamination symptoms, 85% said they ate peanut butter during the past few weeks (Funk, 2007). FDA later managed to narrow down the source of the food borne illness to two brands, Peter Pan and Great Value, after a multistate controlled study conducted in February 2007, which confirmed the earlier suspect (Bakhtavoryan, Salin, and Capps Jr, 2011). Consequently, ConAgra ceased peanut butter production and all the related peanut butter products were destroyed (Bakhtavoryan, Salin, and Capps Jr, 2011). The estimated total value of peanut butter contaminated was as high as $1 billion and the recall cost more than $78 million in total (Nash, 2007). Sales of these two affected brands inevitably dropped by 63 percent in 2007 (Nash, 2007).

ConAgra traced the contamination source back to moisture, which was raised by a leaky roof and dysfunctional sprinklers caused by a rainstorm in Sylvester, Georgia (Bakhtavoryan, et al., 2011). The moisture nourished Salmonella bacteria in peanut dust in the factory and created a moisturized environment that made Salmonella survive several weeks longer than in dry environment. This was how Salmonella slinked into peanut butter and finally led to the disease outbreak (Manufacturing.Net, 2007). Significant recovery efforts were taken by the producers in order to rebuild their production reputation and gain consumer trust and confidence. Nearly $15 million were spent on reconstructing ConAgra's plant in Sylvester (Bakhtavoryan, Salin, and Capps Jr, 2011), including repairing the roof, installing new

equipment, cleaning and sanitizing the plant, creating a new Hazard Analysis and Critical Control Point Plan, and implementing a revised environmental testing program for Salmonella (FDA, 2007). After everything was tested and reconstructed, the plant reopened and resumed its production of Peter Pan in September 2007 but discontinued to produce Great value peanut butter (Sheth, et al., 2011). Peter Pan came back to supermarket shelves with the same brand name yet a redesigned label and a 100 percent satisfaction guarantee in September 2007 (Bakhtavoryan, Salin, and Capps Jr, 2011). This ranks as the largest investment in campaign by the history of Peter Pan (Bakhtavoryan, Salin, and Capps Jr, 2011). "War's over, but the pain remains" (Gelzinis, 2013)– it will take time to gain consumer trust and confidence to purchase Peter Pan peanut butter after this food safety event (Bakhtavoryan, Salin, and Capps Jr, 2011).

CHAPTER 3: LITERATURE REVIEW

3.1 Food Safety and Food Recalls

Food recalls are common as people are increasingly aware of the hazards of food safety issues. In order to keep customers safe, food recalls are the most effective ways through which government is able to regulate and increase food safety through removing potentially hazard products along the supply chain (Cason, 2013). Several consequences come along after the food recalls, some are positive yet some are negative. The food market is better regulated as problems emerge and are solved. The customers become more and more cautious and informative towards food quality, labeling and the safety issues. The manufacturers incur financial losses, and more importantly, substantial efforts are invested to regain brand image and customer confidence. A similar framework applies to a larger extent of product-crisis incidents.

Food recalls could also bring attention to supplier safety practices and food policy regulations (Watson, 2013). Monitoring and enforcing the hygiene systems for food production become necessary, manufacturers should be cautious towards production process for any potential infections to the food products. Also quality control becomes prevailing to ensure food safety. The effects on competitors could be complicated. On one hand, they might suffer from losing market shares due to negative spill-over effect. Yet on the other hand, within the same market other players may benefit from their competitors' mistakes as well (Van Heerde, Helsen, and Dekimpe, 2007), but still in all the cake left for the market could very possibly be less. To be concrete, the consequences of product-harm crisis include shrinking market share and revenue as well as distorted quality perception and company's reputation (Van Heerde, Helsen, and Dekimpe, 2007). Obviously how to quantify

and seek the sources of the consequences of the event could help the producers regain their brand performances (Van Heerde, Helsen, and Dekimpe, 2007).

Three major reasons contribute to food recalls: contamination, adulteration and misbranding (Cason, 2013). All of them could cause serious health issues among consumers. Salmonella contamination, for example, could make consumers infected with symptoms like vomit and fever (Cason, 2013). Adulteration means impure or unsafe food which contains poisonous or deleterious substances. Misbranding gives the misleading information regarding food products. Undeclared allergens could also be a potential hazard to people who are sensitive to some specific ingredients, like peanut and gluten (Cason, 2013). FDA and the USDA Food Safety Inspection Service (FSIS) are the two major agencies that play an important role in monitoring and enforcing food recalls. They categorize food recall into three levels: Class I, II and III as hazard decreases. Class I recall is for the issue which has great possibility leading to death after consuming the food products, Class II recall is for the issue which might potentially lead to adverse health problems as having the products, and Class III recall is for the issue that violates the regulation yet might not be related to potential health problems.

In the U.S. and Canada food markets, during the 12 months of the period of July 2012 till July 2013, there were approximate 610 recalls (Cason, 2013). Among those recalls, Salmonella contamination was the major cause contributing 37.6% of the total (Cason, 2013). Peanut butter contamination stands for the primary source of the Salmonella contamination. Other reasons, such as undeclared allergens, account for 21.6%, while contamination with Listeria Monocytogenes account for 20.2% of the total recalls (Cason, 2013).

Food recalls, if they are national recalls and/or categorized as Class I, likely lead to significant economic consequences. Food recalls are likely to change consumer purchasing behaviors dramatically due to distrust. Consumers might either switch to substitute products and/or other brands in the same product market or stop consuming the product either in the short term or even in the long term. Some consumers may even purchase food necessities from overseas. For example, more and more Chinese consumers start to buy infant formula milk from foreign companies ever since Chinese milk scandal happened in 2008, which suggests that Chinese consumers lose confidence in their domestic brands and domestic manufacturers (Ramzyg, 2008). Therefore, the consequences of product-harm crisis likely lead to shrinking market share and revenue as well as distorted quality perception and company's reputation (Van Heerde, Helsen, and Dekimpe, 2007). Second, recalls impact the product/company competition. On one hand, competitors who produce similar products as the infected one will possibly lose their market share since the total demand decreases due to the recall. Yet, on the other hand, instead of spill-over effect, within the same market other players may benefit from their competitors' mistakes as well (Van Heerde, Helsen, and Dekimpe, 2007), but still in all the cake left for the market could possibly be less. Although recalls are usually initiated by manufacturers, they are extremely expensive and producers want to limit the recall period as short as possible and implement various marketing strategies to regain consumer confidence in their products (Cason, 2013).

3.2 Previous Studies on Product-Harm Crisis and Spillover Effects

The literatures on product-harm crisis can be grouped into three schools (Van Heerde, et al., 2007). First, descriptive studies examine managerial actions to avoid the incident or respond/mitigate the adverse consequences of such incidents, but they do not provide

sufficient information/directions to understand how product harm crisis affect the company or brand (Van Heerde, Helsen, and Dekimpe, 2007). The second stream of research is to use lab experiments based on psychological theories to assess the impact of product harm crises and identify the moderating variables on brand evaluations (Dawar and Pillutla, 2000). Those studies in general lack external validity of the insights (Ma, et al., 2010, Van Heerde, et al., 2007). The third stream of research is concerned with estimating the effects of actual product-harm crises on various product related outcomes such as category consumption and sales (Van Heerde, et al., 2007), brand loyalty, stock and futures prices (Jin, et al., 2008; Salin and Hooker, 2001). This school of literature is most relevant since this study mainly focuses on the change in brand preferences and consumption to an actual food recall.

Previous studies investigating the impact of product harm crisis on consumer behavior, brand equity, and market structure focus on either food items (Burton and Young, 1996; Ma, et al., 2010; Marsh, et al., 2004; Tonsor, et al., 2010; Van Heerde, et al., 2007; Zhao, et al., 2011) or non-food goods (Freedman, et al., 2009). In general, previous empirical research suggests that a spillover effect from the harmed product to non-harmed products could be significant in the case of food recalls (Arnade, et al., 2009; Ma, et al., 2010; Marsh, et al., 2004; Tonsor, et al., 2010; Zhao, et al., 2011), non-food product recalls (Freedman, et al., 2009), and animal disease outbreaks such as Bovine Spongiform Encephalopathy (BSE) and avian influenza (Burton and Young, 1996; Park, et al., 2008).

The spillover effect can occur in multi-aspects. Freedman, et al. (2012) explored the spillover effect in toy industry due to the 276 toy recalls issued in 2007. These recalls involved many big companies and a wide variety of popular brands. Their study included comparison of the recalled products and non-recalled products produced by the same manufacturers as well as the recalled products to non-recalled manufacturers of similar

products. Their study offers the following findings. First, the recall reduced the sales of the recalled products but did not affect sales of dissimilar products produced by the same manufacturer. Second, manufacturers who did not experience any recalls also suffered from large industry-wide spillovers in the form of sales losses. These negative effects are obvious in decreasing sales from other manufacturers not involved in the toy recalls (Freedman, Kearney, and Lederman, 2010). Thus, marketing strategies and communication to the public is critical to the crisis brands and non-crisis brands during and after the crisis when consumers have not make up their minds about which brand to switch to yet (Ma, et al., 2010).

The spillover effect varies by time and duration. In general, it is found to be more significant in the short run (Marsh, et al., 2004; Van Heerde, et al., 2007). In a recent study, Zhao, et al. (2011) extend the consumer learning model by assuming that consumers can update their beliefs about product quality according to information that is incongruent with their prior beliefs such as a product harm crisis. This is contrary to the traditional assumptions that the uncertainty in consumers' beliefs decrease as more information is gathered (Zhao, et al., 2011). Differing from standard learning model, Zhao, et al. (2011) model customers' beliefs towards the brand and the information dynamically so that consumers are Bayesian decision makers. Using the scanner panel data for the product harm crisis of Kraft Foods Australia's peanut butter in 1996, they find that the spillover effects between brands last shortly and differ across brands (Zhao, et al., 2011). Thus, marketing strategies and communication to the public are critical to the crisis brands and non-crisis brands during and after the crisis when consumers have not made their decision about the switch (Ma, et al., 2010). Zhao, et al. (2011) suggest that coping strategies should differ for strong and weak brands – the strong brand, like Kraft, should focus on ways to raise short-

term stimulating sales with marketing tactics to increase consumer, explore and restore consumer trust on the reintroduced brand, while the weak brand should concentrate their resources on increasing the quality profile among consumers (Zhao, et al., 2011).

Several other studies also investigate the peanut butter recalls. Using the weekly Nielsen Homescan data, Bakhtavoryan, et al. (2012) employ the distributed lag model to examine own- and cross-price elasticities and expenditure elasticities for leading peanut butter brands before and after the product recall. They compared market shares and customer preferences across brand. Lag of three weeks was identified as optimum for the model Bakhtavoryan, et al. (2012). AIC, BIC, and HQC[2] were the criterion to insure that n=3 could provide the most accurate and similar results as the real world (Bakhtavoryan, Salin, and Capps Jr, 2011). They find that (a) the infected brand (Peter Pan) recovered from the food recall crisis; and (b) significant changes in cross-price elasticities are found between the pre- and post-recall periods, which suggest the spillover effect resulting from the recall changed the market structure of peanut butter.

Our study differs from Bakhtavoryan, et al. (2012) as the follows. First, Bakhtavoryan, et al. (2012) focus on weekly aggregate sales, whereas we use individual scanner data along with their socio-demographic characteristics and product attributes to examine changes of brand preferences among individual consumers; Second, the literature has shown the spillover effects are likely to be more significant in the short-run and could be short-lived (Marsh, et al., 2004; Van Heerde, et al., 2007; Zhao, et al., 2011). Thus, it is also important to examine the changes occurred in the recall period, which is ignored in Bakhtavoryan, et al. (2012) and is addressed in this study. Third, different from our study, the nature of weekly aggregate

[2] AIC: Akaike Information Criteria; BIC: Bayesian Information Criteria; HQC: Hannan-Quinn Information Criteria

sales data shows that the computed produce price, that is the total expenditure divided by total ounces in each week, is not the actual price that customers paid for. Some other studies focus on the 2009 peanut recall by Peanut Corporation of America (PCA). For example, Vickner (2012) employs hedonic pricing modeling to analyze sales of homogenized peanut butter with weekly scanner data from Nielsen. He finds that the marginal values of several product attributes such as being homogenized, organic or natural increased, but the marginal value for private labeling decreased in the post-recall period.

The conclusion of enhancing demand after recall event is also confirmed by Wittenberger and Dohlman 2010, who performed the study on 2009 recall in processed peanut market caused by a small company named PCA. In 2009 not only PCA lost the game through cost cutting but also there were huge spillover effects in companies who used products from PCA, such as ConAgra Foods (Wittenberger, K and Dohlman, E, 2010), as they believes the food safety event and brankcrupcy of PCA are due to business ethics. Still other companies like ConAgra Foods also suffered huge loss from this event (Roman and Moore, 2012).

CHAPTER 4: METHODOLOGY

4.1 Discrete Choice Model

The logit family of models is recognized as the essential toolkit for analyzing discrete choices (Hensher and Greene, 2002). Within this family of models, the mixed logit model (also known as a random coefficient or parameter model) is capable of capturing the heterogeneity in individual brand. As such, a mixed logit model, which is capable of deriving the individual-specific preferences for brand preferences, is employed. We also perform the analysis using conditional logit model for comparison.

The starting point for logit analysis is the random utility model (RUM). Under this model, the sampled individuals are assumed to have considered the full set of brand choices and choose the alternative that provided the highest utility level. Let *t* denote the choice set[3], *i* represent individual consumer, and *j* indicate brand alternatives of peanut butters. Let $X_{ijt} = \left[Z_{ijt}, w_{it} \right]$ be a vector such that Z_{ijt} is a vector representing product attributes including brand preference that vary by brand alternatives and individuals and w_{it} represent individual characteristics that vary across individuals but stay constant for all brand alternatives to the same individual. The linear RUM for individual i choosing brand *j* in a choice scenario t has the following form (Greene and Zhang, 2003):

$$(1) \qquad U_{ijt}(Z_{ijg}, w_{ijt}) = X_{ijt}^{'}\beta + \varepsilon_{ijt} = Z_{ijt}^{'}\delta + w_{it}^{'}\gamma + \varepsilon_{ijt}$$

where $\beta = \left[\delta, \gamma \right]$ is a vector of individual-specific coefficients to be estimated and ε_{ijt} is the error term or random component that captures unobserved factors that may affect choices. RUM seeks for utility maximization such that decision maker i will choose brand m over n

[3] In the mixed logit model for our study, the choice set is comprised of five choices: Nbrand1, Nbrand2, Nbrand 3, Store Brand and Peter Pan.

in the choice scenario t (Train, 2009), if and only if

$$U_{imt}(x_{imt}, w_{imt}) > U_{\text{int}}(x_{\text{int}}, w_{\text{int}}) \quad (2)$$

Assumptions regarding the distribution of the disturbance term and whether the coefficients are fixed or varying across individuals in the RUM model lead to diverse models. For instance, conditional logit model containing fixed effects only and the mixed logit (MLOGIT) model allowing for random coefficients varying by individual decision maker. Since the objective of our study is to evaluate the brand preference among consumers and how they change by period, we employ the MLOGIT model allowing heterogeneity of brand preferences among consumers.

Each consumer makes multiple purchase choices of peanut butter. Let $y_i = \{y_{i1}, \ldots, y_{ik}\}$ be a vector denoting the sequence of brand choices made by individual *i*. Conditional on β_i the probability of decision-maker *i* choosing alternative brand *j* under choice set *t* is a logit formula:

$$L_{ijt}(y_{it} \mid \boldsymbol{\beta}_i) = \frac{e^{\beta_{ij} X_{ijt}}}{\sum_j e^{\beta_{ij} X_{ijt}}}. \quad (2)$$

Because the error term is assumed to be independent over choice sets, the probability of decision-maker who makes the sequence of choices in the entire choice occasions is the product of logit formulas given in equation (2):

$$P_i(y_i \mid X_i, \beta_i) = L_{i1}(y_{i1} \mid \beta_i) \cdot L_{i2}(y_{i2} \mid \beta_i) \cdots L_{i6}(y_{ik} \mid \beta_i). \quad (3)$$

Individual brand preferences are private information. Researchers may observe the population distribution of β_i up to population parameters, θ, denoted by $f(\beta \mid \theta)$. The unconditional probability of individual *i* chooses a sequence of brand alternatives in the

entire choice occasions that is denoted by y_i is the integral of $P_i(y_i \mid X_i, \beta_i)$ over all the possible values of β_i :

(4) $$P(y_i \mid X_i, \theta) = \int P(y_i \mid X_i, \beta_i) f(\beta \mid \theta) d\beta .$$

Because the integral in equation (4) does not have a closed form, a simulated maximum likelihood approach is employed to estimate the associated population parameters of the population distribution of β.

The question arises is where in the population distribution does a particular individual reside, given his / her choices. Train (2003) provides details on estimating the individual-level parameters. Application of this estimator is emerging in the literature (Hensher, Greene, and Rose 2006; Kamakura and Wedel 2004; Revelt and Train 2000). Let $h(\beta \mid y_i, X_i, \theta)$ denote the distribution of β for the subpopulation of people who would choose the sequences of choices y when facing a series of choice situation described by X. Using Bayes' rule, one obtains

(5) $$h(\beta \mid y_i, X_i, \theta) \times P(y_i \mid X_i, \theta) = P(y_i \mid X_i, \beta) \times f(\beta \mid \theta) .$$

Rearranging equation (5) yields

(6) $$h(\beta \mid y_i, X_i, \theta) = \frac{P(y_i \mid X_i, \beta) \times f(\beta \mid \theta)}{P(y_i \mid X_i, \theta)},$$

where $P(y_i \mid X_i, \beta) \times f(\beta \mid \theta)$ is the product of the probability of y_i conditional on β and the probability of β, and $P(y_i \mid X_i, \theta)$ is the probability of y_i Train (2003, p. 206-267). Both the denominator and nominator of equation (6) based on the choice data and the estimated parameters of the population distribution can be calculated Train (2003, p. 206-267). Based

on equation (6) the mean β of the subpopulation of people who would choose y_i, denoted by $\bar{\beta}(y_i)$, when facing X_i can be derived using the formula below:

(7) $$\bar{\beta}(y_i) = \int h(\beta \mid y_i, X_i, \theta)\beta \, d\beta .$$

The integral in equation (7) does not have a closed form, but can be readily simulated. Details of the procedure are given in Train (2003, p. 206-267).

4.2 Model Specification for Conditional Logit Model

Both multinomial logit and conditional logit models are suitable for the situation when an individual chooses among multiple choices (Hoffman and Duncan, 1988). However they have very distinct differences in both economic explanation and model specification.

Multinomial logit model answers the question of how do household characteristics affect their choice of the five brands of peanut butter products. It focuses more on individual and how his/her characteristics would affect the choice (Hoffman and Duncan, 1988). Conditional logit model answers how households make their choices based on alternatives which are brand dummies in our study (Hoffman and Duncan, 1988). It put more emphasize on product attributes. In conditional logit model, brand dummies no longer function as individual making purchasing choices, instead they are representing the attributes of products, which are treated as fixed effects (Hoffman and Duncan, 1988).

On the other hand, mixed logit model is the combination of multinomial logit and conditional logit models, having the advantage of investigating both household characteristics as well as product attributes (Hoffman and Duncan, 1988). Conditional logit model is specified as (Davies, Greenwood and Li, 2001),

$$U_{ij} = \beta' X_{ij} + \varepsilon_{ij}$$

where X_{ij} represents the vector of characteristics of j^{th} alternative for household i (Davies, Greenwood and Li, 2001). Accordingly the probability of individual i choosing product j follows the rule of utility maximization which shown as below (Davies, Greenwood and Li, 2001)„

$$P_{ij} = P(U_{ij} > U_{ik}), \quad \forall k \neq j$$

Thus it has the following specification (Davies, Greenwood and Li, 2001)„

$$P_{ij} = \exp(\beta' X_{ij}) \Big/ \sum_{k=1}^{J} \exp(\beta' X_{ik}).$$

4.3 Model Specification for Mixed Logit Model

The dependent variable is an index variable indicating whether a specific brand is chosen. Except brand preferences, we assume that individual demographic characteristics and product attributes have fixed coefficients. Product price is a factor that consumers would response negatively and we assume it has a fixed effect. Brand preferences are assume to have a random coefficient that follows an independent normal distribution with mean and standard deviation to be estimated. Based on the above assumptions, the willingness to pay (WTP) for each brand preference will have the same type of the distribution as assumed for the coefficient of brand preferences (Train, 2003).

We also assume each household would choose one brand from a set of alternatives at each shopping scenario. There is no 'no-purchase' in our choice set. The choice set is comprised of five brands: NBrand1, NBrand2, NBrand3, PBrand and Peter Pan, among which first three are national brands and PBrand is a composition of store brands. The indirect utility of individual *i* receives from choosing brand *j* at choice scenario *t* that was expressed in equation (1) can be rewritten as below:

(8) $$u_{ijt} = \sum_{j,k} \xi_{ijk} + z'_{jt}\delta_i z_{jt} - \alpha p_{jt} + \gamma'_{ijt} w_{jt} + \varepsilon_{ijt},, \text{ where } j = 1, \ldots, 5$$

where ξ_{ijk}'s are the interactive terms of five brand dummies (j = 1, 2, 3, 4, 5) and three period dummies (k =0, 1, 2) including pre-recall, during-recall and post-recall periods. ξ_{ijk}'s indicate individual i's preference for brand j during period k, which are assumed to follow independent random normal distributions. z_{jt} is a vector of product attributes indicating whether a product is been homogenized, organic, creamy, and featured in the store and whether a product is packed in a single package and in a bottle container. Product price that each individual faces for brand j in scenario t is represented by p_{jt}. Since the literature has shown significant habit formation in food consumption (Zhen, et al., 2011), we derive a variable capturing the information of the quantity of national brands purchased in the past year for each household.

4.4 Estimating Brand Preferences and WTP for Brands

We denote the estimated coefficient associated with product price by $\hat{\alpha}_j$ and the estimated mean parameter for brand preference by ξ_{jk}. The WTP for each brand j in the period k, which follows a normal distribution as well, can be derived as

(9) $$WTP_{jk} = -\frac{\hat{\xi}_{jk}}{\hat{\alpha}_j}$$

Equation (9) suggests how much an individual is willing to pay as extra to the baseline price for a certain brand in a specific period given his/her characteristics, product attributes, purchase habits and product prices. Assuming that the estimated standard deviation parameter of ξ_{ijt} is denoted by $\hat{\sigma}_{jt}$, the standard deviation of WTP_{jk} is:

(10) $$\sigma_{WTP_{jk}} = \frac{\hat{\sigma}_{jt}}{\hat{\alpha}_j}$$

The percent of consumers who have a positive WTP for brand j at period *k*, $Perc_{jk}$, can be defined as:

(11) $$Perc_{jk} = \left(1 - \phi\left(WTP_{jk} < 0\right)\right) \times 100 = \left(1 - \phi\left(-\frac{\bar{\xi}_{jk}}{\hat{\alpha}_j}\right)\right) \times 100$$

where $\phi(\cdot)$ represents the normal cumulative distribution function.

An individual is predicted to buy brand j if the predicted probability is higher than all the other alternatives. We then calculate the predicted market share for each brand. The comparisons of WTP_{jk} and $Perc_{jk}$ as well as the predicted market share between different periods and brands will help us to estimate changes in brand preferences and market share for infected and uninfected products due to the recall as well as gauge the change of the peanut butter market and the event impacts between strong and weak brands.

CHAPTER 5: DATA

5.1 Nielsen Homescan Data

We use the Nielsen Homescan data for the empirical analysis. The Nielsen Homescan data provide rich information about household food purchases, covering a wide variety of retailers and national coverage of households (see additional details at Einav, et al. 2008)). For this study, we use the individual peanut purchase data from July 1st, 2006 till March 31st, 2008. The sample household made at least one purchase of peanut butter during the study period. We divide the study into three periods: the pre-recall period consisting of approximately seven months from July 1st, 2006 till February 13th, 2007; during recall period ranging from February 14th when the first FDA recall was issued and Peter Pan was removed from the store shelves immediately, till August 31st, 2007; and the post-recall period from September 1st, 2007 when Peter Pan peanut butter was reintroduced to the market to March 31st, 2008 that was approximately seven months after the recall ended.

We group peanut butter products into five brands, including four national brands (NBrand1, NBrand2, and NBrand3, and Peter Pan), one for all private labels (PBrand). [4] As shown in Table 1, national brands including Peter Pan accounts for more than 2/3 of the market share. All three national brands (NBrand1-3) and the aggregate store brands gained significant market share during the recall period – approximately 17-20% for the national brands and 17% for the store brands. Peter Pan tripled its market share in the post-recall period compared with that in the recall period, but its share was still 6% less than the pre-recall period. On the other hand, all three national brands and store brands were losing their gained market share in the post-recall period. The share for NBrand1 and NBrand2 were still

[4] Retailer-specific private label brands are aggregated and other brands are masked, per agreement with Nielsen regarding the use of their Homescan data for this study.

higher than its pre-call level, while the share for NBrand3 and store brands were lower by approximately 2% and 1%, respectively. The results suggests that both national brands and store brands benefit from the recall most at similar percentage change, but the gain in market share by strong national brands last longer and store brands lost its gain in the post-recall period.

Table 1 also shows the number of unique household who purchases peanut butter of national or store brands in the three periods. The summary statistics show more than 2/3 of unique households purchase national brands in each of three periods. The recall reduced the number of unique households who purchase Peter Pan, but increased that for national brands and store brands. However, Peter Pan recovered in the post-recall period measured by the total number of unique purchasing households. The gain in the number of unique households lasted in the post-recall period for NBrand1, NBrand3, but not for NBrand2 and store brands. Compared with the pre-recall periods, the average quantity purchased by unique households is slightly lower in the recall period (31.60 vs. 31.95 ounces), which suggests that some consumer may reduce their purchase due to the recall.

The price of peanut butter is the total net expenditure, which is total expenditure subtracted by redeemed store and manufacturer coupons, by total quantity in ounce. Prices are also deflated by the consumer price index (CPI) reported by the Bureau of Labor Statistics of the US Department of Labor. As shown in Table 1, national brands had a higher price on average than store brands; and NBrand3 had the highest price on average. The recall did not change the average prices for all brands and no price cut was observed in the post-recall period.

Table 1: Market Share and Price of Peanut Butter by Brands and Event Periods

	Pre-recall	Recall	Post-recall
Market Share (%)			
	Pre-recall	Recall	Post-recall
National brands including Peter Pan	71.67	66.72	71.88
Store Brands	28.33	33.28	28.12
Change of the market shares (%)			
	During - Pre	Post-During	Post – Pre[5]
NBrand1	19.99	-14.55	2.53
NBrand2	17.65	-12.41	3.05
NBrand3	17.86	-16.92	-2.08
PBrand	17.47	-15.50	-0.74
Peter Pan	-78.76	344.55	-5.57
Number of Unique Household Purchased Peanut Butter			
National brands excluding Peter Pan	42,382	61,955	64,228
Store brands	23,059	34,772	33,342
Change in Number of Unique Household Purchased Peanut Butter (%)			
	During - Pre	Post-During	Post – Pre
NBrand1	39.66	7.19	49.70
NBrand2	58.24	-1.79	55.41
NBrand3	42.06	4.16	47.97
PBrand	50.80	-4.11	44.59
Peter Pan	-95.55	2840.25	30.85
Product Price ($/ounce)			
NBrand1	0.10	0.10	0.11
NBrand2	0.10	0.10	0.11
NBrand3	0.15	0.16	0.16
PBrand	0.08	0.08	0.09

[5] During – Pre is the difference of market share of during period and pre-recall period; Post – During is the difference of market share of post-recall period and during period; Post – Pre is the difference of market share of post-recall period and pre-recall period.

Overall, Table 1 suggests that during the recall, brands that were not infected gained in market shares regardless of whether they were national brands or store brands. However, the spillover effects across brands were short-lived. The market share and the number of unique households purchase of peanut butter in the post-recall period went back to the similar level as that in the pre-recall period.

5.2 Data of Product Attributes

The Nielsen Homescan data provide the following product attributes of peanut butter: whether the product is homogenized or not, the type of container (box, glass, or squeeze bottle), number of items in multipack, whether a product is featured in the store, product style (creamy, chunky, or glazed), and whether it is identified as organic by USDA or not. Based on the distribution of these product attributes, we create dummy variables indicating a product is not been homogenized (*Formula*), organic (*Organic*), creamy (*Creamy*), featured in the store (*Feature*), and packed in a single package (*Single-package*) and in a bottle container (*Bottle*). As shown in Table 2, the product attributes are similar across brands. The percentages of products that were homogenized, creamy, and certified by USDA as organic were, respectively, 85%, 80%, and 90%. More than 90% were single-packed and less than 2/3 were packed in bottle. More than 2/3 were featured in the store. Variables for the product attributes are incorporated as independent variables with a fixed coefficient.

One challenge in compiling product attribute data is that the information might be incomplete in original data set, and it is even possible the store did not carry all the brands we need to compare. In this case, we mimic all product attributes either from the available scanned data by the same location and time, or, if not, we will use product attributes from other stores in the same area or nearby (if still unavailable) to proxy product attributes for

this particular brand in this particular store. For instance, if we have an individual household bought Peter Pan at store 1 on May 1st, 2006, then we will search the product attributes of other five brands at store 1 or nearby on that day and fill out the choice set. This data imputation process is long and has to be as accurate as possible.

We also incorporate interactive terms between brand dummies and three dummy variables indicating the pre-, during- and post-recall periods in the model as independent variables with a random coefficient. The coefficients of these interactive terms will help us estimate the changes of brand preferences due to the product recall.

Table 2: Product Attributes by Brand (%)

	NBrand1	NBrand2	NBrand3	Peter Pan	PBrand	Total
Formula: non- homogenized	85.13	85.75	84.66	84.92	85.26	85.26
Style: Creamy	78.82	75.33	79.36	78.72	78.19	77.91
USDA Organic	87.49	91.13	90.21	91.19	91.93	90.13
Single pack	94.87	95.90	97.18	98.26	98.49	96.66
Store feature	78.24	76.35	76.80	77.38	78.34	77.74
Container -- Bottle	61.43	60.61	62.27	60.94	61.63	61.18

5.3 Data of Household Characteristics

The household characteristics consist of age, race, education, employment status, education level, marital status, household size, household income, type of residence, presence of children. The panelists choose the interval that closely reflects their age and income. Based on their choices, we estimate the empirical probability density function of the underlying age or income using the maximum entropy density method. Take income as an example following the methodology proposed by Wu and Perloff (2007), we use a flexible functional form that nests many commonly used distributions,

(12) $$f\left(S_{it}^{*}\right)=\exp\left(-\sum_{m=0}^{M}\lambda_{m}\left(S_{it}^{*}\right)^{m}\right),$$

where S_{it}^{*} is the underlying income of panelist *i* in year *t* that is unobservable to researchers, $\lambda_m's$ are parameters to be estimated, and $m=0,1,...,M$ are polynomial orders. We then estimate the interval mean of income based on the empirical probability density function and incorporate the interval mean of income for each individual based on his/her choice of income interval. Therefore, instead of discrete income interval, we assume the income variable is a continue variable, so is the age variable. As shown in Table 3, on average, male and female house head aged 44 and 49, respectively, and the average annual household income was approximately $60,000.

The other variables for individual characteristics consisting whether a household having no more than three family members; single family household, marital status, female household head being employed, male household being employed, being a non-Hispanic white, having at least one child, and completing at least high school education for both male and female heads. As shown in Table 3, over half of male household heads were employed while approximate 52% for females, more than half were married, more than 2/3 of households were single family households, majority of panelists were non-Hispanic white, more than 2/3 of households had three or fewer members, less than 1/3 had children aged 18 and younger, and more than 2/3 had at least high-school education.

The RUM says that an individual consumer will choose brand *j* if it gives the highest utility among all alternatives. Thus, simply incorporating individual characteristics that are invariant by brand alternatives for the same individual will affect the choice. We interact household characteristics with a dummy variable indicating a national brand. The

coefficients of individual characteristics will show how much each type of characteristics contribute to the choice of a product of national brands.

Table 3: Household Characteristics

	Pre-recall	Recall	Post-recall	Total
Age – male household head	44.62	44.76	44.71	44.70
Age – female household head	50.34	48.49	49.53	49.39
Income	57,874.59	59,557.96	59,838.39	59,162.42
Employment status # (%)				
Male household head				
Employed	43,572 (55.70)	59,194 (60.84)	53,923 (58.55)	156,689 (58.55)
Unemployed	34,655 (44.30)	38,102 (39.16)	38,180 (41.45)	110,937 (41.45)
Female household head				
Employed	40,712 (52.04)	51,474 (52.90)	49,042 (53.25)	141,228 (52.77)
Unemployed	37,515 (47.96)	45,822 (47.10)	43,061 (46.75)	126,398 (47.23)
Type of residence # (%)				
Single family	64,658 (82.65)	79,851 (82.07)	76,041 (82.56)	220,550 (82.41)
More than one family	13,569 (17.35)	17,445 (17.93)	16,062 (17.44)	47,076 (17.59)
Race # (%)				
Non-Hispanic white	68,410 (87.45)	86,052 (88.44)	81,147 (88.10)	235,609 (88.04)
Non-Hispanic black	4,108 (5.25)	4,439 (4.56)	4,614 (5.01)	13,161 (4.92)
Hispanic	3,421 (4.37)	3,914 (4.02)	3,639 (3.95)	10,974 (4.10)
Non-Hispanic others	2,288 (2.92)	2,891 (2.97)	2,703 (2.93)	7,882 (2.95)
Marital status # (%)				
Married	54,490 (69.66)	70,587 (72.55)	65,638 (71.27)	190,715 (71.26)
Not Married	23,737 (30.34)	26,709 (27.45)	26,465 (28.73)	76,911 (28.74)
Household size # (%)				
3 family members or fewer	58,790 (75.15)	69,923 (71.87)	68,551 (74.43)	197,264 (73.71)
4 family members or more	19,437 (24.85)	27,373 (28.13)	23,552 (25.57)	70,362 (26.29)
Presence of Children # (%)				
Have kids	22,998 (29.40)	33,266 (34.19)	28,809 (31.28)	85,073 (31.79)
No kid	55,229 (70.60)	64,030 (65.81)	63,294 (68.72)	182,553 (68.21)
Education level # (%)				
Female household head				
Below High School	8,207 (10.49)	9,578 (9.84)	8,949 (9.72)	26,734 (9.99)
Accomplish High School	70,020 (89.51)	87,718 (90.16)	83,154 (90.28)	240,892 (90.01)
Male household head				
Below High School	19,358 (24,75)	20,743 (21.32)	21,064 (22.87)	61,165 (22.85)
Accomplish High School	58,869 (75.25)	76,553 (78.68)	71,039 (77.13)	206,461 (77.15)

CHAPTER 6: ESTIMATION RESULTS

We choose Nbrand2 as a base for both the conditional and mixed logit models as this brand had the smallest change in the market share (see Table 1). Estimation results for the mixed logit model are provided in Table 4. The estimated standard deviations of the coefficients for the interactive terms between brand and period dummies are significant at the 1% significance level. Statistical significance of the estimated standard deviations of these coefficients implies respondents have different brand preferences, which suggests that the mixed logit model is an appropriate model as it is able to model the individual-specific preferences.

6.1 Estimation Results of Brand Preferences

6.1.1 Conditional Logit Model

Based on the conditional logit estimation, for each brand in each period, we compute the willingness to pay relative to Nbrand2, which is summarized in Table 4.1.

During the pre-recall period, compared with a national brand product (Nbrand2), average households were willing to pay $0.1147 more per ounce for Nbrand1. However households are less willing to pay for other national brands (Nbrand3 and Peter Pan) as well as store brand (Pbrand).

In the recall period, relative to Nbrand2, the WTP for recalled brand (Peter Pan) had a significant drop (-$0.0313 versus -$0.8867). Nbrand3 and private brand also experienced downturn in WTP. Nbrand3 dropped slightly from -$0.3299 to -$0.3568, while private brand declines from -$0.0736 to -$0.1147. Still Nbrand1 had the highest WTP among the five brands though it also decreased from $0.1147 to $0.0804, which means on average households were willing to pay $0.0804 more per ounce for Nbrand1.

In the post recall period, compared with Nbrand2, the recalled brand (Peter Pan) had a significant recovery to -$0.1330 indicating the gap of the WTP between Peter Pan and Nbrand2 was narrowed by 4/5. The WTP for Nbrand1 had recovered from $0.0804 to $0.0975, which is still at a lower level than that in pre-call period, which is $0.1147. Nbrand3 experienced a slightly drop to -$0.3620 compared with that in the recall period. Private brand lost a considerable amount of WTP to -$0.1712.

In sum, for national brands, relative to Nbrand2, strong brands Nbrand 1 and Peter Pan regained some WTP to a level lower than pre-recall periods. Nbrand3 still suffered from WTP loss and even lost more in the post period. Store brand has a more severe situation than Nbrand3 since the difference of Pbrand and Nbrand2 was broadened by over 50% compared within the recall period.

Table 4: Estimated Preferences and Willingness to Pay for Brand Preference (Base: NBrand2) Conditional Logit Model

	Pop. mean premium (std. dev.)
NBrand1 X pre-recall	0.1147
NBrand2 X pre-recall	--
NBrand3 X pre-recall	-0.3299
PBrand X pre-recall	-0.0736
PeterPan X pre-recall	-0.0313
NBrand1 X during recall	0.0804
NBrand2 X during recall	--
NBrand3 X during recall	-0.3568
PBrand X during recall	-0.1155
PeterPan X during recall	-0.8867
NBrand1 X post-recall	0.0975
NBrand2 X post-recall	--
NBrand3 X post-recall	-0.3620
PBrand X post-recall	-0.1712

PeterPan X post-recall	-0.1330

[a] "Positive Predicted" indicates the share of consumers who have a non-negative WTP for the particular brand relative to the base brand (NBrand2).

6.1.2 Mixed Logit Model

Based on the mixed logit estimation, for each brand in each period, we calculate the WTP and percent of households who have a positive WTP relative to the base (Nbrand2) as well as the predicted percent of households who have the highest WTP. We summarize the results in Table 4.2. We also calculate the predicted market shares for each brand and present the statistics in Table 5. [6]

In the pre-recall period, compared with a national brand product (Nbrand2), average households were willing to pay $0.0137 more per ounce for Nbrand1 and more than half of households had a positive WTP for Nbrand1. Yet, households were less willing to pay for other national brands (Nbrand3 and Peter Pan) as well as the store brand (Pbrand). Relative to Nbrand2, approximately one third of household had a positive WTP for Peter Pan (33%), followed by store brands (PBrand, 29%), and the least for NBrand3 (14%). Figure 1(a) illustrates the WTP for different brands relative to the WTP for Nbrand2 in the pre-call period. The predicted market shares in the pre-recall period are close to the actual market share for each brand -- the overall market share for the national brands is 83.65% compared with the actual market share of 71.67%. The discrepancy is mainly because of the difference in the predicted market share for NBrand2.

In the recall period, Figure 1(b) shows that the brand preference for Peter Pan had the limited variance as the majority of households were less likely to buy Peter Pan, but the

[6] The discussion on the market share in the estimation results refers to the predicted market shares based on the mixed logit estimation.

preference for other brands exhibited a higher degree of variance, especially for national brands, which suggests a high degree of purchase uncertainty among households during the recall period. Relative to Nbrand2, the WTP for the recall product, Peter Pan, had a significant drop (-$0.31 vs. -$0.71); almost no one had a positive WTP for Peter Pan compared with Nbrand2; and the WTP for Peter Pan ranked the lowest among all brands. The predicted market share for Peter Pan had plunged decreasing from almost 16% to less than 1%.

The recall of Peter Pan also changed competition of other brands. For example, households had a much higher WTP for Nbrand1 in the recall period than in the pre-recall period ($0.024 vs. $0.014) and slightly higher percentage of households having a positive WTP compared with Nbrand2 (51.60% vs. 50.80%). Compared with store brand products, the WTP for Nbrand2 was $0.248 in the recall period, which was lower than that in the pre-recall period. The competition between Nbrand2 and Nbrand3 did not change significantly between the pre-recall period and the during-recall period. The results suggest that Nbrand1 benefited from the recall most, followed by Nbrand2 and Nbrand3, and least by store brands.

In terms of market shares, Table 5 shows that while Peter Pan lost almost the entire market share, both national brands and store brands gain from the recall event. The strong national brand such as NBrand1 gained approximately eight percentage points that is equivalence to 25%, in its predicted market share. The predicted market share for each of the other two national brands (NBrand2 and NBrand3) increased by 10%. Store brands gained their predicted market share by almost 20% corresponding to a three percentage point increase. The change in the predicted market shares suggest differential spillover effects on unrecalled products -- strong national brands such as NBrand1 gained most and

weak brands such as store brands gained less measured by percentage points change in their predicted market share.

In the post recall period, Peter Pan had a significant recovery – the difference of the WTP for Peter Pan and Nbrand2 was narrowed by almost 2/3 and about a quarter of households had a positive WTP for Peter Pan relative to Nbrand2. The predicted market share of Peter Pan went by nine percentage points from less than 1% in the recall period. Yet, its predicted market share in the post-recall period was only half of the pre-recall level. On the other hand, store brands lost a considerable predicted market share – 7 percentage points corresponding to a 37% decrease compared with the recall period level. Whereas the predicted market shares for national brands did not change significantly in the post-recall period compared with the recall period. The predicted market share for both Nbrand1 and NBrand3 increased further in the post-recall period, while NBrand2 lost almost 3 percentage points in its predicted market share. Compared with the pre-event level, the gain in the predicted market share persisted in the post-recall periods for all three national brands, especially for the strong national brand such as NBrand1.

The results suggest that once the recalled product gained consumer in the post-recall period, weak brands (e.g., store brands) are more likely to lose their market shares they gained in the recall period, but strong national brands are able to maintain the gained market share.

Table 5: Estimated Preferences and Willingness to Pay for Brand Preference (Base: NBrand2) Mixed Logit Model

	Pop. mean premium (std. dev.)	Positive percent [a]	Predicted market share [b] (%)
NBrand1 X pre-recall	0.0137	50.80	33.13
NBrand2 X pre-recall	--	--	30.42
NBrand3 X pre-recall	-0.6764	13.57	4.37
PBrand X pre-recall	-0.2481	29.12	16.35
PeterPan X pre-recall	-0.3138	33.36	15.73
NBrand1 X during recall	0.0237	51.60	41.41
NBrand2 X during recall	--	--	33.55
NBrand3 X during recall	-0.6254	11.90	4.82
PBrand X during recall	-0.1468	27.09	19.57
PeterPan X during recall	-0.7120	0	0.65
NBrand1 X post-recall	-0.0180	48.80	42.48
NBrand2 X post-recall	--	--	30.58
NBrand3 X post-recall	-0.3109	1.25	4.86
PBrand X post-recall	-0.2373	24.20	12.27
PeterPan X post-recall	-0.2353	26.76	10.01

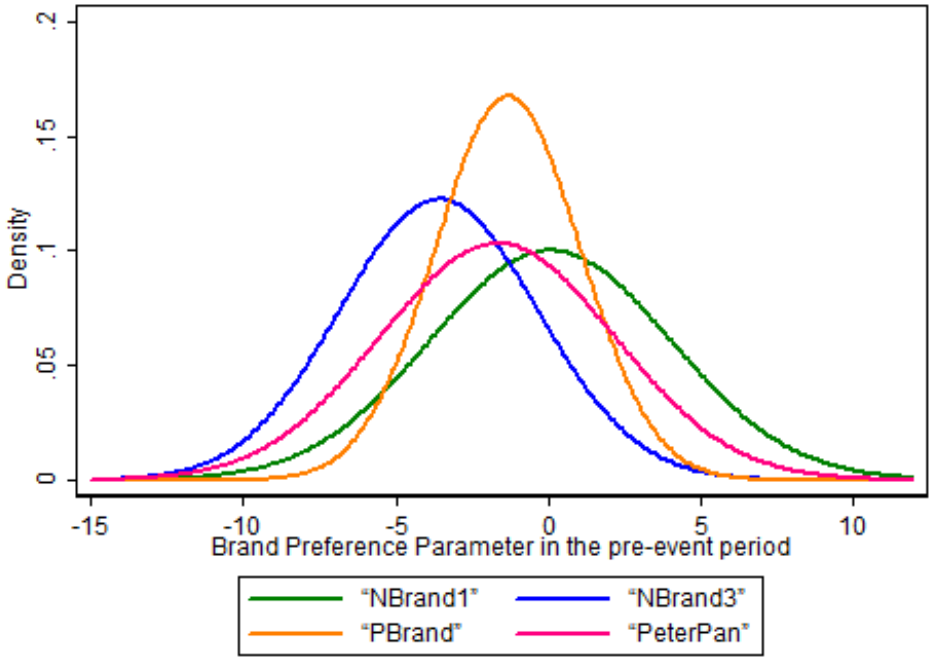
[a] "Positive Predicted" indicates the share of consumers who have a non-negative WTP for the particular brand relative to the base brand (NBrand2).

Table 6: Predicted Market Shares and the changes based on the Mixed Logit Model

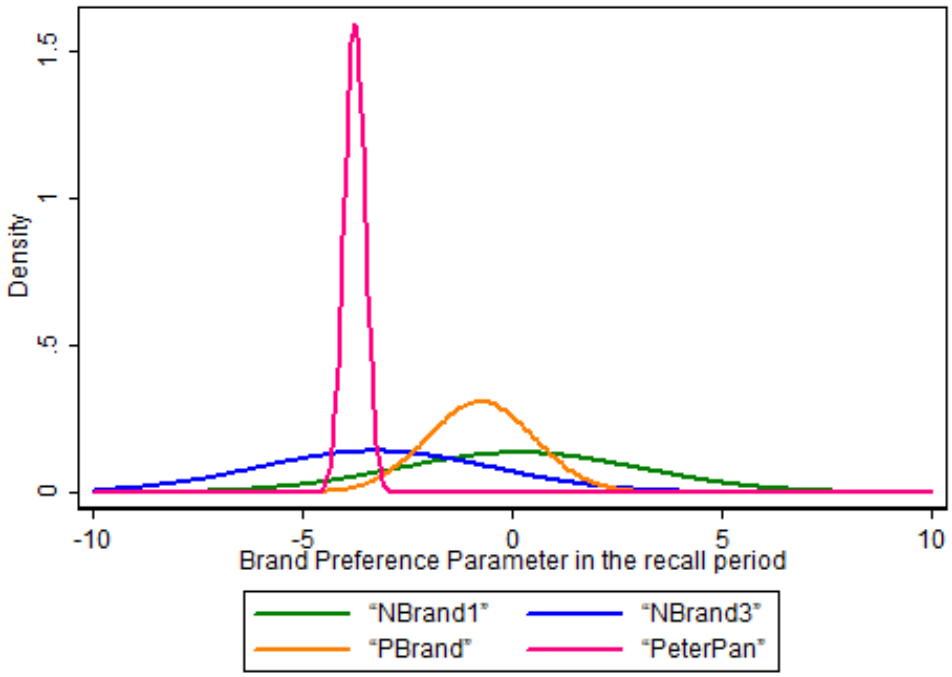
	Pre-recall	Recall	Post-recall
	Market Share (%)		
	Pre-recall	Recall	Post-recall
National brands including Peter Pan	83.65	80.43	87.93
Store Brands	16.35	19.57	12.27
	Change of the market shares (%)		
	During - Pre	Post-During	Post – Pre
NBrand1	24.99	2.58	22.01
NBrand2	10.29	-8.85	0.52
NBrand3	10.30	0.83	10.08
PBrand	19.69	-37.30	-33.25
Peter Pan	-95.87	1440.00	-57.14

Figure 1. Willingness to pay for different brands in same period

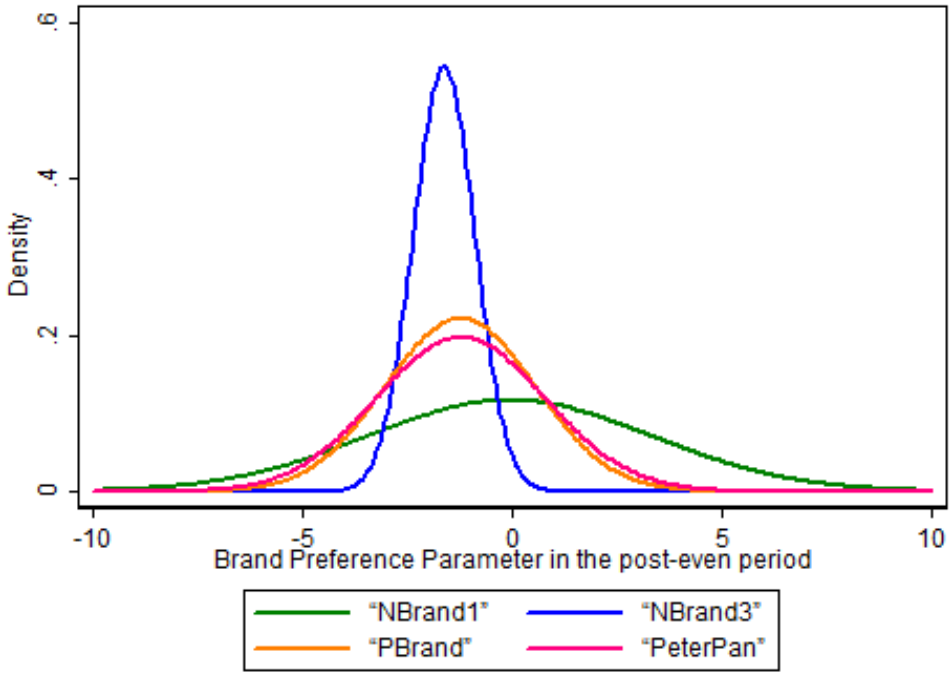
(a) Pre-recall period



(b) During recall period



(c) Post-recall period



6.2 Estimation Results on Product Attributes

6.2.1 Conditional Logit Model

Estimation results of the conditional logit model presented in Table 7.1 show that households are more likely to choose peanut butter products which are homogenized, non-creamy, organic, contained in bottle, featured in store as well as multi-package. Table 6.1 gives the willingness to pay in terms of product attributes, indicating that consumers are willing to pay $0.16 more per ounce for multiple packaged products. The WTP per ounce for other product attributes are $0.06 for being homogenized and organic, followed by $0.03 for being non-creamy style, $0.02 for being packaged in bottle and being store featured.

Table 7: Willingness to Pay for Product Attributes of the Conditional Logit Model

Product Attribute	WTP
FORMULAR	0.0617
STYLE	-0.0321
CONTAINER	0.0215
ORGANIC	0.0621
FEATURE	0.0168
MULTIPACK	-0.1567

6.2.2 Mixed Logit Model

Estimation results of the mixed logit model presented in Table 7.2 also show that households prefer peanut butter products that are homogenized, non-creamy and organic and those featured in the store and packaged in bottle and multi-package. As shown in Table 6.2, consumers are willing to pay $0.20 more per ounce for multi-package products and the

WTP doubles the average price of two national brands (1 and 2). The WTP per ounce for other product attributes are $0.10 for being homogenized, followed by $0.05 for being organic, $0.04 for being packaged in bottles, $0.04 for being non-creamy, and the lowest for being featured in the store ($0.02).

Table 8: Willingness to Pay for Product Attributes of Mixed Logit Model

Product Attribute	WTP
FORMULAR	0.0967
STYLE	-0.0409
CONTAINER	0.0443
ORGANIC	0.0481
FEATURE	0.0197
MULTIPACK	-0.2021

6.3 Estimation Results on Household Characteristics

6.3.1 Conditional Logit Model

Household characteristics are interacting with national brand dummies in the conditional logit model. Estimation results are shown in Table 7.1. It suggests that the following household characteristics significantly and positively contribute to choosing a national brand product: age of male household head, household income, household type showing number of families, marital status, the highest education attachment being at least high school for female household head, male household head being employed. On the other hand, relative to households with at most three family members, household with at least four members are less likely to buy national brand products. Relative to non-Hispanic white, households from other ethnicity are less inclined to purchase national brand products.

Table 9. Estimation Results of the Conditional Logit Model

Variable Name	Coefficient	Std. Deviation
NBrand1 X pre-recall	0.4803***	0.0109
NBrand3 X pre-recall	-1.3808***	0.0289
PBrand X pre-recall	-0.3081***	0.0483
PeterPan X pre-recall	-0.1310***	0.0128
NBrand1 X during recall	0.3365***	0.0089
NBrand3 X during recall	-1.4938***	0.0263
PBrand X during recall	-0.4833***	0.0475
PeterPan X during recall	-3.7118***	0.0430
NBrand1 X post-recall	0.4083***	0.0096
NBrand3 X post-recall	-1.5153***	0.0276
PBrand X post-recall	-0.7165***	0.0484
PeterPan X post-recall	-0.5568***	0.0125
Product Attributes		
FOMULAR	0.2584***	0.0198
STYLE	-0.1342***	0.0065
CONTAINER	0.0900***	0.0141
ORGANIC	0.2601***	0.0104
FEATURE	0.0705***	0.0087
MULTIPACK	-0.6558***	0.0201
PRICE	-4.1861***	0.0940
STORE BRAND	1.5737	7.3606
Household Characteristics X National Brand		
FEMALE AGE	0.0006	0.0007
MALE AGE	0.0023***	0.0006
INCOME	0.0303***	0.0021
SIZE	-0.0437*	0.0238
TYPE	0.0396**	0.0192
MARITAL STATUS	0.0936***	0.0293
FEMALE EDUCATION	0.1063***	0.0358

MALE EDUCATION	-0.0428	0.0319
FEMALE EMPLOYMENT	0.0029	0.0160
MALE EMPLOYMENT	0.0467**	0.0203
RACE 2	-0.1664***	0.0307
RACE 3	-0.2521***	0.0335
RACE 4	-0.2255***	0.0400
PRESENCE OF KIDS	0.0331	0.0235

Single, double, and triple asterisks (*, **, ***) represent the 10%, 5%, and 1% significance level.

6.3.2 Mixed Logit Model

We incorporate household characteristics interactive with national brands in the model. Estimation results of the mixed logit model presented in Table 7.2 suggest that the following household characteristics significantly, positively contribute to choosing a national brand product: age of male household head, household income, the highest education attainment being at least high school for female household head, male household head being employed, and the presence of children aged 18 and younger. On the other hand, relative to households with at most three members, households with at least four members are less likely to buy national brand products. Relative to non-Hispanic white, households from other ethnicity background are less likely to purchase national brand products.

Table 10. **Estimation Results of the Mixed Logit Model**

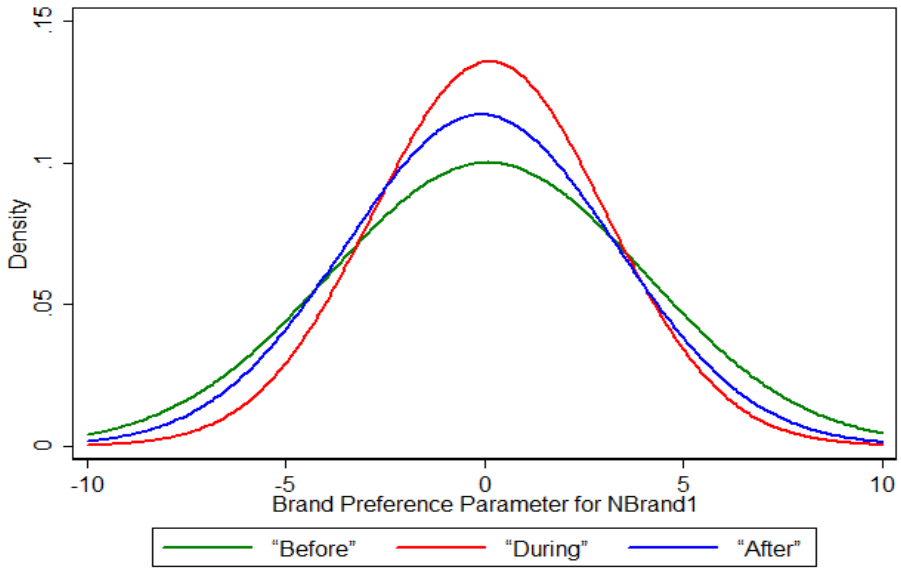
Variable Name	Mean of the Coefficient	Std. Deviation of the Coefficient
Random Effect		
NBrand1 X pre-recall	0.0726**	3.9818***
NBrand3 X pre-recall	-3.5851***	3.2553***
PBrand X pre-recall	-1.3147***	2.3826***
PeterPan X pre-recall	-1.6629***	3.8640***

NBrand1 X during recall	0.1256***	2.9337***
NBrand3 X during recall	-3.3148***	2.8162***
PBrand X during recall	-0.7782***	1.2847***
PeterPan X during recall	-3.7735***	0.2495***
NBrand1 X post-recall	-0.0953***	3.4047***
NBrand3 X post-recall	-1.6477***	0.7344***
PBrand X post-recall	-1.2579***	1.7966***
PeterPan X post-recall	-1.2470***	2.0193***
Variables with a fixed coefficient		
Product Attributes	Coef.	Standard deviation
FOMULAR	0.5125***	0.0305
STYLE	-0.2170***	0.0121
CONTAINER	0.2346***	0.0243
ORGANIC	0.2551***	0.0173
FEATURE	0.1042***	0.0160
MULTIPACK	-1.0711***	0.0394
PRICE	-5.3000***	0.1594
STORE BRAND	2.6742	9.2001
Household Characteristics X National Brand		
FEMALE AGE	0.0010	0.0011
MALE AGE	0.0036***	0.0011
INCOME	0.0478***	0.0033
SIZE	-0.1807***	0.0408
TYPE	0.0025	0.0329
MARITAL STATUS	0.0703	0.0487
FEMALE EDUCATION	0.1820***	0.0608
MALE EDUCATION	-0.0289	0.0556
FEMALE EMPLOYMENT	-0.0283	0.0273
MALE EMPLOYMENT	0.0811**	0.0346
RACE 2	-0.2666***	0.0522
RACE 3	-0.2256***	0.0557
RACE 4	-0.1492**	0.0662
PRESENCE OF KIDS	0.0925**	0.0402

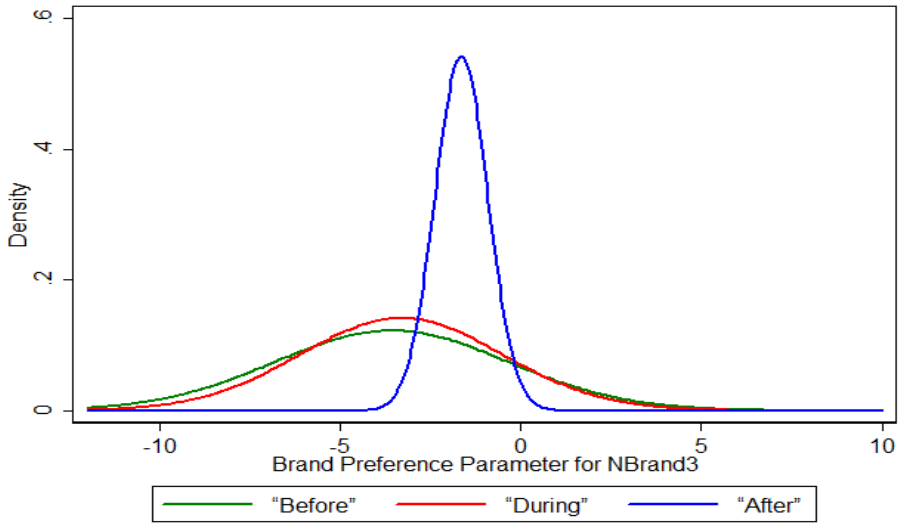
Single, double, and triple asterisks (*, **, ***) represent the 10%, 5%, and 1% significance level.

Figure 2. Willingness to pay for the same brand in different periods

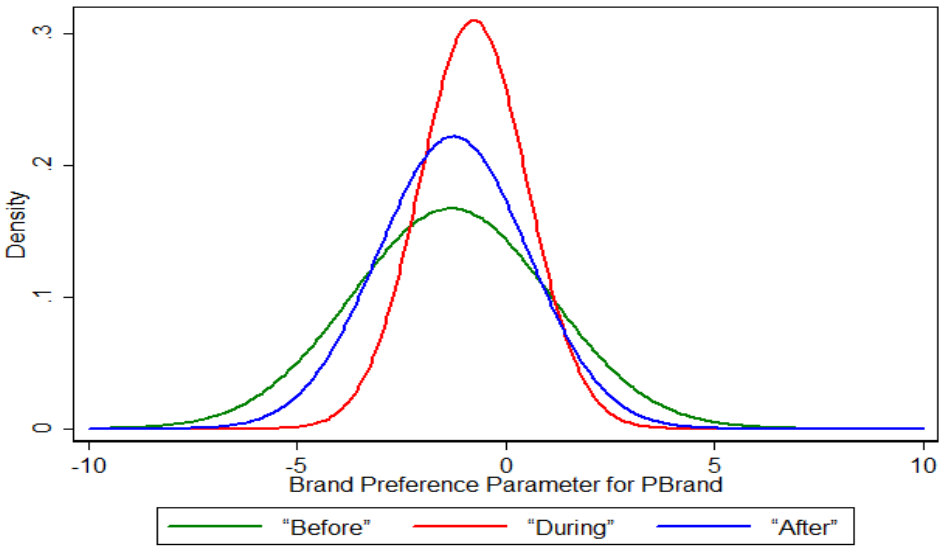
(a) WTP for NBrand1



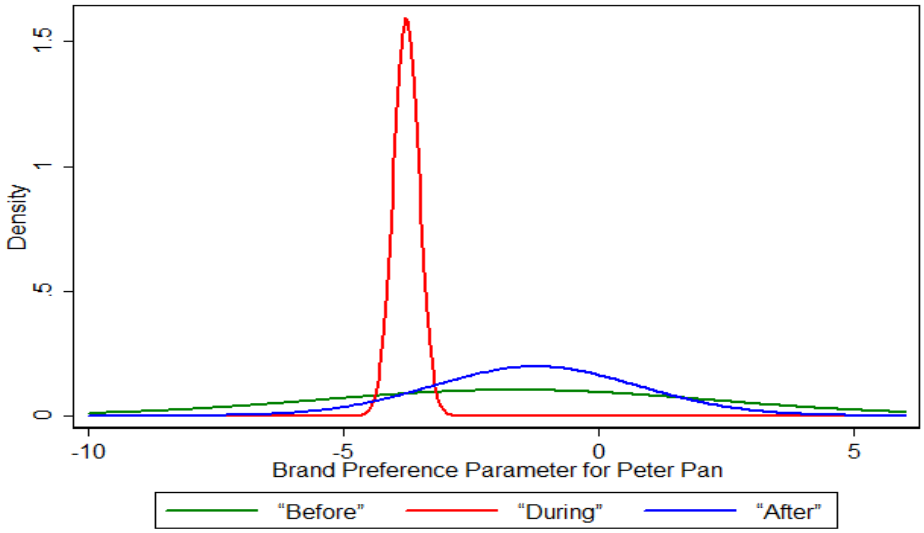
(b) WTP for NBrand3



(c) WTP for PBrand



(c) WTP for Peter Pan



6.4 Discussion on Profiling Customers

Based on the predicted WTP, we ran the four logit models listed on Table separately to investigate what household characteristics could explain the purchasing change by period, to identify customer groups. Different marketing strategies should be applied to the customer groups accordingly.

Model 1 showed the significant demographic variables affecting the change from store brand to national brands in the before and during periods. From the estimation result, households with the following characteristics were more likely to switch to national brands: younger female/male head, higher income, one family, married with kids, no more than three family members, female head with above high school education. Compared with Non-Hispanic White, Non-Hispanic Black and Non-Hispanic others were more likely to switch to national brands during the recall period. Thus unrecalled national brands should focus on those households to gain the market shares in the recall period.

Model 2 listed the estimation results related to the change from store brand to national brands in the during and after periods. In the post-recall period the following characteristics significantly and positively affected the purchasing behavior change: younger male head, higher income, one family with kids, female head with employed status, no more than three family members, female head with above high school education. Compared with Non-Hispanic White, Non-Hispanic Black and Hispanic were more likely to switch to national brands after the recall period. Therefore national brands should select the potential customer groups with those attributes to gain more market share in the post-recall period.

Model 3 checked the purchasing change from national brands to private brands in during and after periods. In the post-recall period, the following variables significantly and

positively contributed to the brand loyalty to national brands: younger household head, one family, married with kids, no more than three family members, female head with higher education level. Compared with Non-Hispanic White, Non-Hispanic Black and Hispanic were more likely to stick to national brands after the recall period. These are the loyal customers for national brands. On the other hand, the complete set of these customer groups provided potential market for store brands, giving them the opportunity to gain more market share in the post-recall period.

Model 4 checked the purchasing change from Peter Pan to all the other brands in the before and after periods. The following characteristics significantly and positively contribute to the behavior change from recalled brand to unrecalled brands: older male head, higher income, more than one family, non-married with no kids, more than three family members. Compared with Non-Hispanic White, household with other ethnicity backgrounds are more likely to switch to unrecalled brands. Thus the household who used to purchase Peter Pan in the pre-recall period and with those characteristics are more likely to abandon Peter Pan in the post-recall period. Unrecalled brands should focus on these groups to maintain and gain the market share as the recall ended. On the other hand, Peter Pan should focus on the other customer groups to build image and regain the market share from the recall.

Table 11. Logit Models of Predicted WTP on Household Characteristics

	Model 1	**Model 2**	**Model 3**	**Model 4**
	Before VS During	During VS After	During VS After	Before VS After
	PBrand VS NBrand	PBrand VS NBrand	NBrand VS PBrand	PeterPan VS Others

	Mean	**St.Dev**	**Mean**	**St.Dev**	**Mean**	**St.Dev**	**Mean**	**St.Dev**
FEMALE AGE	-0.0015**	0.0006	-0.0007	0.0007	0.0027***	0.0006	0.0010	0.0009
MALE AGE	-0.0027***	0.0006	-0.0013**	0.0006	0.0020***	0.0006	0.0018**	0.0009
INCOME	0.0000***	0.0000	0.0000***	0.0000	0.0000***	0.0000	0.0000***	0.0000
TYPE	0.0410**	0.0182	0.1060***	0.0195	-0.0738***	0.0178	-0.1318***	0.0284
MARITAL STATUS	0.0964***	0.0273	0.0214	0.0300	-0.0744***	0.0273	-0.2182***	0.0434
PRESENCE OF KIDS	0.0632***	0.0221	0.0786***	0.0241	-0.0559**	0.0221	-0.1561***	0.0338
MALE EMPLOYMENT	-0.0057	0.0189	-0.0181	0.0203	0.0158	0.0186	-0.0058	0.0282
FEMALE EMPLOYMENT	0.0133	0.0149	0.0399**	0.0161	-0.0151	0.0148	-0.0105	0.0224
SIZE	0.1247***	0.0217	0.1531***	0.0239	-0.1263***	0.0218	-0.0796**	0.0339
MALE EDUCATION	-0.0113	0.0293	-0.0048	0.0314	-0.0047	0.0286	0.1523***	0.0422
FEMALE EDUCATION	0.2110***	0.0343	0.1806***	0.0366	-0.2218***	0.0328	0.0360	0.0514
RACE 2	0.0723**	0.0329	0.1487***	0.0343	-0.0875***	0.0319	-0.1828***	0.0427
RACE 3	0.0197	0.0348	0.0978***	0.0381	-0.0762**	0.0353	0.1395**	0.0552
RACE 4	0.0863**	0.0408	-0.0260	0.0432	0.0099	0.0397	0.1573**	0.0647
CONSTANT	-0.1019**	0.0435	0.0297	0.0475	-0.8434***	0.0431	2.3895***	0.0677

CHAPTER 7: CONCLUSIONS AND MANAGERIAL IMPLICATIONS

Using the Nielsen Homescan data, this study first employs a conditional logit model then a mixed logit model to investigate the effect of the 2007 peanut butter recall on brand preferences and market competition. The main results about brand preferences are summarized below. First, the recall significantly reduced the WTP for the product that has been recalled and competitors gain more market shares from the recall. The positive spill-over effect on unrecalled products was greater for strong brands (national brands) than for weaker brands (store brands). Second, the recalled product regained its market share but could not reach its pre-recall level even seven months after the recall. While the recalled product regains its market and customer confidence, weak brands (store brands) were more likely to lose their market share compared with national brands.

We also find that product attributes and household characteristics matter. National brands should target high income household with kids, highly educated female household head, male household head employed, and a small household size. On the other hand, product lines with the following features -- homogenized, non-creamy, organic, store-featured, packed in bottle and multi-pack -- are most attractive to customers.

This study offers the following managerial implications. First, producers of the recall products can regain customer confidence but it is challenging. Significant recovery efforts were taken by Peter Pan to rebuild their production reputation and gain consumer trust and confidence. Nearly $15 million were spent on reconstructing ConAgra's plant in Sylvester (Bakhtavoryan, Salin, and Capps Jr, 2011), including repairing the roof, installing new equipment, cleaning and sanitizing the plant, creating a new HACCP Plan, and implementing a revised environmental testing program for Salmonella (FDA, 2007). Peter Pan came back

to the market with the same brand name and a redesigned label and a 100 percent satisfaction guarantee in September 2007 (Bakhtavoryan, Salin, and Capps Jr, 2011). However, despite the significant recovery efforts, the market share of Peter Pan was still below the pre-recall level even seven months after the recall. Although manufacturers take great effort to recover brand image and customer confidence, customers are more cautious towards purchasing products from the recalled brand. Our study covers seven months after the recall period, so the situation may have changed since then.

Second, this study finds empirical evidence for asymmetric impacts of the recall on national brands and store brands. That is, national brands might gain more in the market share than store brands though the latter also benefit while the recall product is losing its market share. However, when the recall product regains its market share, store brands are more likely to lose their market shares than national brands. The asymmetric impact suggests that different market strategies are needed for national brands and store brands to maintain their market share gained during the product recall period.

For national brands which want to maintain their customers in the future, the following household attributes should be their main targets based on the discussion on logit model 4: older male head, higher income, more than one family, non-married with no kids, more than three family members. Also compared with Non-Hispanic White, household with other ethnicity backgrounds are more likely to switch to unrecalled national brands. For national brands which want to gain more customer groups in the near future, they need to focus on these other household groups with the features mentioned in logit model 2: younger male head, higher income, one family with kids, female head with employed status, no more than three family members, female head with above high school education, Non-Hispanic Black and Hispanic.

Based on our results, product lines with the following features, homogenized, non-creamy, organic, store-featured, packed in bottle and multi-pack, should be most attractive to customers. We call it 'benchmark' products here, they represents the peanut butter products that most people in the market prefer. All national brands should have product lines fitting those attributes. Meanwhile, they can further segment their own customer groups to see which product lines are more profitable in the whole market comparatively, thus develop those areas as specialty.

On the opposite, store brands should focus on three aspects. First, they should focus on the customer groups depicted in logit model 3: older household head, more than one family, non-married without kids, more than three family members, female head below high school. Second, they can develop 'benchmark' product line but with lower average price than national brands in order to gain potential customers who favor 'benchmark' products. Third, they should focus on localized and personalized peanut butter products differentiating from most common types. The advantage is the second type of product line could suffer less from the recall event because of its uniqueness and differentiation.

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