HOUSEHOLD- AND MARKET-LEVEL PERSPECTIVES ON THE PETER PAN PEANUT BUTTER RECALL USING NIELSEN HOMESCAN PANEL DATA

A Dissertation

by

RAFAEL GAGIK BAKHTAVORYAN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2011

Major Subject: Agricultural Economics

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ABSTRACT

Household- and Market-Level Perspectives on the Peter Pan Peanut Butter Recall Using Nielsen Homescan Panel Data. (December 2011)

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Co-Chairs of Advisory Committee: Dr. Oral Capps Jr.
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Using household level scanner data for 2006, 2007, and 2008, this dissertation consists of four studies, which present household- and market-level analyses of food safety issues concerning the 2007 Peter Pan recall on the demand for peanut butter at the category level and at the brand level. Findings of the first study suggested that the recall had a statistically significant positive effect on the demand for peanut butter at the category level. At the brand level, spillover effects were evident in that the demand for Jif was positively affected, while the demand for Skippy was negatively affected.

The second study examined structural change in the demand for peanut butter using demand system models corresponding to the pre-recall and the post-recall periods. Matrices of own-price, cross-price, and expenditure elasticities were calculated for both recall periods, and upon comparison, there were statistical differences in the corresponding estimated elasticities. In general, most price elasticities in the post-recall period were larger in absolute value than the comparable elasticities in the pre-recall period.

The third study investigated the impact of household socio-economic characteristics associated with choices to purchase peanut butter across the pre- and the post-recall periods. Four choice scenarios were *no buy-no buy*, *buy-no buy*, *no buy-buy*, and *buy-buy*. Socio-economic characteristics considered included age, employment, education, race, ethnicity, presence of male and/or female household head, region, age and presence of children in the household, household size, and income. While the results varied by brand, region was the socio-demographic characteristic that was consistently significant among the choice scenarios for the respective peanut butter brands.

Conditional on households purchasing peanut butter in both the pre- and the post-recall periods, the final analysis examined the influence of the same aforementioned socio-economic variables as well as the change in the own price on the change in the quantity purchased. The results varied across brands, but the principal drivers of the conditional change in the quantity purchased were the change in the own price and the age and presence of children in the household.

DEDICATION

This dissertation is dedicated to my wife who has supported me throughout all of my accomplishments both in graduate school and in life.

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First, I would like to thank Dr. Capps, my committee co-chair, whose personality, teaching, and mentoring skills provided me with the excellent guidance necessary to complete this dissertation. Without a doubt, Dr. Capps is a role model who sets a perfect example of a great academician. Apart from the fruitful discussions about the research, I also greatly enjoyed passionately sharing opinions on college and professional basketball with Dr. Capps.

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Thanks to Drs. David Bessler, Ximing Wu, and Peter Murano for their readily available help and cooperation whenever it was necessary. A special thank you to Senarath Dharmasena and Gayaneh Kyureghian, who helped me immensely with SAS programming. In addition, my indebtedness lies with my friends and incredible persons Susan Livingston and Dr. John Nichols. I would also like to acknowledge my fellow graduate students for their friendship, which made my research less stressful and more enjoyable.

I am eternally grateful to my Mom and Dad, my sister and Grandma, for all the accomplishments in my life. It has been their unconditional love, care, and warmth that has gotten me through difficult times. Most importantly, I am thankful to my wife for her endless love and support. She has been my inspiration, and I could not have accomplished my goals and fulfilled my dreams without her.

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CHAPTER I

INTRODUCTION

Background

Consumers throughout the world are becoming increasingly concerned about food safety issues. Support for this contention comes from the growing body of research dedicated to studying the impacts of food safety issues on consumer behavior in many countries. Federal regulatory agencies, such as the Food Safety and Inspection Service (FSIS) of the U.S. Department of Agriculture (USDA), the U.S. Food and Drug Administration (FDA), the Centers for Disease Control and Prevention (CDC), and the U.S. Department of Health and Human Services (HHS) issue health alerts about possible contamination of various food products, which, in most cases, are later followed by recalls of the affected products.

Among quite a few food recalls taking place in recent years was the peanut butter (PB) recall. Based on the increase in the number of reports at the CDC and state health departments in November of 2006 linking PB to salmonella contamination, the FDA launched a multistate control-study during February 5-13, 2007 (CDC 2007). The study confirmed that the foodborne illness was caused by the consumption of two PB brands, Peter Pan and Great Value, manufactured by ConAgra Foods Inc., at its Sylvester, Georgia, processing plant. As a result, ConAgra ceased the production of PB at its plant,

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This dissertation follows the style of the *American Journal of Agricultural Economics.*

destroyed all affected products in their possession, and through a news release on February 14, 2007, voluntarily issued a nationwide recall of its Peter Pan and Great Value (a brand made for Wal-Mart by ConAgra) PB products produced since May 2006 with product code 2111 and sold through grocery and retail stores throughout the United States (CDC 2007). It was believed to be the first salmonella outbreak involving PB in the United States.

Opened and unopened jars of the affected PB brands, together with environmental samples collected from the plant, were used to conduct tests for possible contamination. The test results helped isolate an outbreak strain of Salmonella serotype Tennessee. This strain of salmonella sickened 628 persons from 47 states since August 1, 2006 (CDC 2007). In Figure 1.1, the breakdown of confirmed cases of Salmonella Tennessee infection associated with consumption of PB by state is shown.

Initially the source of contamination was unknown; however, later it was revealed that the PB was contaminated because of moisture resulting from a leaky roof and sprinkler malfunctioning during a rainstorm in Sylvester, Georgia. This moisture mixed with dormant salmonella bacteria from peanut dust and raw peanuts stored in the facility, led to this food safety issue (Funk 2007).

In an effort to restore the consumer confidence in the safety of the recalled PB brands, ConAgra undertook repairs of its peanut processing plant in Sylvester, Georgia, and started a large-scale marketing campaign. Particularly, ConAgra claimed that it had spent considerable amount of money on upgrading machinery, technology, and design throughout the plant before re-opening it in Georgia and returning Peter Pan PB on store shelves in August 2007 (ConAgra Foods Inc. 2007). During its massive marketing campaign, ConAgra sent out 2 million coupons for free Peter Pan PB, $1-off coupons, and updated the design of Peter Pan PB jars (Dorfman 2007).

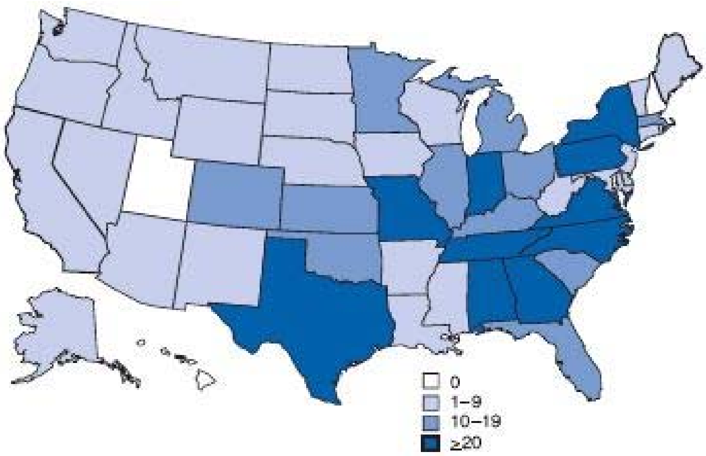

Figure 1.1. Number of confirmed cases of Salmonella Tennessee infection associated with consumption of peanut butter, by state, United States, August 1, 2006 to May 22, 2007 (CDC 2007)

According to ConAgra, this marketing campaign was the largest investment the company had ever made in Peter Pan. To encourage customers, ConAgra introduced a new design of the Peter Pan PB jars with a "New Look" label and a 100% satisfaction guarantee, in which a full purchase price refund was available in case customers were not satisfied with the purchase (Dorfman 2007).

Objectives

There are five general objectives in this study: (1) to discern whether the issuance of the recall had a statistically significant impact on PB demand; (2) to identify the changes in the demand for PB distributed over time; (3) to determine whether consumers returned to previous consumption patterns of PB prior to the recall and, if they did, how long it took them to do so; (4) to determine any potential cross-brand effects among three major PB brands, private label PB, and other small PB brands in the presence of the recall; and (5) to obtain the socio-economic profile of the households that changed their consumption pattern of PB as a result of the recall.

Contribution to the Literature

To the best of our knowledge, this study differs from other studies in that: (1) given the recall, the change in the demand for PB is evaluated from both the product category perspective and the brand perspective. This evaluation allows us to capture what happened to the demand for PB as a product category and to monitor any potential spillover effects among PB brands, at the same time. Consequently, we are in position to analyze possible substitutability and complementarity effects across PB brands; (2) while previous research has attempted to quantify recall events, this study considers the number of confirmed cases of infections resulting from the consumption of PB in developing the outbreak variable. This information underlying the construction of the outbreak variable is unique, and, to the best of our knowledge, has not been used previously; and (3) this study also undertakes a household-level analysis of the recall concerning PB. This household-level perspective fills a research void in the extant literature dealing with recall events or outbreaks.

Significance of the Results

The successful completion of the objectives ensures contributions to the economic literature in a couple of ways. First, the application of alternative econometric approaches for studying the impact of the recall on the consumption of PB assists in shedding light on determining the "best" model specification and approach for analyzing a specific aspect of the recall. Second, to the best of our knowledge, the demand for PB in the presence of a recall has not been studied extensively.

Organization of the Dissertation

The dissertation is organized as follows. In Chapter I, the background, the objectives, the contribution to the literature, the significance of the results, and the organization of the dissertation are presented. In Chapter II, information on the overview of peanut industry, competition and spillover effects between store brands and national brands, and food safety with a focus on salmonella and its economic cost is discussed. In Chapter III, a polynomial distributed lag specification of PB consumption is estimated that helps to detect the distribution of the recall effect over time. In Chapter IV, a demand system model is estimated (the Barten synthetic model) covering the pre-recall and the post-recall periods with the focus on own-price, cross-price, and expenditure elasticities. This work helps to analyze the nature of consumer responsiveness to the PB recall. In Chapter V, a multinomial logit model is estimated to identify the socio-economic profile of households whose demand behavior was affected by the PB recall. In Chapter VI, a Heckman sample selection model is estimated to study the effect of different socio-economic variables on the change in the quantity purchased of the PB across the pre- and the post-recall periods. Finally, summary, conclusions, limitations, and recommendations for future research are discussed in Chapter VII.

CHAPTER II

OVERVIEW OF THE U.S. PEANUT INDUSTRY AND FOOD SAFETY POLICIES

Overview of the Peanut Industry

Due to their high nutritional values, peanuts and peanut products are considered to be an integral part of diet for Americans. Peanuts and PB are a rich source of such nutrients and phytonutrients as protein, vitamin E, magnesium, phosphorus, manganese, potassium, fiber, and niacin (Vitamin B). They do not contain cholesterol and transfats (National Peanut Board accessed 10/30/2010). One ounce of all types of salted peanuts contains 7.95 grams of protein, and one tablespoon of smooth-style salted PB contains 4.01 grams of protein (USDA, National Nutrient Database for Standard Reference accessed 10/30/2010). In addition, consumption of peanuts helps to reduce heart diseases and diabetes as well as brings down weight and cholesterol level (He et al. 2005).

As Figure 2.1 shows, annual per capita consumption of peanuts in the United States has been relatively constant around its mean of 6 pounds; the height of per capita consumption occurred in 1989 at 7 pounds, with annual consumption at 6.3 pounds in 2008 (USDA, Economic Research Service 2011a). Data on a per capita consumption of peanuts for 2009 and 2010 were not found.

Originating in South America, peanuts were imported into the United States in the 1700s. At that time peanuts were not major cultivated crops due to their rather capital-intensive nature and the lack of relevant equipment for peanut production, harvesting, and shelling (American Peanut Council accessed 10/30/2010).

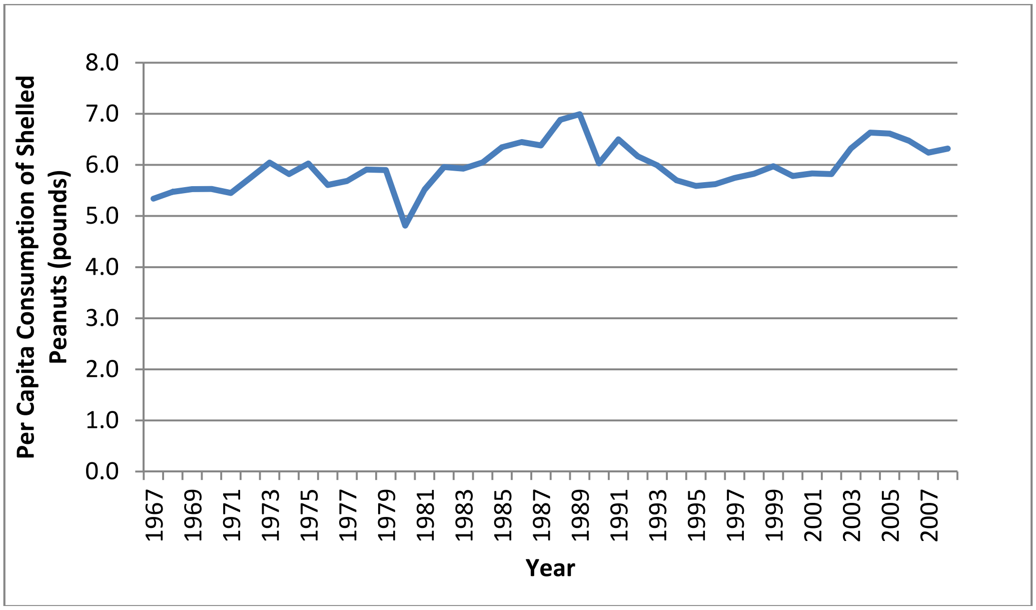

Figure 2.1. Annual per capita consumption of shelled peanuts (pounds) in the United States, 1967-2008 (USDA, Economic Research Service 2011a)

However, the picture is quite different today with peanuts being the twelfth most valuable cash crop grown in the United States. The production volume of peanuts reached a record high 5.1 billion pounds with a farm value of over one billion U.S. dollars in crop year 2008/2009 (USDA, National Agricultural Statistical Service 2009). In 2002, with the passage of the current Farm Bill, the old marketing quota system was replaced with a market/loan system, eliminating the distinction between peanuts sold in domestic and export markets and qualified peanut producers for the same government programs targeted towards other field crop producers (USDA, Economic Research Service 2005).

The United States is the third largest producer of peanuts in the world after China and India. Four major types of peanuts, Runner, Virginia, Spanish, and Valencia are grown in the following states: Georgia (41%), Texas (24%), Alabama (10%), North Carolina (9%), Florida (6%), Virginia (5%), and Oklahoma (5%) (American Peanut Council accessed 10/30/2010). Figure 2.2 illustrates the peanut producing areas in the United States.

Peanut products as PB, peanut candies, roasted and flavored kernels, roasted and sized peanut granules, salted inshell peanuts, peanut flour, peanut oil (both refined and crude) and aromatic oil and extracts are available to U.S. consumers at various outlets. Of all these peanut products, PB is a key food product. Over 50% of all domestically manufactured peanuts go into the production of PB, which contributes $850 million in retail sales every year (American Peanut Council accessed 10/30/2010).

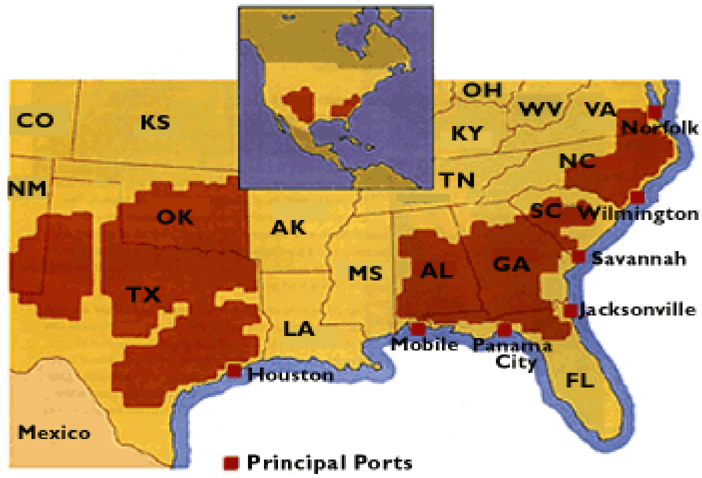

Figure 2.2. Peanut producing areas (American Peanut Council accessed 10/30/2010)

In Figure 2.3, we present an overview of peanut processing. While Figure 2.3 is rather intricate; however, as far as food safety issues go, the health regulatory agencies focus solely on processors, since peanuts are rarely sold fresh. Once peanuts are in control of processors, they are heated to a high temperature killing all the harmful bacteria, thus absolving peanut farmers of any responsibility for causing foodborne illnesses.

The data on peanut production and processing for PB manufacturing provided by USDA's National Agricultural Statistical Service (USDA-NASS 2009) as well as the price of retail creamy PB provided by U.S. Department of Labor are presented in Table 2.1.

As Table 2.1 shows, the production of peanuts on a shelled-equivalent basis before the recall period was 4,288 and 4,870 million pounds in 2004/05 and 2005/06, respectively, with the crop year beginning on August 1. The volume of peanuts processed for manufacturing PB was 1,248 and 1,296 million pounds in 2004/05 and 2005/06, respectively (USDA, Economic Research Service 2010). The average price of retail creamy PB on a per pound basis was $1.75 and $1.71 in 2004/05 and 2005/06, respectively (U.S. Department of Labor, BLS accessed 10/30/2010).

In 2006/07 and 2007/08, which coincide with the post-recall periods, the production of peanuts fell to 3,464 and 3,672 million pounds, respectively, with the total amount of peanuts processed for producing PB rising to 1,321 and 1,346 million pounds in 2006/07 and 2007/08, respectively, with year beginning on August 1 (USDA, Economic Research Service 2010). Finally, the average price of retail creamy PB price on a per pound basis was $1.73 and $1.92 in 2006/07 and 2007/08, respectively (U.S. Department of Labor, BLS accessed 10/30/2010).

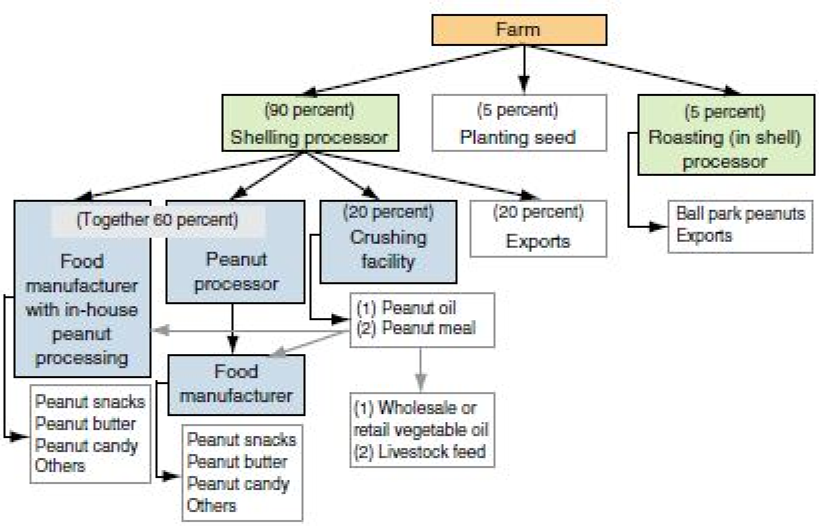

Figure 2.3. An overview of peanut processing (USDA, Economic Research Service 2010)

Table 2.1. Peanut Production, Processing, and Peanut Butter Prices, 2004-2007

	Units	2004/05	2005/06	2006/07	2007/08
Production of peanuts	million pounds	4,288	4,870	3,464	3,672
Volume of peanuts processed for peanut butter	million pounds	1,248	1,296	1,321	1,346
Average price of retail creamy peanut butter	$/pound	1.75	1.71	1.73	1.92

*Source: USDA, Economic Research Service 2010 and U.S. Department of Labor.

As the numbers in Table 2.1 reveal, even though the total production of peanuts decreased in the post-recall period compared to that in the pre-recall period, the quantity of peanuts used for making PB increased in the post-recall period. A possible cause for the increase in total volume of peanuts processed for PB production may have been a rise of PB price (by 9.71%) from 2004/05 to 2007/08 (USDA, Economic Research Service 2010).

Store Brands versus National Brands and Associated Spillover Effects

The U.S. PB industry is concentrated in the hands of primarily three firms, Procter and Gamble Company, ConAgra, and CPC International Inc., producing national brands such as Jif, Peter Pan, and Skippy, respectively. The rest of the market share is attributed to regional and/or store brand PB producers. Specifically, over the study period from January 2006 to December 2008, Private Label, Jif, Peter Pan, Skippy, and Other Brands accounted for 23%, 35.5%, 9.8%, 19.7%, and 12% market share, respectively (ACNielsen Homsescan panels for household purchases, 2006, 2007, and 2008).

Because the PB category is characterized by competition among three major brands and several private label brands, a crisis in a brand might impact the whole category via changing the competitive environment through spillover effects. This contention is supported by the general discussion of the competition between private label brands and national brands and the spillover effects among them resulting from negative publicity concerning one of the brands as per the following presentation.

Private label brands (or store brands) were first introduced in the late 1970s (Goldsmith et al. 2010) targeting low-income consumers (Hassan and Monier-Dilhan 2006). However, they have rapidly become a force to be reckoned with, evidenced by their increasing market share. According to the Private Label Manufacturers Association (PLMA), all private label food and non-food grocery sales in the United States exceeded $86.4 billion in all retail outlets with its market share reaching a record-high 18.7% dollar share and 23.7% volume share (PLMA 2011).

An increase in the number of offers of private-label products allows retailers not only to improve their profit margins but also to strengthen their bargaining power and ability to differentiate themselves from competitors (Heese 2010). Partially the success of the private-label products stems from consumer loyalty towards them (Goldsmith et al. 2010) as well as the ability of retailers to offer store brand products that have the same or even better quality relative to the national-brand products at a lower price (De Wulf et al. 2005). As a recipe for success, Dunne and Narasimhan (1999) recommended that national brand manufacturers introduce private labels taking into account the subtleties of the distribution chain.

In general, negative publicity is considered to be one of the important determinants that affects buying decisions of consumers (Ahluwalia et al. 2000) and is normally viewed as a relatively more credible source of information than advertising (Dahlen and Lange 2006). Furthermore, negative information is more diagnostic compared to positive information (Maheswaran and Meyers-Levy 1990), which is why consumers typically place more weight on negative information in their brand judgments (Dahlen and Lange 2006). Among other effects that are direct results of negative publicity, Dawar and Pillutla (2000) through a field survey and lab experiments showed that negative publicity affects equity of a brand that was involved in a product recall crisis. In addition, taking into account that consumers form associative networks of brands that contain information on individual brands, product features, and consumption experiences (Meyers-Levy and Tybout 1989), there is expected to be spillover effects among competing brands as a result of a crisis associated with one brand. Spillover effects can happen in two ways: among brands within a product category (peanut butter in our case) and within the same brands in other product categories.

In their study, Janakiraman et al. (2006) found that unexpected changes in a product's quality and price led to spillover effects across product categories. In addition, the results of the study provided evidence to suggest that positive surprises (i.e., price decreases) generated larger spillover effects relative to the negative spillover effects stemming from negative surprises (i.e., price increases).

Using the example of airlines and contact lenses, Dahlen and Lange (2006) showed that consumer perceptions of the product category attributes are affected by the brand crisis. They also emphasized the role of similarity among brands. Particularly, they showed that negative effects spilled over onto a competing brand from the focal brand where the two brands were regarded as similar by consumers. At the same time, if consumers perceived the two brands as dissimilar, then the spillover effects from the focal brand on to a competing one were positive.

Korkofingas and Ang (2010) studied the spillover effects among private label brands and national brands resulting from product recall. The brands considered were Kraft, Woolworth's Select, and Woolworth's Home Brand and the products included cream cheese, peanut butter, and cheese slices. According to the findings of their study, no significant spillover effects to the other brands were recorded within the affected product category. However, significant spillover effects were found in other product categories for the focal (recalled) brand. Notwithstanding the difference in the approach undertaken, the focus of our analysis is in line with that of Dahlen and Lange (2006) in the study of the spillover effects among brands in the presence of a brand crisis.

As far as economic implications of Peter Pan PB recall are concerned, in Figure 2.4, we show that the Peter Pan PB recall did not seem to have a negative impact on the use of peanut products. In fact, there is an increase in the quantity of peanuts processed during a few months following the recall announcement, which, according to the report of the Economic Research Service of USDA (2010), can be attributed to additional peanuts being processed to make up for the destroyed PB. They also suggested that the fact that consumers and retailers were able to quickly destroy the tainted jars of PB based on a unique product code might lead to switching towards the consumption of competing brands of PB (USDA, Economic Research Service 2010). In this study, using an econometric approach we are in position to examine this conjecture and to ascertain the brands benefiting from the Peter Pan PB recall.

Food Safety and Policies

Despite the growing body of research suggesting recommendations directed at reducing health risk issues caused by foodborne illness outbreaks as well as federal government's efforts in the form of laws, foodborne illness is still an issue. According to the CDC estimates, every year foodborne pathogens sicken 1 out of 6 American (or 48 million people), and 128,000 are hospitalized with 3,000 lethal cases (CDC 2011). Eight known pathogens cause the most illnesses, hospitalization, and deaths.

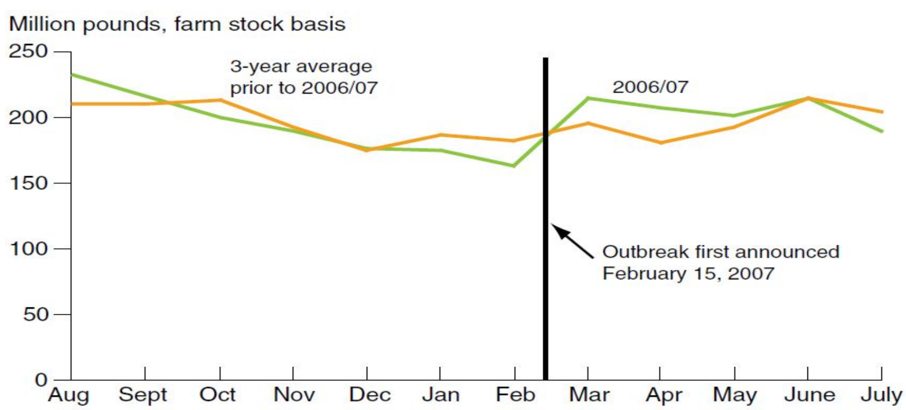

Figure 2.4. Peanut processing increased for several months following the 2007 recall of Peter Pan peanut butter (USDA, Economic Research Service 2010)

Table 2.2 details the breakdown of the annual number of illnesses, hospitalizations, and deaths for the top five food-borne pathogens. Figures in Table 2.2 reveal that *Norovirus* is the major contributor to foodborne illnesses followed by *nontyphoidal Salmonella*, *Clostridium perfringens*, *Campylobacter spp*., and *Staphylococcus aureus*. In terms of number of hospitalizations, *Salmonella, nontyphoidal* ranks first, followed by *Norovirus*, *Campylobacter spp*., *Toxoplasma gondii*, and *E. coli (STEC) O157*. Finally, in terms of deaths, *nontyphoidal Salmonella* is the major contributor, *Toxoplasma gondii* ranks second, followed by *Listeria monocytogenes*, *Norovirus*, and *Campylobacter spp*.

Table 2.2. Top Five Pathogens Causing Domestically Acquired Foodborne Number of Illnesses, Hospitalizations, and Deaths

Pathogen	Illnesses	Pathogen	Hospitalizations	Pathogen	Deaths
Norovirus	5,461,731	Norovirus	14,663	Norovirus	149
Salmonella, nontyphoidal	1,027,561	Salmonella, nontyphoidal	19,336	Salmonella, nontyphoidal	378
Clostridium perfringens	965,958	Toxoplasma gondii	4,428	Toxoplasma gondii	327
Campylobacter spp.	845,024	Campylobacter spp.	8,463	Campylobacter spp.	76
Staphylococcus aureus	241,148	E. coli (STEC) O157	2,138	Listeria monocytogenes	255

*Source: CDC 2011.

Various food safety policies are implemented focusing on the reduction of consumer health risks (Hoffmann 2010). For example, Ralston et al. (2001) studying consumer hamburger cooking and ordering behavior suggested that one of such policies is encouraging consumers to follow food safety recommendations through TV and magazine stories or through carefully designed and implemented food safety education (safer food handling, preparation practices). The significance of these recommendations become more pronounced given the existence of the research that indicate that improper handling of food, preparation, and consumption practices account for a large proportion of foodborne illness (Lin et al. 2004).

Without a doubt, one of the most notable pieces of legislation was the passage of the Food Safety Modernization Law (FSML), an improvement of a previous similar law (Knutson and Ribera 2011). Knutson and Ribera present a detailed side-by-side comparison of quite a few provisions of the FSML and the previous law. As far as food recalls go, the FSML requires a mandatory food recall if it is found that the food is adulterated, misbranded, or can cause human health problems or deaths; for the previous legislation, the decision to conduct a recall was left up to the producing firms, with the exception of infant formula (Knutson and Ribera 2011).

Salmonella and its Economic Cost

Salmonella is a type of bacterium that lives in the intestinal tracts of humans, mammals, reptiles, and birds, which is typically spread to humans via a variety of tainted foods or water. Particularly, salmonella can be discovered in the waste of pets who suffer from diarrhea, and also such reptiles as lizards, turtles and snakes are likely carriers of the bacteria (CDC 2010a). The salmonella germ was named after an

American scientist Salmon who discovered it (CDC 2010b). Among many kinds of salmonella bacteria, Salmonella serotype Typhimurium and Salmonella serotype Enteritidis are the most common in the United States causing more than 50% of infections in humans (Medical News Today 2009). The symptoms of foodborne illness of salmonellosis (Salmonella infection) include diarrhea, fever, and abdominal cramps that start to develop from 12 to 72 hours after contact with bacteria and sickened people normally heal from 4 to 7-day period without medical intervention (CDC 2010b). However, in groups of people with compromised immune systems (infants, pregnant women, and the elderly), the infection can take severe forms to the extent that the infected persons need to be hospitalized. In addition, in case the bacteria move from the intestinal tract into bloodstream, the consequence can be lethal, if not treated quickly with the use of antibiotics (CDC 2010b).

Even though salmonella infections commonly originate in foods of animal origin; however, the pathogens also can be found on fruits and vegetables that are not handled properly (for example, handlers fail to wash hands with soap after using the bathroom). The conventional treatment for salmonella includes drinking fluids and staying hydrated. Thorough cooking of poultry, ground beef, and eggs, washing fruits and vegetables, washing hands after touching pets, and reptiles, and cleaning kitchen work surfaces and utensils that touched raw meat or poultry are among strong recommendations for avoiding contracting salmonella infections (CDC 2010a).

As Table 2.2 showed, according to the CDC 2011 estimates, over one million (1,027,561 to be exact) Americans are sickened with nontyphoidal Salmonella infections each year, with 19,336 cases of hospitalizations and with 378 lethal cases (CDC 2011). In accordance with the estimates provided by the Economic Research Service (ERS), an agency of the U.S. Department of Agriculture (USDA), the annual total cost of all types of salmonella infections from all sources (medical costs due to illness, the cost of time lost from work due to nonfatal illness, and the cost of premature death) is slightly more than $2.6 billion with an average cost of $1,896 per case (USDA, Economic Research Service 2011b). Compared to foodborne illness cases caused by other salmonella serotypes, the Salmonella Tennessee constitutes a small number of cases with most of the infection sources unidentified (CDC 2007). Particularly, the total number of Salmonella Tennessee infections from human sources from 1996 through 2006 was 855, while that of Salmonella Typhimurium infections for the same period was 75,058 (CDC 2006).

Another outbreak of Salmonella serotype Tennessee with known sources was recorded in the United States and Canada in 1993, where powdered infant formula was contaminated (CDC 1993). Cases of foodborne diseases caused by contaminated PB outside of the United States also took place in Australia in 1996 (Salmonella Enterica serovar Mbandaka) (Scheil et al. 1998). It needs to be pointed out that the outbreak strain of Salmonella serotype Tennessee was associated with the PB recall analyzed in this study.

The PB recall did not seem to affect the volume of peanuts processed for PB adversely. However, the PB recall was anticipated to have resulted in spillover effects among PB brands as suggested by the marketing literature. Chapter III empirically analyzes the consumer responsiveness to the PB recall at the same time focusing on the spillover effects among the PB brands.

CHAPTER III

EFFECT OF HEALTH INFORMATION ON THE DEMAND FOR PEANUT BUTTER: THE CASE OF THE PETER PAN PEANUT BUTTER RECALL

Introduction

The release of negative information by federal agencies or individual companies concerning a specific product, the consumption of which might cause health issues for humans may entail a lagged response from consumers due to psychological, technological, and institutional reasons (Gujarati 2003; Griliches 1967). Through application of polynomial distributed lag (PDL) specifications, economists attempt to better explain the dynamics related to the dissemination of negative information.

By estimating a PDL specification, this study attempts to shed light on the following: (1) whether or not the recall had a statistically significant impact on the demand for peanut butter (PB); (2) how the impacts of the PB recall were distributed over time; (3) whether or not consumers returned to the pre-recall purchase levels of PB, and if so, the length of time it took to reach this situation; (4) ascertaining the spillover effects among PB brands; and (5) estimating the short-run and long-run elasticities associated with the outbreak.

To the best of our knowledge, this study is different from prior research in a few aspects: (1) the analysis is conducted both at the PB category and at the brand level, allowing us to capture spillover effects among PB brands and shed light on the identification of major competition among brands; (2) the number of confirmed cases of infections due to the consumption of a specific product (in our case the product is PB) never has been used previously in constructing the outbreak variable; and (3) the demand for the PB has not been extensively studied in the light of the recall.

The significance of the findings of our analysis is important for PB producing firms given the competitive environment in the PB industry where three national brands (Jif, Peter Pan, and Skippy) comprise over 65% of market share over the study period from January 2006 through December 2008. Having accurate coefficient estimates from the PDL model enables PB producing firms to render better decisions when undertaking a specific business strategy in dealing with short-run and long-run consumer responses to negative information.

Chapter III proceeds by first presenting the relevant literature review. Then the theoretical framework is discussed, and the methodology is presented. Subsequently, data indigenous to this econometric analysis are described in the next section. The model specification and estimation results are discussed in the ensuing section. The conclusions, limitations, and recommendations for future research comprise the final section.

Literature Review

A PDL method developed by Almon (1965) can be used to study the response of consumption of particular food products to negative information (recalls, food safety announcements). Swartz and Strand (1981) studied the influence of information about oyster contamination in the James River due to kepone on the demand for shucked oysters in Baltimore, a spatially separated area from the contaminated region, using a second-order and four-lag PDL model and employing biweekly data from 1973 through 1976. The negative information variable was developed using articles from the four major Baltimore and Washington newspapers. First, articles were assigned values based on their probability of negatively affecting the demand for oysters. Particularly, articles stating that oysters were tainted with kepone were given a probability of 1, articles that talked about general fisheries having kepone contamination issues were given a probability of 0.75, articles covering only finfish were awarded a probability of 0.5, articles that presented general information on James River contamination were assigned a probability of 0.25, and other articles were given a probability of zero. Next, these values were weighted based upon the probability of being read. In this case, advertisement expenditures across newspapers were used as weights considering size, location and day of sale of the newspaper. Then the weighted values were weighted one more time by the market shares of each newspaper in the Baltimore/Washington market to accommodate the likelihood of the information reaching oyster consumers. The parameter estimates for all the negative media indices were statistically significant. After eight weeks, the consumers returned to pre-announcement consumption levels.

Smith, van Ravenswaay, and Thompson (1988) used a second degree PDL specification with lag length of three to evaluate the response of fluid milk sales to the negative newspaper coverage regarding the incident of heptachlor contamination of fresh fluid milk in Oahu, Hawaii utilizing monthly data from January 1977 to June 1983. A negative media variable was constructed first by identifying newspaper articles concerning the food contamination incident from two major Honolulu newspapers during the period of analysis that contained negative information on milk quality, the level of government protection, and the integrity of milk processors in handling the incident problem. Next, the negative newspaper articles were assigned weights from 0 to 5 based on the distinction of each article. Finally, aggregating the assigned weights yielded a monthly measure representing the negative media coverage. Other sources of information (in-store, word of mouth) related to the contamination incident were incorporated into the model via a dummy variable. According to the estimation results, the coefficients associated with current and lagged negative media variables were negative and significantly different from zero. The negative information effect reached its maximum contemporaneously with the announcement of the food contamination and subsequent impacts followed a geometric decay pattern.

Van Ravenswaay and Hoehn (1991) estimated a PDL model with three lags to evaluate the effect of Alar on apple demand empirically utilizing monthly data from January 1980 to July 1989. The risk information regarding Alar was included in the model as an index, which consisted of monthly number of articles in New York Times that had words “Alar” or “daminozide” located in Nexis electronic database during the period from July 1984 to July 1989. Also incorporated in the model were cumulative measures of monthly articles and a dummy variable assuming a value of 0 before the announcement about Alar, and thereafter 1. The parameter estimates for the current and lagged risk information variables from the model, which excluded the cumulative measure and the aforementioned dummy variable, were all negative in sign; however, only the first-lag and the third-lag of the risk information variable were significant.

The aforementioned articles emphasize the empirical analysis of the impact of a recall on the demand for various products taking into account the delayed response of consumers to the recall announcement. However, these articles did not focus attention on the possible spillover effects both among brands within a product category and within the same brands in other product categories. Spillover effects were considered in the marketing literature, as evidenced by the articles reviewed in Chapter II; however, the marketing literature did not address delayed consumer responses to recalls. Our study combines both approaches, a combination of information economics and marketing. Particularly, by estimating the PDL specification, consumer responsiveness to the recall is evaluated along with determining possible cross-brand effects resulting from the recall.

Theoretical Framework

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

$$U_t = U\big(q_t, \theta(r_t)\big), \qquad (3.1)$$

where q_t is the vector of the product consumed and $\theta(r_t)$ denotes consumer preferences for q_t and is a function of r_t, which stands for attributes of q_t (quality, safety) and the consumer's personal attributes. By assumption, changes in the product attributes lead to changes in the consumer's consumption decisions regarding q_t, which in turn results in changes in the parameters of the utility function. Assuming a quasi-concave and twice differentiable utility function for a rational consumer, the solution of the first-order conditions of the utility maximization with respect to q_t, given r_t, and subject to a budget constraint, gives the Marshallian demands $q_t = q_t(y, p, \theta(r_t))$, where y is total consumption budget and p is the vector of prices.

This theoretical framework is quite amenable for analyzing the effects of both negative food safety information (e.g. recalls) and advertising (Capps and Schmitz 1991b). Particularly, regarding negative food safety information (recalls), the focus of our study, by assumption consumer utility depends not only on quantities of goods consumed, but also on consumer perceptions concerning the quality of the goods, $\theta(r)$, which in turn is dependent on the information available to consumers, r. The demand decreases conditional on the severity of negative publicity, because consumers adjust their consumption based on their perceptions concerning the quality of the good.

Methodology

The PDL model, also known as Almon distributed lag model, is a *k*th-order distributed lag model as follows:

$$Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \beta_3 X_{t-3} + \cdots + \beta_k X_{t-k} + \varepsilon_t, \qquad (3.2)$$

where α is the intercept and β_0 is called the short-run multiplier, since it shows the change in Y given a unit change in X in the same period. If the change in X is the same over the period of study, then, following the same logic, ($\beta_0 + \beta_1$) shows the change in Y

in the next period, and ($\beta_0 + \beta_1 + \beta_2$) yields the change in Y in the following period. These sums of β's are referred to as interim multipliers, and, the long-run multiplier, β, which shows the total effect if the change is sustained permanently, is the sum of all the βs after k periods given by

$$\beta = \sum_{i=0}^{k} \beta_i. \tag{3.3}$$

In (3.2) ε_t is the disturbance term with mean 0 and constant variance, $E(\varepsilon_t)=0$, $var(\varepsilon_t)=\sigma^2$, and $cov(\varepsilon_t\ \varepsilon_s)=0$ for $t \neq s$. Equation (3.2) can also be written the following way:

$$Y_t = \alpha + \sum_{i=0}^{k} \beta_i X_{t-i} + \varepsilon_t \tag{3.4}$$

According to Almon, β_i can be approximated by the polynomial in i of m degree as follows:

$$\beta_i = \alpha_0 + \alpha_1 i + \alpha_2 i^2 + \alpha_3 i^3 + \cdots + \alpha_m i^m. \tag{3.5}$$

A constraint that must be put in place is that the degree of the polynomial must be less than the maximum length of lag, $m < k$ (Fouda 2010). For the sake of illustration simplicity, let's assume β_i can be approximated by the second-degree polynomial, that is

$$\beta_i = \alpha_0 + \alpha_1 i + \alpha_2 i^2. \tag{3.6}$$

Plugging (3.6) into (3.4) we get

$$Y_t = \alpha + \sum_{i=0}^{k} (\alpha_0 + \alpha_1 i + \alpha_2 i^2) X_{t-i} + \varepsilon_t = \alpha + \alpha_0 \sum_{i=0}^{k} X_{t-i} + \alpha_1 \sum_{i=0}^{k} i X_{t-i} + \alpha_2 \sum_{i=0}^{k} i^2 X_{t-i} + \varepsilon_t. \tag{3.7}$$

Given k, equation (3.7) can be rewritten as

$$Y_t = \alpha + \alpha_0(X_t + X_{t-1} + \cdots + X_{t-k}) + \alpha_1(X_{t-1} + 2X_{t-2} + \cdots + kX_{t-k}) +$$

$$\alpha_2(X_{t-1} + 4X_{t-2} + \cdots + k^2X_{t-k}) + \varepsilon_t. \qquad (3.8)$$

Equation (3.8) can be estimated using the method of ordinary least squares as long as the disturbance term ε follows the classical assumptions. Once (3.8) is estimated and the α's are obtained, the original β's can be recovered using (3.6).

Oftentimes, researchers impose endpoint restrictions on the β's by assuming that β_{-1}= 0 and β_{k+1} =0. The first assumption means that no relationship exists between the value of explanatory variable before the current period and the value of the dependent variable in the current period. In other words, the relationship between the dependent variable and the value of the explanatory variable before the current period is not anticipatory. The second assumption concerning endpoint restrictions implies that after some period of lag *k*, the explanatory variable no longer has any effect on the current value of the dependent variable. In other words, at some lag the relationship between the current value of the dependent variable and the explanatory variable is going to die out.

During the estimation process, the issue that arises is the determination of the appropriate length of lag as well as the degree of the polynomial. Normally, metrics such as Schwarz Information Criterion (SIC), Akaike Information Criterion (AIC) and Hannan-Quinn Information Criterion (HQC) are used to determine the length of lag and the degree of polynomial.

Data

For our analysis, the data regarding the quantities purchased, prices, and coupons used of PB were derived from the ACNielsen Homescan Panel for calendar years 2006, 2007 and 2008. ACNielsen Homsescan panels are the largest on-going household scanner data survey system, tracking purchases made by households in the United States. Since the analysis is conducted both at the PB category level and at the brand level, overall, two separate data sets were derived, one for each level.

Data for Analyzing PB at the Category Level

In this analysis, the time-series data set spans 156 consecutive weeks, from Wednesday January 4, 2006 to Tuesday December 30, 2008 and includes weekly totals of quantities purchased, prices (unit values), and value of coupons. The data set also was supplemented with weekly income and a set of information variables. Despite the availability of detailed demographic information on participating households in the ACNielsen Homescan panels, this information was forgone because the final data set actually used in our analysis was of a time series nature developed from aggregating relevant variables over weeks across the households. This approach taken during data preparation was justified since the present analysis was not concerned about the impact of selected households, which is the focus of the later chapters.

Quantity variables were constructed as follows. The household quantity purchased of PB was constructed by aggregating weekly total ounces of all PB brands across households and then dividing it by the number of unique households that purchased PB in the given week. Because PB prices were unavailable, unit values were used as a proxy for them. For each week, PB unit values were calculated by dividing total expenditures by total ounces. The same imputation procedure was used to derive weekly unit values for jelly. The coupon variable for PB was developed first by aggregating weekly values of coupons used and then dividing it by the number of unique households to express the variable on a per household basis.

Real disposable personal income was reported on a monthly basis (U.S. Department of Commerce, accessed 10/30/2010); however, weekly interpolation of these data was used in the estimation. To obtain weekly interpolations of the income, first, a weekly growth rate for each quarter over the entire study period was calculated as $r_i = \left(\frac{Q_c}{Q_p}\right)^{1/13} - 1$, where r_i is the weekly growth rate for quarter i, Q_c is the current quarter, Q_p is the previous quarter, and the exponent 1/13 is for rendering the growth rate on weekly basis (13 weeks in a quarter). Next, starting from the income given for the first month of 2006, each successive interpolated weekly income was calculated as $I_p * (1 + r_i)$, where I_p is the income in the previous week.

The product recall event was represented with three different variables that were included in the models at the same time. The outbreak variable was developed based on the histogram reported by the CDC that showed weekly number of confirmed cases of Salmonella Tennessee infection associated with consumption of PB (CDC 2007). Constructed based on the weekly number of confirmed cases of the infection the outbreak variable, to some extent, allows for tracking the severity associated with the outbreak. The first 29 observations of this variable are zeros, observations from 30 through 68 correspond to the actual number of confirmed cases, and observations running from 69 through 156 are all zeros again. Due to unavailability of the actual data underlying the histogram, a simple iterative procedure attempting to come up with the data that would replicate the original histogram was conducted. After multiple similar iterations, a one-to-one matching between histograms was achieved. The square root transformation was used for the outbreak variable to handle zero observations and to capture diminishing marginal returns associated with it.

To test the hypothesis that with the passage of time after the initial release of the recall announcement consumers gradually increase their consumption of PB, a variable that counts the weeks from the recall was created. The first 58 observations of this variable are zeros, the 59th observation is 1, and the last observation is 98, with intermediate observations running chronologically.

A possible permanent shift in the demand for PB was modeled as a dummy variable taking on a value of 0 before the issuance of the recall and 1 afterwards[1]. This permanent shift corresponds to an abrupt structural change. To assess the effects of seasonality on PB demand, the 52 weeks in a year were divided into 4 13-week periods. Using the 4th 13-week period as a reference period, three dummy variables were used in the actual estimation to circumvent the dummy variable trap.

[1] To test for alternative structural breakpoints, the final specification of the single-equation model for PB category was re-estimated with the dummy variable successively lagged one period (week) for each estimation. Overall, the dummy variable was lagged for 13 periods (weeks). As Table A.1 in Appendix A shows, based on the Schwarz Information Criterion, the specification with no lag of the dummy variable was selected as the best for the PB category level. To be consistent across the single-equation and the system of equations, the final specifications of both models were estimated with no lags of the dummy variable.

Unit values, coupon, and income variables are deflated using the consumer price index with 1982-84=100 reported by the Bureau of Labor Statistics of U.S. Department of Labor (BLS). Descriptive statistics of the continuous variables incorporated in the model are presented in Table 3.1 (see Table A.3 in Appendix A for the description of the variable labels).

The average weekly total amount of PB purchased (*QPB*) per household was 33.22 ounces with a standard deviation of 1.29 over the sample period. The average real unit value of PB (*PPB*) was about 5 cents per ounce with a standard deviation of 0.23 cents. The average real unit value of jelly (*PJ*) was 3.22 cents per ounce with a standard deviation of 0.24. The standard deviation of the average real coupon values on a per household basis (*COUPPB*) of 2.75 was more than half its mean of 5.22 cents. Real per household income (*INC*), on average, was $84,840 with a standard deviation of $694. Finally, the average of CDC confirmed cases (*CDCCASE*) was approximately three with a standard deviation of roughly seven.

Table 3.1. Descriptive Statistics of the Variables Used in the Analysis of Peanut Butter at the Category Level[a]

Variables	Units	N	Mean	Std Dev	Min	Max
QPB	oz	156	33.22	1.29	30.54	36.97
PPB	cents/oz	156	4.99	0.23	4.39	5.65
PJ	cents/oz	156	3.22	0.24	2.76	4.26
COUPPB	cents	156	5.22	2.75	0.81	18.96
INC	dollars	156	84,840.09	693.77	83,071.55	86,114.40
CDCCASE	number of confirmed cases	156	3.08	7.30	0.00	36.00

[a]Derived from ACNielsen Homsescan panels for household purchases, 2006, 2007, and 2008.
*See Table A.3 in Appendix A for the description of the variable labels.

Data for Analyzing PB at Brand Level

The time-series data set for the brand level analysis covers 156 consecutive weeks from Wednesday January 4, 2006 to Tuesday December 30, 2008 and includes weekly totals of quantities purchased, prices (unit values), and coupons. The final data set also included interpolated weekly income and a set of information variables.

This data set differs from the one used for PB category analysis in that it is broken into five distinct PB brands. As a result, instead of having one unit value (or total amount of PB purchased, or coupon) variable for the entire PB category, we now have five unit value (and five total amounts of PB purchased, and five coupons) variables, one for each PB brand. Particularly, one general group for jelly and five groups of PB brands are explored in this study: Private Label, Jif, Peter Pan, Skippy, and Other Brands. The Private Label PB brand group includes store brands of PB. The Jif PB brand group includes Jif, Simply Jif, Jif Smooth Sensations, and Jif To Go. The Peter Pan PB brand group incorporates Peter Pan, Peter Pan Whipped, and Peter Pan Plus. The Skippy PB brand consists of Skippy, Skippy Carb Options, and Skippy Natural. Finally, Other Brands include all the brands of PB except for Jif, Peter Pan, Skippy, as well as Private Label brands.

While the description and construction of the variables for the analysis are exactly the same as before, the imputation process of the missing values for Peter Pan unit values is different. To impute Peter Pan missing unit values, four regressions were successively run, in each case regressing Peter Pan unit values on one of the other brand's unit values. Then, the predicted Peter Pan unit values for the missing observations were collected from the four regression models and averaged yielding the imputed values to fill in for the missing ones (see Table A.2 in Appendix A). The basis for this regression-based imputation rests on the hypothesis that prices of substitutable brands move together. In addition, it needs to be mentioned that the quantity information for Peter Pan was zero over the recall weeks. Descriptive statistics of the variables included in the model are given in Table 3.2.

Table 3.2 shows that the average weekly total amounts of PB purchased per household of Private Label (*QPL*), Jif (*QJIF*), Peter Pan (*QPPAN*), Skippy (*QSKIPPY*), and Other Brands (*QOBRAND*) were 31.49, 35.74, 30.14, 34.96, and 22.60 ounces, respectively, over the studied period, suggesting that Jif is the leading brand followed by Skippy, Private Label, Peter Pan and Other Brands. In addition, the average real unit values of Private Label (*PPL*), Jif (*PJIF*), Peter Pan (*PPPAN*), Skippy (*PSKIPPY*), Other Brands (*POBRAND*), and jelly (*PJ*) were 4.14, 5.17, 4.84, 5.16, 7.40, and 3.22 cents per ounce, respectively, revealing that of all the PB brands Other Brands had the highest unit value, followed by Jif, Skippy, Peter Pan, and Private Label. The average of real per household coupon values of Private Label (*COUPPL*), Jif (*COUPJIF*), Skippy (*COUPSKIPPY*), and Other Brands (*COUPOBRAND*) were 1.63, 5.60, 8.27, and 4.25 cents, respectively, implying that, on average, larger coupon values were offered for Skippy, followed by Jif, Other Brands, and Private Label.

According to the law of demand, there is a negative relationship between price and quantity demanded. As such, all the coefficients associated with the own real unit values of PB were expected to be negative. In addition, theory posits a positive relationship between the price of a substitute good and the quantity of the good demanded in question. Thus, the coefficients associated with the real unit values of other PB brands were hypothesized to be positive. Theory suggests a negative relationship between the price of a complement good and the demand for the good in question. Hence, it was expected that the coefficients associated with the unit value of jelly would be negative.

Table 3.2. Descriptive Statistics of the Variables Used in the Analysis of Peanut Butter at the Brand Level[a]

Variables	Units	N	Mean	Std Dev	Min	Max
QPL	oz	156	31.49	1.33	28.68	35.12
QJIF	oz	156	35.74	2.48	30.93	44.49
QPPAN	oz	156	30.14	5.94	18.00	79.33
QSKIPPY	oz	156	34.96	2.18	29.93	43.13
QOBRAND	oz	156	22.60	1.15	19.93	27.98
PPL	cents/oz	156	4.14	0.23	3.67	4.61
PJIF	cents/oz	156	5.17	0.19	4.78	5.77
PPPAN	cents/oz	156	4.84	0.51	3.07	7.09
PSKIPPY	cents/oz	156	5.16	0.37	4.20	6.35
POBRAND	cents/oz	156	7.40	0.27	6.54	8.13
PJ	cents/oz	156	3.22	0.24	2.76	4.26
COUPPL	cents	156	1.63	1.42	0.22	8.63
COUPJIF	cents	156	5.60	3.69	0.10	20.34
COUPSKIPPY	cents	156	8.27	5.50	0.58	24.84
COUPOBRAND	cents	156	4.25	1.94	0.79	12.09

[a]Derived from ACNielsen Homsescan panels for household purchases, 2006, 2007, and 2008.
*See Table A.3 in Appendix A for the description of the variable labels.

Based on theory and the good in question (PB) the income effects were hypothesized to be positive, suggesting that PB is a normal good rather than an inferior good. Theory suggests a positive relationship between positive information and the demand for the good in question. Hence, the coefficient estimate associated with the coupon variable was anticipated to be positive, since coupon is a form of promotion (positive information).

The parameter estimate for the variable that counts weeks from recall was expected to be positive implying that as more and more weeks passed from the announcement of the recall, consumers would increase their consumption of PB. According to theory, the issuance of recalls likely results in a consumer response that ultimately leads to a decrease in the demand for the affected good. However, theory does not reveal any information regarding the magnitude and duration of this negative consumer response, which largely depends on consumer perceptions of the health risks and extent of knowledge associated with recalled products. As such, a negative sign was anticipated on all the coefficients associated with current and lagged outbreak variables, as well as the parameter estimate for the dummy variable associated with the beginning of the recall.

Empirical Specification and Estimation Results

One single-equation model and one system of equations concerning the demand for PB were estimated. The single-equation model that dealt with the analysis of PB as a category was specified as follows:

$$lnQPB_t=f(lnPPB_t, lnPJ_t, lnCOUPPB_t, lnINC_t, WKSFRRECALL_t, Q1, Q2, Q3,$$
$$SQRTCDCCASE_t,...SQRTCDCCASEt_{t-j}\ DUMMY_t)+v_t \qquad (3.9)$$

where $lnQPB_t$ is the natural logarithm of quantity purchased of PB per unique household; $lnPPB_t$ is the natural logarithm of the real unit value of PB; $lnPJ_t$ is the natural logarithm of the real unit value of jelly; $lnCOUPPB_t$ is the natural logarithm of values of coupons used when purchasing PB per unique household; $lnINC_t$ is the natural logarithm of real disposable personal income on a per household basis; $WKSFRRECALL_t$ counts number of weeks from the recall announcement; *Q1*, *Q2*, and *Q3*, are seasonality dummy variables; $SQRTCDCCASEt_{t-j}$ is the square root of the outbreak variable with lag j; $DUMMY_t$ is the dummy variable; and, v_t is the disturbance term in time t.

A system of equations dealing with the analysis of PB at the brand level was specified as follows:

$$lnQPB_{it}=f(lnPPB_{it}, lnPPB_{jt}, lnPJ_{t}, COUP_{it}, lnINC_t, WKSFRRECALL_t, Q1, Q2, Q3, SQRTCDCCASE_t, \ldots SQRTCDCCASEt_{t-j}, laglnQPB_{it}, DUMMY_t)+ \varepsilon_{it} \quad (3.10)$$

where $lnQPB_{it}$ is the natural logarithm of quantity purchased of PB of brand i per unique household; $lnPPB_{it}$ is the natural logarithm of the real unit value of PB of brand i; $lnPPB_{jt}$ is the natural logarithm of the real unit value of PB of brand j; $lnPJ_t$ is the natural logarithm of the real unit value of jelly; $COUP_{it}$ is the values of coupons used when purchasing PB of brand i per unique household; $lnINC_t$ is the natural logarithm of real disposable personal income on a per household basis; $laglnQPB_{it}$ is the dependent variable lagged one period; and, ε_{it} is the disturbance term in time t.

The description of $WKSFRRECALL_t$, *Q1*, *Q2*, *Q3*, $SQRTCDCCASEt_{t-j}$, and $DUMMY_t$ variables is the same as in the case of single-equation discussed above. Both single-equation and the system of equations were estimated using a second degree PDL specification with length of lag three. Head and tail endpoint restrictions were imposed and their use was supported through statistical tests. In addition, it needs to be noted that various combinations of both models were estimated using alternative lag lengths and degrees of polynomial. However, based on the SIC, the specification with lag length of three and a polynomial degree of two was chosen as the best (see Table A.4 in Appendix A). SAS 9.2 was the statistical software package used to estimate the double-log models without intercepts to circumvent degrading collinearity problems (see Tables A.5, A.6, A.7, and A.8 in Appendix A).

The four equations in the system were estimated simultaneously using a seemingly unrelated regressions (SUR) procedure for Private Label, Jif, Skippy, and Other Brands leaving Peter Pan out. In this way, we attempted to account for possible spillover effects among PB brands resulting from the recall of the Peter Pan PB. Before the estimation of the SUR, four equations, one for each PB brand, were estimated and the results from these four single-equation estimations were later compared to the ones from the SUR procedure. The comparison showed that the reductions in the standard errors of the coefficient estimates in the SUR approach were small implying weak cross-equation correlations. This finding also was confirmed by the correlation coefficients reported in Table 3.3 based on the residuals from the SUR procedure.

Table 3.3. The Variance-Covariance Matrix of Residuals in Correlation Form

	resid_lnQPL	resid_lnQJIF	resid_lnSKIPPY	resid_lnOBRAND
resid_lnQPL	1	0.06	-0.02	0.16
resid_lnQJIF	0.06	1	0.08	0.11
resid_lnSKIPPY	-0.02	0.08	1	-0.03
resid_lnOBRAND	0.16	0.11	-0.03	1

Notwithstanding the rather small improvement in the statistical significance of parameter estimates, the SUR procedure was ultimately used. In the SUR procedure, all the insignificant variables were sequentially dropped from the system of equations based on their extent of insignificance as measured by p-values. To account for serial correlation, a first order autoregressive correction was utilized. The R^2 was calculated by squaring the correlation coefficient between the actual and the predicted values of the dependent variables.

The estimated coefficients, which also are the elasticities, as well as the associated p-values from the single-equation and the system of equation specifications, were reported in Tables 3.4 and 3.5, respectively. The significance of coefficient estimates is indicated with asterisks; these correspond to p-values below the 0.05 level of significance chosen for this analysis.

According to Table 3.4, the R^2 for the PB category was 0.66 meaning that 66% of variation in the dependent variable was explained by the model. As expected, the parameter estimate for the unit value of PB was negative and statistically significant. Furthermore, the demand for PB was inelastic such that a 10% decline in PB unit value led to 8.5% increase in the quantity of PB demanded, holding all other factors constant.

The result of inelastic demand for PB compares favorably with the finding by Deodhar and Fletcher (1998) who calculated the long run own price elasticity of demand for PB to be -0.23. The parameter estimate for the unit value of jelly was negative, as hypothesized; however, it was statistically insignificant. As expected, the parameter estimate for the coupon was positive and statistically significant indicating that a 10% increase in the value of coupon resulted in a 0.1% increase in the demand for PB, *ceteris paribus*.

Table 3.4. Estimated Coefficients for the Peanut Butter Demand at the Category Level

Variables	Estimate	p-value
lnPPB	-0.848*	0.000
lnPJ	-0.016	0.671
lnCOUPPB	0.011*	0.039
lnINC	0.426*	0.000
WKSFRRECALL	0.001*	0.000
Q1	-0.015	0.061
Q2	-0.001	0.827
Q3	-0.003	0.291
DUMMY	-0.010	0.224
SQRTCDCCASE(0)	0.0011*	0.009
SQRTCDCCASE(1)	0.0017*	0.009
SQRTCDCCASE(2)	0.0017*	0.009
SQRTCDCCASE(3)	0.0011*	0.009
AR1	-0.268*	0.002
R^2	0.66	
Durbin-Watson	1.90	
F test of the quarterly dummies	1.54	
Pr > F	0.208	

* Statistically significant at the 5% level.
*See Table A.3 in Appendix A for the description of the variable labels.

The parameter estimate associated with income was positive and significantly different from zero implying that PB is a normal good and a 10% increase in income led to 4.3% increase in the demand for PB, controlling for all other factors. The parameter estimate for *WKSFRRECALL* variable was positive and statistically significant, as hypothesized. The estimated coefficient for the *DUMMY* variable, which controls for the structural shift in the demand for PB, was negative; however, it was statistically insignificant. Based on the joint test of the significance of the quarterly dummy variables, seasonality appeared to be an insignificant determinant of the demand for PB.

Contrary to our expectations, all estimated coefficients associated with the outbreak variable were positive and statistically significant suggesting that the recall had a demand-enhancing impact on the PB category. The maximum influence of the recall announcement took place one to two weeks after its release.

Letting w_s stand for the weight for lag period s, the short-run response in the quantity purchased of PB for a unit change in outbreak variable, evaluated at the sample means, is computed by $\frac{\sum w_0}{2} CDCCASE^{-0.5} QPB$ and the short-run elasticity associated with the outbreak variable is calculated by $\frac{\sum w_0}{2} CDCCASE^{0.5}$. In addition, the long-run response in the quantity purchased of PB given a one unit change in outbreak variable, at the sample means, is given by $\frac{\sum w_s}{2} CDCCASE^{-0.5} QPB$ and the long-run elasticity associated with the outbreak variable, at the sample means, is given by $\frac{\sum w_s}{2} CDCCASE^{0.5}$. It needs to be noted that both the short-run and the long-run elasticities associated with the outbreak variable measure the sensitivity of consumers' response to the number of confirmed cases of Salmonella Tennessee infection associated with consumption of PB reported by the CDC in the short-run and the long-run, respectively.

For the PB category, the short-run response was 0.011 indicating that each successive unit increase in the outbreak variable increased the short-run quantity purchased of PB by 0.011 ounces, *ceteris paribus*. The short-run elasticity associated with the outbreak variable was 0.001 indicating that as the outbreak variable went up by 10%, the short-run quantity purchased of PB increased by 0.01%, *ceteris paribus*.

For the PB category the long-run response was 0.053 meaning that for every unit increase in the outbreak variable, the long-run quantity purchased of PB increased by 0.053 ounces, everything else held constant. The long-run elasticity associated with the outbreak variable was 0.005 meaning that, in the long-run, a 10% increase in outbreak variable resulted in a 0.05% increase in the quantity purchased of PB, other factors held constant.

Table 3.5 is broken down into four pairs of columns with each pair of columns representing a specific PB brand. The discussion of the results in Table 3.5 is done one PB brand at a time and then summarized across the brands.

Table 3.5. Estimated Coefficients for the Peanut Butter Demand at the Brand Level

Variables	Private Label Estimate	Variables	Jif Estimate	Variables	Skippy Estimate	Variables	Other Brands Estimate
lnPPL	-1.025*	lnPJIF	-1.040*	lnPSKIPPY	-0.809*	lnPOBRAND	-0.776*
	(0.000)		(0.000)		(0.000)		(0.000)
lnPPAN	-0.061*						
	(0.025)						
lnINC	0.440*	lnINC	0.457*	lnINC	0.429*	lnINC	0.412*
	(0.000)		(0.000)		(0.000)		(0.000)
WKSFRRECALL	0.002*	WKSFRRECALL	0.002*	WKSFRRECALL	0.002*		
	(0.000)		(0.000)		(0.000)		
Q1	-0.019*	Q1	-0.018	Q1	0.035*	Q1	-0.015
	(0.042)		(0.054)		(0.005)		(0.149)
Q2	-0.007	Q2	0.002	Q2	0.011	Q2	-0.007
	(0.104)		(0.617)		(0.106)		(0.232)
Q3	-0.010*	Q3	0.001	Q3	0.005	Q3	-0.008*
	(0.000)		(0.722)		(0.226)		(0.031)
SQRTCDCCASE(0)	0.0006	SQRTCDCCASE(0)	0.0023*	SQRTCDCCASE(0)	-0.0019*	SQRTCDCCASE(0)	0.0004
	(0.253)		(0.000)		(0.005)		(0.403)
SQRTCDCCASE(1)	0.0008	SQRTCDCCASE(1)	0.0035*	SQRTCDCCASE(1)	-0.0029*	SQRTCDCCASE(1)	0.0007
	(0.253)		(0.000)		(0.005)		(0.403)
SQRTCDCCASE(2)	0.0008	SQRTCDCCASE(2)	0.0035*	SQRTCDCCASE(2)	-0.0029*	SQRTCDCCASE(2)	0.0007
	(0.253)		(0.000)		(0.005)		(0.403)
SQRTCDCCASE(3)	0.0006	SQRTCDCCASE(3)	0.0023*	SQRTCDCCASE(3)	-0.0019*	SQRTCDCCASE(3)	0.0004
	(0.253)		(0.000)		(0.005)		(0.403)
DUMMY	-0.050*	DUMMY	0.023*	DUMMY	-0.082*		
	(0.000)		(0.032)		(0.000)		
AR(1)	0.164	AR(1)	0.235*	AR(1)	0.118	AR(1)	0.129
	(0.050)		(0.005)		(0.155)		(0.116)
Test for seasonality:							
Wald's ChiSquared	14.51		7.76		8.21		5.03
p-value	0.002		0.051		0.042		0.170
R^2	0.51		0.81		0.50		0.38
Durbin-Watson	1.97		2.00		1.96		1.99

*p-values are in the parentheses.
*Statistically significant at the 5% level.
*Missing parameter estimates imply that corresponding variables were dropped from the model due to their statistical insignificance.
*See Table A.3 in Appendix A for the description of the variable labels.

Private Label

The R^2 for the Private Label model was 0.51 meaning that 51% of variation in the dependent variable was explained by the regression model. As hypothesized, the parameter estimate for the unit value of Private Label was negative and statistically significant. Furthermore, the demand for Private Label was elastic such that for 10% decrease in the unit value of Private Label the quantity of Private Label demanded increased 10.25%, *ceteris paribus*. Contrary to our expectations, the parameter estimate for the unit value of Peter Pan was negative and significant suggesting that Peter Pan was a complementary brand for Private Label products. Thus, a 10% decrease in the unit value of Peter Pan led to 0.61% decline in the demand for the Private Label PB, other factors held invariant. This unusual finding may be related to the presence of Great Value brand in the store brands (Private Label) group.

The coefficient estimate associated with income was positive and significantly different from zero meaning that Private Label PB is a normal good and a 10% increase in income led to 4.4% increase in the demand for Private Label PB, *ceteris paribus*. The coefficient estimate associated with *WKSFRRECALL* variable was positive and statistically significant, as anticipated, showing that as time passed by from the issuance of the recall, the demand for Private Label PB went up. The result of the joint test of the significance of the quarterly dummy variables implied that seasonality was a significant factor of the demand for Private Label PB. Particularly, the demand for Private Label PB was lower in the first three quarters relative to that in the fourth quarter. As anticipated, the coefficient estimate of the *DUMMY* variable was negative and significantly different from zero suggesting a structural decline in the demand for Private Label PB.

Contrary to our expectations, all the parameter estimates for the current and lagged outbreak variables were positive with the most impact occurring one to two weeks after the issuance of the recall; however, they were all statistically insignificant. For the Private Label PB, the short-run response was 0.005 meaning that for each additional unit increase in the outbreak variable, the short-run quantity purchased of Private Label PB increased by 0.005 ounces, all else held fixed. The short-run elasticity associated with the outbreak variable for Private Label was 0.0005 meaning that, in the short-run, a 10% increase in the outbreak variable resulted in 0.005% increase in the quantity purchased of Private Label PB, everything else held fixed.

For the Private Label PB, the long-run response was 0.025 implying that for every unit increase in the outbreak variable, the long-run quantity purchased of Private Label PB increased by 0.025 ounces, *ceteris paribus*. The long-run elasticity associated with the outbreak variable for Private Label PB was 0.002 meaning that, in the long-run, a 10% increase in the outbreak variable resulted in 0.02% increase in the quantity purchased of Private Label PB, *ceteris paribus*.

Jif

The R^2 for the Jif model was 0.81 meaning that 81% of variation in the dependent variable was accounted for by the model. As expected, the coefficient estimate of the unit value of Jif was negative and significantly different from zero.

Furthermore, the demand for the Jif PB was elastic such that a 10% decrease in the unit value of Jif resulted in a 10.4% increase in the quantity of Jif PB demanded, all other factors held constant. The income coefficient estimate was positive and statistically significant rendering Jif PB a normal good and indicating that a 10% increase in income increased the demand for Jif PB by 4.6%, everything else held constant. The parameter estimate for *WKSFRRECALL* variable was positive and statistically significant, as expected, meaning that with passage of time from the recall announcement, the demand for Jif PB increased. Seasonality was concluded to be a statistically insignificant factor affecting the demand for Jif PB according to the joint test of the significance of the quarterly dummy variables. Contrary to our anticipation, the coefficient estimate of the *DUMMY* variable was positive and significantly different from zero suggesting a structural increase in the demand for Jif.

Contrary to our hypothesis, the recall had a demand-enhancing impact on the demand for Jif with its biggest influence taking place one to two weeks after the release of the recall and with all the parameter estimates associated with the current and lagged outbreak variables exhibiting statistical significance. For the Jif PB, the short-run response was 0.024 meaning that, in the short-run, as the outbreak variable increased by one unit, the quantity purchased of Jif PB went up by 0.024 ounces, everything else held constant. The short-run elasticity associated with the outbreak variable for Jif PB was 0.002 meaning that, for every 10% increase in the outbreak variable, the short-run quantity purchased of Jif PB increased by 0.02%, everything else held constant.

For the Jif PB, the long-run response was 0.118 indicating that for every unit increase in the outbreak variable, the long-run quantity purchased of Jif PB increased by 0.118 ounces, controlling for the other variables. The long-run elasticity associated with the outbreak variable for Jif was 0.01 meaning that, in the long-run, a 10% increase in the outbreak variable led to 0.1% increase in the quantity purchased of Jif PB, *ceteris paribus*.

Skippy

The coefficient of determination for the Skippy model was 0.5 implying that half of the variation in the dependent variable was explained by the model. As anticipated, the coefficient estimate associated with the unit value of Skippy was negative and statistically significant. Furthermore, the demand for Skippy PB was inelastic such that a 10% decrease in the unit value of Skippy resulted in an 8.1% increase in the quantity of Skippy demanded, holding everything else fixed. The income parameter estimate was positive and significantly different from zero making the Skippy PB a normal good and implying that a 10% increase in income increased the demand for Skippy by 4.3%, everything else held fixed. In line with our expectations, the coefficient estimate associated with *WKSFRRECALL* variable was positive and statistically significant, indicating that the demand for Skippy increased, as more and more time went by from the announcement of the recall. Joint test of significance done on the seasonality dummies showed that seasonality was a statistically significant driver of the demand for the Skippy PB. Though the demand for Skippy was higher in the first three quarters relative to the fourth quarter; however, it was the strongest in the first quarter. The parameter estimate associated with the *DUMMY* was negative and significant, which was consistent with the hypothesis, pointing out that, on average, the demand for Skippy PB decreased after the recall.

Consistent with our expectations, the recall had a distorting impact on the demand for Skippy with its maximum effects occurring one to two weeks after the recall announcement and with all the coefficient estimates associated with the current and lagged outbreak variables displaying statistical significance. For the Skippy PB, the short-run response was -0.019 indicating that for each additional unit increase in the outbreak variable, in the short-run, the quantity of Skippy decreased by 0.019 ounces, *ceteris paribus*. The short-run elasticity associated with the outbreak variable for Skippy was -0.002 indicating that for every 10% increase in outbreak variable, there was 0.02% decrease in the quantity purchased of Skippy, *ceteris paribus*.

For the Skippy PB, the long-run response was -0.096 meaning that for every unit increase in the outbreak variable, the long-run quantity purchased of Skippy decreased by 0.096 ounces, everything else held fixed. The long-run elasticity associated with the outbreak variable for Skippy was -0.008 meaning that, in the long-run, a 10% increase in outbreak variable resulted in 0.08% decrease in the quantity purchased of Skippy, everything else held constant.

Other Brands

The coefficient of determination for the Other Brands model was 0.38 meaning that 38% of the variation in the dependent variable was accounted for by the model. As expected, the coefficient estimate of the unit value of Other Brands was negative and statistically significant. Furthermore, the demand for Other Brands PB was inelastic such that a 10% decrease in the unit value of Other Brands led to 7.8% increase in the quantity of Other Brands PB demanded, controlling for all the other factors. The income coefficient estimate was positive and statistically significant meaning that the Other Brands PB was a normal good and 10% increase in income increased the demand for the Other Brands PB by 4.1%, *ceteris paribus*. Seasonality did not appear to be a significant determinant of the demand for Other Brands PB, as evidenced by the joint test of the significance of the seasonal dummy variables.

Like Jif, Other Brands experienced a positive impact of the recall with the peak of the influence taking place one to two weeks after the public release of the recall announcement; however, in this case, the effects of the current and lagged outbreak variable were statistically insignificant.

For the Other Brands PB, the short-run response was 0.003 indicating that as the outbreak variable increased by one unit, the short-run quantity purchased of Other Brands increased by 0.003 ounces, holding all other factors fixed. The short-run elasticity associated with the outbreak variable for Other Brands was 0.0004 indicating that the short-run quantity purchased of Other Brands increased by 0.004%, as the outbreak variable went up by 10%, everything else held fixed.

For the Other Brands PB, the long-run response was 0.014 meaning that for every unit increase in the outbreak variable, the long-run quantity purchased of Other Brands increased by 0.014 ounces, *ceteris paribus*. The long-run elasticity associated with the outbreak variable for Other Brands was 0.002 meaning that, in the long-run, a 10% increase in outbreak variable resulted in 0.02% increase in the quantity purchased of Other Brands, *ceteris paribus*.

General Discussion of the Results in Tables 3.4 and 3.5

The discussion of the results in Tables 3.4 and 3.5 helps to answer the questions posed in the first section of Chapter III. First, it needs to be pointed out that the sporadic significance of the *DUMMY* variable and the *SQRTCDCCASE* variable, throughout the PB category and brand analysis, made it obvious that the recall did have an impact on the demand for the PB. The results showed that the peak effect of the recall occurred one to two weeks after its issuance. The statistically significant positive coefficient estimates of the current and lagged outbreak variables for the PB category and for the Jif brand attested to the fact that the recall had demand-enhancing effects on the PB category as a whole and on the Jif PB brand in particular. At the same time, the statistically significant negative coefficient estimates of the current and lagged outbreak variables for the Skippy brand imply that the recall had demand-diminishing effect on the Skippy PB brand. The current and lagged outbreak variables associated with the Private Label brand and Other Brands were statistically insignificant. The estimation results revealed that only own-price and income variables consistently exhibited statistical significance across the brands. According to the results, jelly was never a statistically significant complement for PB on any level and Peter Pan turned out to be a complement for the Private Label brand. Coupons had a significant positive influence on PB demand only at the category level. Seasonality appeared to have had a statistically significant effect on the demand for the Private Label PB brand and the Skippy PB brand. Finally, the calculated short-run and long-run elasticities associated with the recall were small in magnitude both at the category and brand levels. These results are consistent with the extant literature associated with measuring the impacts of either positive information (advertising and promotion) or negative information (food safety).

Conclusions, Limitations, and Recommendations for Future Research

The impact of a recall on the demand for PB was evaluated by estimating a second degree PDL with three lags (a lag length of three weeks) and endpoint restrictions imposed. The estimation results showed that the recall did have a statistically significant positive impact on the demand for PB as a category. A possible explanation for this result could be the re-stocking behavior of the households. In other words, not only did the households replace the jars of recalled PB brands with jars of other PB brands that were perceived to be safer, but they may have ended up actually purchasing more PB. In addition, the recall appeared to have had a statistically significant demand-enhancing effect on the Jif PB brand and a demand-diminishing effect on the Skippy PB brand. This result indicates spillover effects among PB brands where the recall of one PB brand (Peter Pan) led consumers to move away from the contaminated brand (Peter

Pan) toward other brand (Jif). In addition, it needs to be mentioned that in all the cases the maximum impact of the recall took place one to two weeks after the release of the recall. This finding suggests that consumers were paying close attention to the released recall announcement and they responded promptly.

Jelly was not found to be a statistically significant complement for PB either at the category or at the brand level. The seasonality was found to be a significant determinant of the demand for the Private Label brand and the Skippy brand. Finally, the computed short-run and long-run elasticities associated with the recall were small in magnitude both at the category level and at the brand level, which is somewhat indicative of consumer loyalty to PB brands.

A few limitations should be mentioned. First, the information on the likelihood of the recall release reaching the consumers was not included in this study. Hence, future research, perhaps, should consider appropriate adjustments to account for this situation, because with this additional information; we may have a better understanding of household behavior. Second, considering the fact that the recall also involved the Great Value brand, it would be appealing to have purchase data as well as sufficient information to construct a distinct outbreak variable for the Great Value brand too. However, because the data on this brand were collapsed into the group of the Private Label brand, it was impossible to disaggregate information on this brand from the rest of the private label PB products. Hence, future research should attempt to gather information on the Great Value brand and include it in the model as a separate brand to assess the impact of the recall associated with Great Value on the demand for PB.

However, due to its rather small market share, it is anticipated that the inclusion of Great Value in the analysis as a distinct factor may not result in notable changes in the overall findings. Third, given the time-series nature of the data, demographic variables such as age, sex, race, size of the households were not incorporated into the analysis. A future study associated with the consideration of detailed demographic variables merits consideration.

CHAPTER IV

PRE- AND POST-RECALL DEMAND SYSTEMS ESTIMATION FOR PEANUT BUTTER IN LIGHT OF THE RECALL OF THE PETER PAN BRAND

Introduction

Demand systems often have been favored over single equations when dealing with consumer demand analysis (Lee et al. 1994) perhaps due to the ease with which theoretically consistent restrictions such as homogeneity and symmetry are imposed. Specifically, the Linear Expenditure System (LES) was introduced by Stone (1954) and was derived from the maximization of a well-specified utility function subject to a budget constraint. The translog model was developed by Christensen et al. (1975) who obtained estimable demand equations by applying Roy's identity to a specified indirect utility function. The Almost Ideal Demand System (AIDS) was derived by Deaton and Muellbauer (1980) from the minimization of a functionally specified expenditure (or cost) function making use of Shephard's lemma. Finally, Barten (1964) and Theil (1965) introduced the Rotterdam model, which was based on a first-order approximation to Marshallian demand equations.

Barten (1993) developed a general model, known as Barten's synthetic model (BSM), which nests the differential versions of the Rotterdam and AIDS models, as well as the Dutch Central Bureau of Statistics (CBS) model introduced by Keller and van Driel (1985) and the NBR model introduced by Neves (1987). Barten's differential demand system possesses a few appealing features including functional form flexibility, linearity in parameters, potential to render variables stationary due to the required first-differencing process, and its ability to introduce dynamics. All of these, coupled with the fact that the BSM allows a determination of the specific functional form best supported by the data set used, enhance its practical application.

In this study, we use the BSM to analyze the effects of the peanut butter (PB) recall on the demand for the product. Specifically, the objectives of this study are (1) to empirically investigate whether the PB recall resulted in a significant structural change in demand relationships by obtaining matrices of compensated and uncompensated demand elasticities for the pre- and post-recall periods and testing each element in the matrices from the pre-recall (post-recall) period against its counterpart from the post-recall (pre-recall) period; (2) to determine the "best" model specification for studying the particular PB recall event by comparing and analyzing four versions of the differential functional forms of demand systems nested within the BSM; and (3) to capture any changes in the own-price and cross-price effects across PB brands under consideration brought about by the PB recall event.

This analysis differs from previous research in a few ways: (1) a one-to-one comparison of the respective elements of compensated and uncompensated demand elasticity matrices is used to detect a structural change in the demand for PB caused by a recall as opposed to a conventional way of incorporating dummy variables to capture the structural change; (2) the study is done at the brand level using ACNielsen Homescan scanner data, thus adding to our understanding of the competition among the PB brands in the presence of the recall; and (3) the research work uses the BSM, which helps in identifying the “best” differential demand system supported by the data set for studying the effects of the recall as well as to introduce dynamics into the analysis.

The research results will be important to policy makers in the public sector as well as decision makers in the private sector in helping them render strategic decisions on food recalls in general and with PB as a case study. The remainder of Chapter IV is structured as follows. The next section provides a literature review on the empirical application of demand systems for studying the impact of recalls on consumer demand. The subsequent section presents a theoretical background on differential demand systems where the derivation of the final empirical model estimated in this study is presented. Then, data sets are discussed in the ensuing section followed by the discussion of the estimation procedure and empirical results. The conclusions and recommendations for future research are presented in the final section.

Literature Review

The issue of consumer responsiveness to public health information provided via different sources of media has been studied by estimating single equations as well as by estimating demand systems. These models incorporated various types of media indices to capture the impact of information on the consumption of a variety of food products. While some studies used exclusively negative health information (e.g. recalls), others incorporated only positive information (e.g. advertising), and another group of articles included both types of information to investigate the effects of information on the demand for various food products.

The application of demand systems has not been limited to studying exclusively health information impacts on consumer behavior. The demand systems approach also can be applied to study the impacts of informational shocks of various types. For example, in a study by Lusk (2010), the AIDS was estimated to analyze the informational influence of Proposition 2 on the demand for eggs empirically. Proposition 2 dealt with the use of cage-free systems for egg production in the state of California. Overall, two alternative AIDS specifications were estimated for four types of eggs: cage-free, organic, conventional, and other types, employing weekly retail scanner data set from January 1, 2007 to January 25, 2009 for two spatially separated locations: San Francisco/Oakland (SFO) and Dallas/Fort Worth (DFW). The SFO was the target location for Proposition 2, and the DFW location was a control site. The first specification included a time trend variable and the second specification included an "information index." This "information index" was constructed based on the cumulative number of articles in the *San Francisco Chronicle* giving publicity to Proposition 2 by searching Lexis-Nexis using "Prop 2" and "Proposition 2" keywords. Ultimately, the first specification of AIDS was preferred over the second one based on the Schwarz Information Criterion (SIC) and Akaike Information Criterion (AIC) values. The results of the study showed that Proposition 2 had a significantly positive impact on the demand for cage-free eggs and organic eggs in SFO.

Brown and Schrader (1990) studied the influence of cholesterol information on the demand for the shell eggs by estimating a variant of a double log demand equation. The quarterly time-series data used covered the periods from 1955 to 1987 and from

1966 to 1987. The cholesterol index was developed after reviewing almost 3,200 journals from Medline database and was constructed based on the running total of the number of articles that either supported or questioned a link between diet cholesterol or serum cholesterol and heart disease. The results of the study showed that cholesterol index had a statistically significant impact on the consumption of shell eggs.

Capps and Schmitz (1991a) analyzed the impact of the health information on the demand for beef, pork, poultry, and fish by estimating a Rotterdam model. In their study, annual data from 1966 to 1988 were utilized. The aforementioned cholesterol information index developed by Brown and Schrader (1990) was used in the analysis. The estimation results showed that cholesterol information index had a statistically significant impact on the demand for all meat types except beef.

Burton and Young (1996) empirically analyzed the impact of BSE on the demand for beef and other meat products in Great Britain employing a dynamic AIDS model allowing for short-term and long-term responses to changes in market conditions. The quarterly data used in this study ranged from 1961:1 to 1993:3. An indicator variable developed to account for consumer awareness of BSE was constructed given the number of newspaper articles published that mentioned BSE. The results showed that consumer awareness of BSE led to the loss in market shares of beef producers both in the short-run and in the long-run.

Kinnucan et al. (1997) empirically analyzed the impact of health information and generic advertising surrounding beef, pork, poultry (chicken and turkey), and fish on meat consumption in the United States by estimating a meat demand system applying the absolute-price version of the Rotterdam model. The quarterly data used in analysis ranged from 1976 through 1993. However, the entire data set was broken into two separate data sets, original and updated, in order to check the robustness of parameter estimates to sample updating. The original data set spanned from 1976:1 to 1991:3 and the updated data set included the original data set plus nine subsequent observations. The advertising data came from quarterly issues of AD $ Summary published by the Leading National Advertisers, Inc. A health information index was developed using Brown and Schrader's cholesterol index as basic data updated through 1993:4. The results showed that the cholesterol information index was a statistically significant determinant of meat consumption. As for the generic advertising effects, out of 24 parameter estimates obtained from the estimations using both original and updated data sets, only three were found to be statistically significant. In particular, employing the original data set revealed that a one-period lag of generic advertising of beef had a statistically significant positive impact on the demand for beef and a statistically significant negative impact on the demand for poultry. At the same time, the results from using the updated data set showed that advertising of beef led to a statistically significant positive impact on the demands for pork and fish but had statistically insignificant impact on the demands for beef and poultry.

Verbeke and Ward (2001) empirically investigated consumer behavior in the light of negative public media coverage concerning food safety issues and positive advertisement surrounding fresh meat in Belgium. The analysis was conducted by estimating a linear approximation of the AIDS model for three meat product groups:

beef and veal, pork and meat mixtures, and poultry. The panel data employed in this analysis included monthly observations ranging from January 1995 to December 1998, a total of 48 data points. The television advertising expenditures variable was measured as the nominal amount of money spent for generic and brand advertising for the product groups in question. The mass media index, expected to account for consumer awareness of meat-related health issues, was constructed by subtracting the number of positive TV reports from the number of negative TV reports regarding the effects of meat consumption on human health. The influence of adverse publicity primarily concerning BSE was statistically significant and had a negative effects on the consumption of beef/veal and positive effects on the consumption of pork/mixture. Own advertising effects were shown to be positive and significant on pork/mixture consumption, and positive, although insignificant, on beef/veal consumption.

Smed and Jensen (2003) analyzed the effects of negative press news concerning the presence of salmonella in eggs on the consumption for “safe” (i.e., pasteurized) eggs using dynamic models. The analysis was conducted by estimating an Error Correction Model (ECM) specification of the AIDS model allowing for both short-run dynamics and adjustments to long-run equilibrium. The household panel data used in this analysis included weekly observations ranging from 1997 to 2000 with for about 2,000 households. The information variable was constructed as a weighted sum of the number of articles in major newspapers and the amount of TV coverage in the same week where the weights were assigned to articles based on the seriousness of the news provided.

They found that negative press news regarding salmonella in shell eggs led to statistically significant demand-enhancing effects on the demand for pasteurized eggs.

Vickner, Marks, and Kalaitzandonakes (2003) attempted to measure consumer response to the recall event of Starlink corn empirically. Overall, two conditional nonlinear AIDS models for two separate product groupings such as salted snacks (Starlink corn tortilla chips versus non-Starlink corn tortilla chips and potato chips) and chili seasonings (Carroll Shelby's Original Texas Brand chili seasonings kit versus all other non-Starlink chili seasonings kits) were estimated accounting for relative prices, per capita real expenditure, holidays, post-recall demand trends and the media. A syndicated point-of-purchase scanner data set for two product categories, salted snacks and chili seasonings at the national level were used in this study. The data set consisted of observations for 154 consecutive weeks, from the Saturday ending January 22, 2000 to the Saturday ending December 28, 2002.

The recall variable in the Starlink share equation was included as a dummy variable, which assumed 1 for the recall week and 0 otherwise, to account for an immediate impact of the recall announcement. One of the media variables was constructed based on the frequency of the word "Starlink" found in three newspapers: *USA Today*, *The Washington Post*, and the *Wall Street Journal*, by searching Lexis-Nexis using "Starlink" as the keyword. These three frequency series each coming from a separate newspaper were then put together to form one composite frequency series, which also was aggregated into a weekly series to match the scanner data set. In addition, the effect of *USA Today* was tested separately. The other media variable was included in the model as a dummy, which took on 1 in the week ending Saturday September 23, 2000, and 0 otherwise. This week corresponded to Dan Rather's breaking newscast on the CBS evening news. Findings in this study showed that the coefficient estimates for the recall variables were statistically insignificant. Some evidence was present indicating a market share loss for corn tortilla chips because of the story in *USA Today*; however, the post-recall consumption level for corn tortilla chips recovered soon and reached its pre-recall level by the end of 2002.

Fousekis and Revell (2004) analyzed the demand for nineteen disaggregated retail meat cuts in Great Britain in the light of food scares. The analysis was carried out by estimating a linear approximation of the AIDS model. The data used in this study were aggregate price and expenditure data that had been derived from the use of weekly Taylor Nelson Sofres consumer Superpanel data that consisted of a sample of more than 8,000 households over the period from 1989 to 2000 provided by the Meat and Livestock Commission (MLC). In addition, the MLC provided data on calendar monthly advertising expenditures in the media (press, TV, and radio) for beef, pork, and lamb as well as on generic red meat advertising. The stock of meat scares was derived from an index of adverse publicity for meat labeled the ‘‘Meat Press Reports Index’’ collected for the Department of the Environment, Food and Rural Affairs (DEFRA). This index consisted of the number of articles in the major UK daily newspapers (*The Times*, *Sunday Times*, *Guardian*, and *Observer*) giving adverse publicity to meat and health issues. According to the findings, BSE led consumers to switch from the consumption of red meat towards the consumption of white meat. Overall, the consumer reaction to meat scares exceeded consumer reaction to advertising.

Marsh, Schroeder, and Mintert (2004) evaluated the impact of meat product recall events on the demand for beef, pork, poultry, and other products in the United States. The analysis was conducted through the estimation of the absolute price version of the Rotterdam model. The quarterly beef, pork, chicken, and turkey data set employed in this study ranged from 1982 to 1998. Two measures of meat product recalls were developed, one based on Food Safety Inspection Service (FSIS) reports, and the other based on media reports from the popular press. The first measure was constructed by aggregation of the number of FSIS reported recall events for beef, pork, and poultry in each quarter. The second measure was constructed by searching the top 50 English language newspapers in circulation from 1982 to 1998. The newspaper articles were then aggregated to develop quarterly beef, pork, and poultry media indices. They found that unlike newspaper reports, FSIS reported recall events had mainly negative significant effects on the demand for beef and pork and predominantly positive significant effects on the demand for poultry and other products.

Piggott and Marsh (2004) studied the impact of public information related to food safety issues regarding beef, pork, and poultry reported in the media on consumption of meat using a Generalized Almost Ideal Demand System (GAIDS). Own- as well as cross-commodity impacts on the demand from food safety concerns were estimated. Quarterly meat data ranging from 1982:1 to 1999:3, 71 observations total were used in this study. Separate food safety indices for beef, pork, and poultry were constructed by aggregating the number of newspaper articles concerning food safety issues from the top 50 English language newspapers in circulation from 1982 to 1999. They found that consumers responded to contemporaneous media coverage of health hazards.

Peterson and Chen (2005) empirically evaluated the impact of BSE on the demand for different types of beef such as wagyu beef (Japanese native breed cattle), dairy, U.S., and Australian imported beef. Along with these four types of beef, other commodities such as pork, poultry, and seafood were included in the demand system for empirical analysis. The meat demand system was estimated applying the absolute price version of the Rotterdam model. The data set consisted of 105 monthly observations from April 1994 through December 2002. A transition function (l_t) was specified to capture the structural change in demand to account for the impact of BSE that looks as follows l_t=0 for t=1,...,t_1, l_t=f((t-t_1)/(t_2-t_1)) for t=t_1+1,...,t_2, and l_t=1 for t=t_2+1,...,T, where t_1 is the end of the first regime, t_2 is the end of the transition period, and T is the end of the sample period. Depending on the size of t_2-t_1 and the functional form f(.), the transition path could be abrupt or gradual. They found that the demand for all types of beef went through a transition period for two months starting from the initial discovery of BSE.

Pritchett et al. (2007) empirically investigated consumer demand for meat cuts of beef, pork, and chicken given the announcements of BSE in Canada and the United States. In addition, the study addressed the issues of analyzing if and by how much consumer behavior had been affected by the intensity and nature of media coverage of

BSE events. Budget share equations for products considered were estimated using the AIDS model. The data set employed in this study was constructed from monthly retail scanner data for 191 different meat products sold in U.S. retail grocery stores from January 2001 through February 2005. To measure the impact of media coverage, an information variable was included in four different model specifications. Particularly, the media coverage was included as a dummy, as a number of positive articles (describing beef food safety in favorable terms), as a number of negative articles (suggesting issues regarding beef food safety), as well as a "net" between negative and positive articles. The results showed that the BSE events had a negative impact on the demand for ground beef and chuck roasts and a positive impact on the demand for center-cut pork chops.

Arnade, Calvin, and Kuchler (2008) empirically measured consumer responsiveness to public information related to food safety issues surrounding spinach reported by Food and Drug Administration (FDA). A linear approximation of the AIDS model was estimated to capture the own- as well as cross-commodity impacts of food safety issues on the demands for six related leafy green products (bulk lettuce, bulk spinach, spinach in bags, bulk iceberg lettuce, salad without spinach, romaine hearts). The data set used in the analysis contained national-level, weekly (total of 208 weeks) point-of-sale scanner data from 2004 to 2007, two and a half years before the spinach shock and one and a half years after. To account for the impact of public information concerning food safety issues, five "shock" variables, each representing a distinct nature of consumer response, were included in the model. The first shock variable was expected to account for a permanent shift in demand and was modeled as a dummy variable taking on a value of zero before the announcement and one after the announcement. The other four dummy shock variables allowed for the possibility of consumer response to be transitory. The first pair of dummy shock variables was used to allow the shock to be immediate followed by either rapid or slow decay. The second pair of binary shock variables was used to allow the shock to be immediate followed by gradual increase and decay. More than one of the shock variables turned out to be statistically significant meaning that food safety issues did have an impact on consumer demand for the spinach; however, it was impossible to identify the exact nature of consumer response due to the simultaneous statistical significance of the few shock variables. For example, variables that were simultaneously included in the model to capture both transitory and permanent consumer response were found to be statistically significant, which makes it hard to conclude whether the response was transitory or permanent.

Theoretical Background on Differential Demand Systems

The following discussion of the differential demand systems (DDS) is borrowed mainly from the work of Matsuda (2005). Satisfying certain assumptions, well-behaved consumer preferences can be represented by a quasi-concave and twice differentiable utility function as follows:

$$U(q_i), i = 1, \dots, n, \tag{4.1}$$

where q_i represents the quantity of the good i. Given the consumer's non-zero but limited budget (expenditure), the consumer's problem is to maximize utility subject to the budget constraint, such as:

$$\max_{q_i} U(q_i) \ s.t. \sum_{i=1}^{n} p_i q_i = m, \tag{4.2}$$

where p_i is the nominal price vector of n goods and m is the total expenditure on the goods. The solution of the first-order conditions (FOC) yields the Marshallian (uncompensated) demand for good i as a function of prices and total expenditure, represented as $q_i(\boldsymbol{p}, m)$.

The first step in developing differential demand systems envisions taking a total differential of $q_i(\boldsymbol{p}, m)$ as follows:

$$dq_i(\boldsymbol{p}, m) = \frac{\partial q_i(\boldsymbol{p},m)}{\partial m} dm + \sum_j \frac{\partial q_i(\boldsymbol{p},m)}{\partial p_j} dp_j, i, j = 1, \ldots, n, \tag{4.3}$$

Define $h_i(p, u)$ as the Hicksian (compensated) demand function for good i, where u is the given level of utility. Then the Slutsky equation is used to establish the relationship between the Marshallian and the Hicksian demand functions in the following way:

$$\frac{\partial q_i(p,m)}{\partial p_j} = \frac{\partial h_i(p,u)}{\partial p_j} - \frac{\partial q_i(p,m)}{\partial m} q_j(\boldsymbol{p}, m), i, j = 1, \ldots n. \tag{4.4}$$

The total differentiation of the budget constraint yields

$$\sum_i p_i dq_i = dm - \sum_i q_i dp_i \,. \tag{4.5}$$

Plugging equation (4.4) into equation (4.3) and using equation (4.5) and finally multiplying both sides of the resulting equation by p_i/m results in

$$w_i d \log q_i = p_i \frac{\partial q_i}{\partial m} d \log Q + \sum_j \frac{p_i p_j}{m} \frac{\partial h_i}{\partial p_j} d \log p_j, \ i = 1, \ldots, n, \tag{4.6}$$

where log is the natural logarithm, $w_i = \frac{p_i q_i}{m}$ is the expenditure share of good i, $d\,log\,Q = \sum_i w_i d\log q_i$ is the Divisia volume index, $\frac{p_i \partial q_i}{\partial m}$ is the marginal budget share of good i, and $\left(\frac{p_i p_j}{m}\right)\left(\frac{\partial h_i}{\partial p_j}\right)$ is the Slutsky term or the *ij*th element of the Slutsky matrix. Equation (4.6) serves as a backbone for deriving alternative differential demand systems via different approximations of the marginal budget share and the Slutsky terms. So, if the marginal budget share and the Slutsky terms are approximated to be constant, the equation (4.6) becomes

$$w_i d\log q_i = b_i d\log Q + \sum_j s_{ij} d\log p_j, i = 1, \dots, n, \tag{4.7}$$

which is the Rotterdam model.

Subtracting $w_i\, d\, log\, Q$ from both sides of equation (4.7) and defining a new parameter $c_i = b_i - w_i$, another specification of differential demand systems is obtained as

$$w_i(d\log q_i - d\log Q) = c_i d\log Q + \sum_j s_{ij} d\log p_j, i = 1, \dots, n, \tag{4.8}$$

which is known as the CBS model.

Define the Divisia price index as $d\,log\,P = \sum_i w_i d\,log\,p_i = d\,log\,m - d\,log\,Q$ and δ_{ij} as the Kronecker delta, which is equal to 1 if i=j and zero otherwise. Adding $w_i(d\log p_i - d\log P)$ to both sides of equation (4.8), the left-hand side becomes

$$w_i(d\log p_i + d\log q_i - d\log m) = dw_i, \qquad (4.9),$$

and then defining parameter $r_{ij} = s_{ij} + w_i(\delta_{ij} - w_j)$ results in

$$dw_i = c_i d\log Q + \sum_j r_{ij} d\log p_j\,, i = 1, \dots, n. \tag{4.10}$$

Equation (4.10) is the linear approximation of the AIDS model in differential form, where the price index of the original nonlinear AIDS defined as $\log P^* = \alpha_0 +$

$\sum_i \alpha_i \log p_i + 0.5 \sum_i \sum_j r_{ij} \log p_i p_j$ is replaced by the Stone price index defined as $\log P = \sum_i w_i \log p_i$.

Adding $w_i\ d\ log\ Q$ to both sides of equation (4.10) results in yet another specification of a differential demand systems known as the NBR model:

$$dw_i + w_i d \log Q = b_i d \log Q + \sum_j r_{ij} d \log p_j\ , i = 1, \dots, n. \qquad (4.11)$$

The equations (4.7), (4.8), (4.10), and (4.11) have the same right-hand side variables but different left-hand side variables. Using the relation derived from equation (4.9),

$$dw_i = w_i d \log q_i - w_i d \log Q + \sum_j w_i (\delta_{ij} - w_j) d \log p_{j,} \qquad (4.12)$$

the left-hand sides of equations (4.8), (4.10), and (4.11) can be made the same as that of the equation (4.7). As such, equations (4.8), (4.10), and (4.11) can be rewritten as

$$w_i d \log q_i = (c_i + w_i) d \log Q + \sum_j s_{ij} d \log p_j, i = 1, \dots, n. \qquad (4.13)$$

$$w_i d \log q_i = (c_i + w_i) d \log Q + \sum_j \left(r_{ij} - w_i (\delta_{ij} - w_j) \right) d \log p_j,\ i = 1, \dots, n. \qquad (4.14)$$

$$w_i d \log q_i = b_i d \log Q + \sum_j \left(r_{ij} - w_i (\delta_{ij} - w_j) \right) d \log p_j, i = 1, \dots, n. \qquad (4.15)$$

From equations (4.7), (4.13), (4.14), and (4.15) it becomes obvious that the marginal budget shares are constant in the Rotterdam model and in the NBR model, while they vary with expenditure shares in the AIDS model and in the CBS model. In addition, the Slutsky terms are constant in the Rotterdam model and in the CBS model, while they vary with expenditure shares in the AIDS model and the NBR model.

The aforementioned models (Rotterdam, AIDS, CBS, and NBR) are not nested within each other; however, Barten (1993) developed a general model (the Barten Synthetic Model, or BSM) that nested all of them as follows:

$$w_i d \log q_i = (\beta_i + \lambda w_i) d \log Q + \sum_j \left(\gamma_{ij} - \mu w_i(\delta_{ij} - w_j)\right) d \log p_j, i = 1, \dots, n, \tag{4.16}$$

where $\beta_i = (1 - \lambda) b_i + \lambda c_i$ and $\gamma_{ij} = (1 - \mu) s_{ij} + \mu r_{ij}$. Equation (4.16) becomes the Rotterdam model when both λ and μ are restricted to zero; the CBS model when λ is equal to 1 and μ is equal to 0; the NBR model when λ is equal to 0 and μ is equal to 1; and, finally, the AIDS model when both λ and μ are restricted to one. The equation given by (4.16) is estimated in this study with a correction for serial correction.

Classical demand restrictions consistent with economic theory are imposed in the BSM model using parameter constraints.

Adding-up: $\sum_{i=1}^{n} \beta_i = 1 - \lambda_i$ and $\sum_{i=1}^{n} \gamma_{ij} = 0, j = 1, \dots, n,$ (4.17)

Homogeneity: $\sum_{j=1}^{n} \gamma_{ij} = 0, i = 1, \dots, n,$ (4.18)

Symmetry: $\gamma_{ij} = \gamma_{ji}, i, j = 1, \dots, n, i \neq j.$ (4.19)

The compensated price elasticities of equation (4.16) are given by

$$e_{ij}^{c} = \frac{\gamma_{ij}}{w_i} - \mu(\delta_{ij} - w_j), \tag{4.20}$$

where w_i and w_j denote the budget shares of commodity i and j, respectively, and δ is the Kronecker delta.

Using the Slutsky equation, the uncompensated price elasticities are computed as

$$e_{ij}^{u} = e_{ij}^{c} - e_i w_j. \tag{4.21}$$

The uncompensated cross-price elasticities are used to evaluate the symmetry property in elasticity form using the following equation:

$$e_{ij}^{u} = \left(\frac{w_j}{w_i}\right) e_{ji}^{u} + w_j\left(e_j - e_i\right), \tag{4.22}$$

where e_i and e_j are the expenditure elasticities of commodity i and j, respectively.

The expenditure elasticity is given by

$$e_i = \frac{\beta_i}{w_i} + \lambda. \tag{4.23}$$

Data

The differential terms used in the estimation of the BSM are developed from the same time-series data set used in Chapter III of the polynomial distributed lag analysis at the PB brand level consisting of weekly totals of quantities purchased and prices (real unit values) of competing PB brands. The variable construction process is outlined in detail in the data section of Chapter III. However, for this exercise the entire data set is broken into two separate data sets: the pre-recall and the post-recall. The pre-recall period ranges from January 4, 2006 through February 13, 2007 totaled 58 weekly observations, while the post-recall period ranges from August 22, 2007 through December 30, 2008 totaled 71 weekly observations.

Table 4.1 presents the descriptive statistics of the PB quantities and prices (real unit values) for the five PB brands for the pre-recall period. According to the results in Table 4.1, on average, Skippy is number one in terms of quantities purchased with 35.46 ounces per week followed by Jif, Private Label, Peter Pan, and Other Brands with 33.51, 31.93, 30.49, and 22.67 ounces, respectively. However, Other Brands ranks first in terms of prices with an average weekly price of 7.44 cents per ounce. The second most expensive PB brand is Jif with an average price of 5.09 cents per ounce followed by Skippy and Peter Pan with average prices of 4.96 and 4.68 cents, respectively. Finally, not surprisingly, Private Label is priced the lowest in terms of the average price. In terms of market share in the pre-recall period, Jif and Skippy led the way (with 22% each) followed by Other Brands (21%), Peter Pan (18%), and Private Label (16%).

Table 4.1. Descriptive Statistics of Peanut Butter Quantities Purchased and Prices (Real Unit Values[a]) from January 4, 2006 through February 13, 2007[b] (Pre-Recall)

Variables	Units	N	Mean	Median	Std Dev	Min	Max
Private Label Quantity	oz	58	31.93	31.82	1.56	28.68	35.12
Jif Quantity	oz	58	33.51	32.94	1.83	30.93	37.92
Peter Pan Quantity	oz	58	30.49	29.52	2.95	27.18	41.76
Skippy Quantity	oz	58	35.46	35.33	2.24	29.93	42.12
Other Brands Quantity	oz	58	22.67	22.60	1.52	19.93	27.98
Private Label Price	cents/oz	58	4.01	4.02	0.13	3.67	4.21
Jif Price	cents/oz	58	5.09	5.11	0.13	4.78	5.37
Peter Pan Price	cents/oz	58	4.68	4.71	0.16	4.21	4.97
Skippy Price	cents/oz	58	4.96	5.01	0.26	4.20	5.32
Other Brands Price	cents/oz	58	7.44	7.43	0.31	6.54	8.13

[a]Prices reported in the Table are the unit values, which also account for coupons.
[b]Derived from ACNielsen Homsescan panels for household purchases 2006, 2007, and 2008.

Table 4.2 presents the descriptive statistics of the PB quantities and prices for the five PB brands for the post-recall period. Table 4.2 shows that the average total quantities purchased of Jif are the highest, with 37.69 ounces. In addition, in terms of average quantities, Skippy ranks second with 35.03 ounces followed by Private Label, Peter Pan, and Other Brands with 31.07, 30.44, and 22.56 ounces, respectively. In addition, Other Brands is still the highest priced PB brand with an average price (real unit value) of 7.43 cents per ounce. The second most expensive PB brand is Skippy with 5.37 cents per ounce followed by Jif, Peter Pan, and Private Label with average prices of 5.26, 4.90, and 4.32 cents per ounce. In terms of market share in the post-recall period, Jif enjoyed the largest market share (24%) followed by Skippy (22%), Other Brands (20), Peter Pan (18%), and Private Label (16%).

Overall, the results in both tables reveal that in terms of average quantity purchased, the recall slightly affected the ordering of brands across the pre-recall and the post-recall periods; Jif replaced Skippy as the number one brand followed by Private Label, Peter Pan, and Other Brands. In fact, there is a change in quantity purchased for the respective PB brands. The percentage change in terms of average quantity purchased for Jif is 12.46%, for Skippy is -1.21%, for Other Brands is -0.45%, for Private Label is -2.67%, and for Peter Pan is -0.15%. As such, only Jif recorded a positive change in its sales volume, while the rest of the brands posted a negative change in their corresponding sales volumes going from the pre-recall period to the post-recall period.

Table 4.2. Descriptive Statistics of Peanut Butter Quantities Purchased and Prices (Real Unit Values[a]) from August 22, 2007 through December 30, 2008[b] (Post-Recall)

Variables	Units	N	Mean	Median	Std Dev	Min	Max
Private Label Quantity	oz	71	31.07	30.99	1.06	29.35	34.74
Jif Quantity	oz	71	37.69	37.21	1.61	35.28	44.49
Peter Pan Quantity	oz	71	30.44	29.88	3.77	24.29	42.80
Skippy Quantity	oz	71	35.03	34.97	2.15	31.24	43.13
Other Brands Quantity	oz	71	22.56	22.49	0.88	20.89	25.68
Private Label Price	cents/oz	71	4.32	4.36	0.19	3.88	4.61
Jif Price	cents/oz	71	5.26	5.18	0.22	4.81	5.77
Peter Pan Price	cents/oz	71	4.90	5.02	0.59	3.37	5.73
Skippy Price	cents/oz	71	5.37	5.39	0.40	4.28	6.35
Other Brands Price	cents/oz	71	7.43	7.46	0.23	6.64	7.94

[a]Prices reported in the table are the unit values, which also account for coupons.
[b]Derived from ACNielsen Homsescan panels for household purchases, 2006, 2007, and 2008.

As far as the average prices (real unit values) go, the ordering of the brands changed from the pre- to post-recall periods with Jif switching places with Skippy. Except for Other Brands, the average prices for all the PB brands increased from the pre- to the post-recall periods. Particularly, Skippy recorded an 8.2% increase; Private Label recorded a 7.5% increase; Peter Pan recorded a 4.7% increase; Jif recorded a 3.4% increase; and, finally, Other Brands posted a 0.1% decrease. Across the two recall periods, no change in the market share was recorded for Private Label, Peter Pan, and Skippy. From the pre-recall period to the post-recall period, the market share for Jif increased by 2% and the market share for Other Brands decreased by 1%.

In the following series of figures, graphical illustrations of the quantities purchased and prices (real unit values) for all PB brands for the pre- and the post-recall periods are presented. Figure 4.1 shows that PB quantities purchased for all PB brands revolve around their respective means; however, Peter Pan displays a sharp increase in weeks 30 and 42, which correspond to the periods covering the end of July and the beginning of October 2006, respectively. A possible explanation for these spikes could be the fact that as the data on the number of outbreaks of the strain of Salmonella serotype Tennessee associated with Peter Pan PB reported by CDC started to become available exactly in week 30 and that number slowly increased through week 42, consumers increased their purchases of Peter Pan in an anticipation that soon it would become unavailable as the negative information on this PB brand continued to be released. Figure 4.2 shows that prices for all PB brands, on average, remained at a relatively constant level over the pre-recall period.

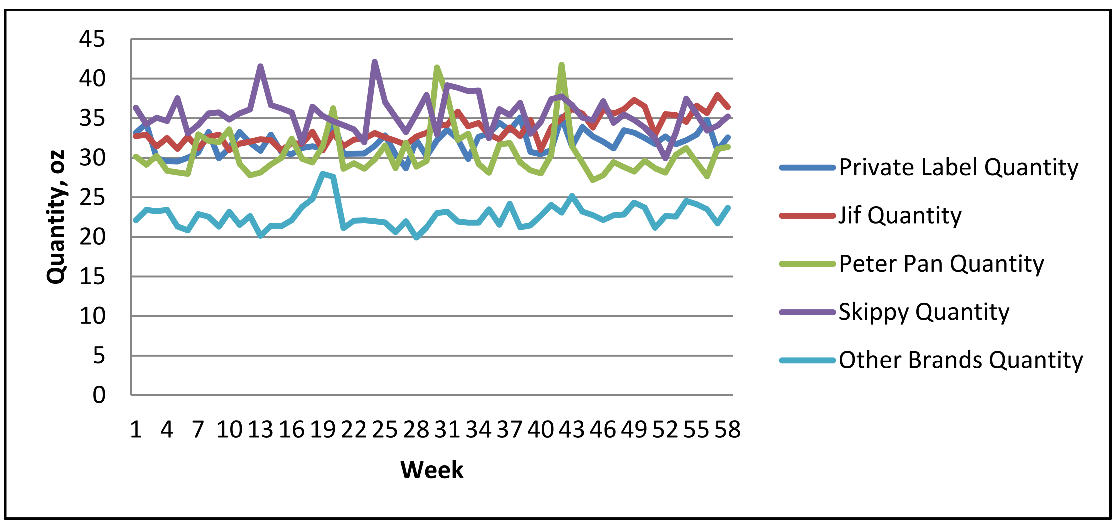

Figure 4.1. Peanut butter quantities purchased (ounces) from January 4, 2006 through February 13, 2007 (Pre-recall)

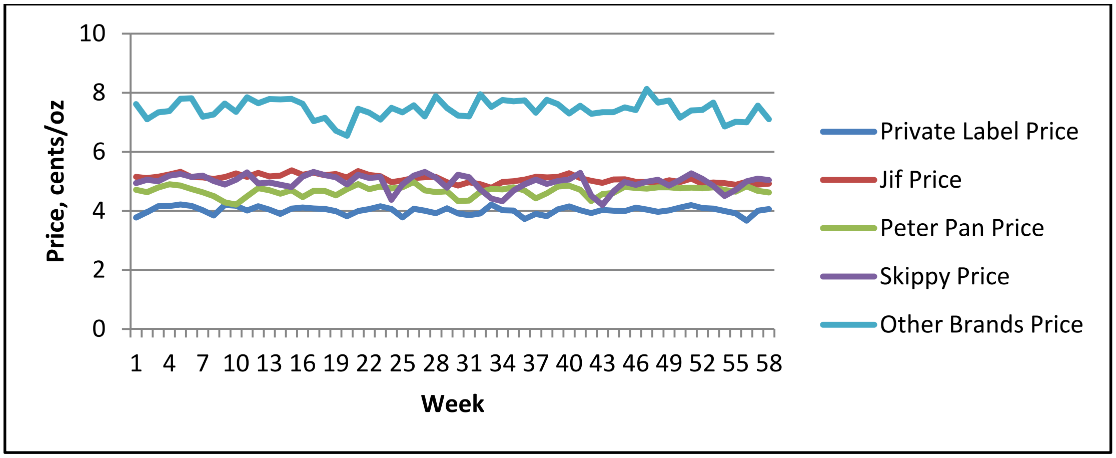

Figure 4.2. Peanut butter prices (real unit values, cents/oz) from January 4, 2006 through February 13, 2007 (Pre-recall)

Figure 4.3 reveals that quantities of PB purchased over the post-recall period revolved around their respective means with Peter Pan spiking at around week 16 (beginning of December, 2007) and week 40 (middle of May, 2008). A sudden increase in the quantity purchased of Peter Pan can be explained by the decrease in the real price (unit value) of Peter Pan in the same periods. Particularly, the real prices of Peter Pan in weeks 16 and 40 were 4.5 and 4.7 cents/oz, respectively, compared to the average price of Peter Pan PB for the entire post-recall period of 4.9 cents/oz. According to Figure 4.4, real unit values for all PB brands exhibit a stable, although slightly upward trending pattern, over the post-recall period.

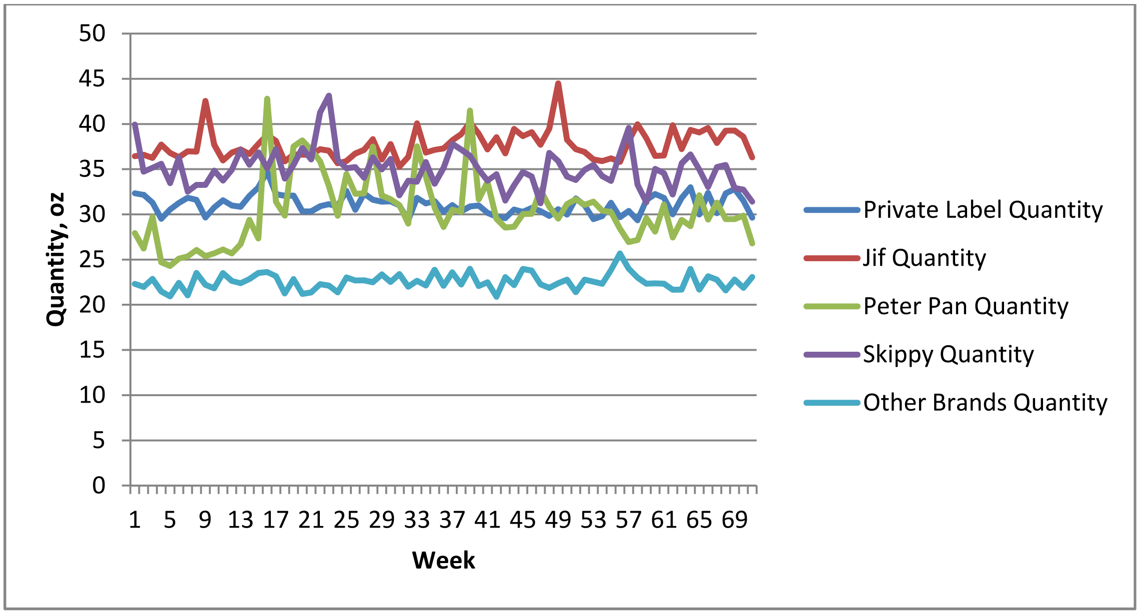

Figure 4.3. Peanut butter quantities purchased (ounces) from August 22, 2007 through December 30, 2008 (Post-recall)

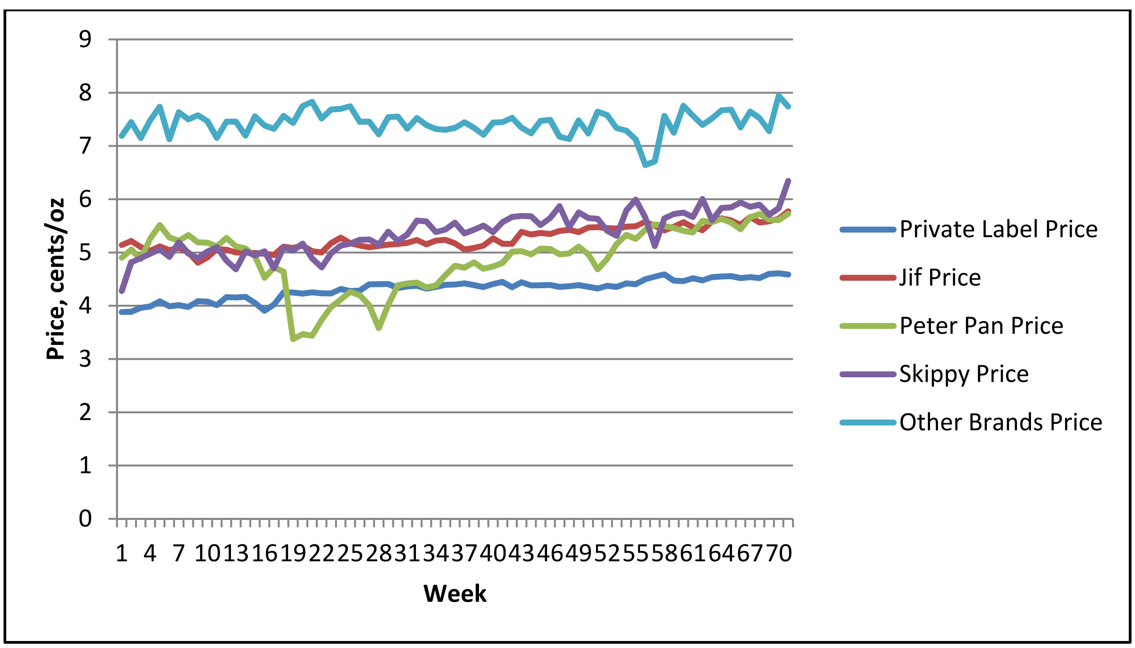

Figure 4.4. Peanut butter prices (real unit values, cents/oz) from August 22, 2007 through December 30, 2008 (Post-recall)

Estimation Procedure and Results

To obtain the matrices of uncompensated and compensated price elasticities of demand, two Barten synthetic models corresponding to (4.16) one for the pre-recall and the other for the post-recall periods were estimated using an Iterated Seemingly Unrelated Regression (ITSUR) procedure with parametric restrictions imposed. The estimations were done using SAS 9.2 statistical software. Each demand system consisted of five equations, one for each PB brand (Private Label, Jif, Peter Pan, Skippy, and Other Brands). The equation for Other Brands was dropped to circumvent the problem of singularity of the variance-covariance matrix of error terms. The parameters of the omitted equation were recovered using the theoretical restrictions given by (4.17), (4.18), and (4.19). The R^2 for the omitted equation (Other Brands) was computed by squaring the correlation coefficient between the actual and the predicted values of the dependent variable. The Durbin-Watson statistic for the omitted equation (Other Brands) was calculated as the ratio of the sum of squared differences in successive residuals to the residual sum of squares.

The compensated (Hicksian) price elasticities were calculated using (4.20) and (4.21). The uncompensated (Marshallian) price elasticities were computed according to (4.21) and (4.22). Finally, the expenditure elasticities were computed according to (4.23). The own-price elasticities were hypothesized to be negative based on the law of demand. In addition, theory posits a positive relationship between the price of a substitute good and the demand for the good in question (PB). As such, it was anticipated that the cross-price elasticity estimates would be positive. Finally, based on the theory and the good in question (PB), the expenditure elasticities were expected to be positive. Put another way, we did not expect to find the presence of inferior goods. To account for serial correlation, a first-order autoregressive correction [AR(1)] was used. The joint test of the significance of the seasonal dummy variables indicated that seasonality was not a significant determinant, and, hence, was not accounted for in the final estimation. Given that the employed data sets are time-series, augmented Dickey-Fuller and Phillips-Perron tests were done to support the differential form of the variables used in the estimation. For both tests, the null hypothesis is that the variable contains a unit root and the alternative is that the variable was generated by a stationary process. All the MacKinnon approximate p-values for the first-differenced variables were 0.0000 pointing out that they were all stationary in first differences. Finally, all statistical tests are performed using the 10% significance level.

Discussion of Estimation Results for Pre-recall Period

Table 4.3 details the Durbin-Watson, R^2 statistics, parameter estimates, and p-values for the Barten synthetic model for the pre-recall period. The moderately high R^2s ranging from 0.53 to 0.73 suggest that the BSM model provides reasonably good fits. The Durbin-Watson statistics for the five estimated equations coupled with statistically significant rho1 coefficient indicate that serial correlation was accounted for in the model. Based on the significance of the Wald chi-square statistics for the joint hypothesis tests of lambda and mu presented in Table 4.4, it can be inferred that the data best supported the general Barten model (the BSM).

Table 4.3. Parameter Estimates and Goodness-of-Fit Statistics for the Barten Synthetic Model for the Pre-recall Period (from January 4, 2006 through February 13, 2007), N=58

Brand	Durbin-Watson	R-squared
Private Label	2.0758	0.7286
Jif	2.2493	0.6048
Peter Pan	2.2648	0.6573
Skippy	2.4840	0.5334
Other Brands (omitted)	2.2785	0.6840

Parameter	Estimate	p-value
g_{11}	0.8247	0.0277
g_{12}	-0.2062	0.0395
g_{13}	-0.1703	0.0409
g_{14}	-0.2423	0.0158
g_{15}	-0.2060	0.0321
g_{22}	1.0434	0.0252
g_{23}	-0.2452	0.0235
g_{24}	-0.3359	0.0121
g_{25}	-0.2560	0.0477
g_{33}	0.8880	0.0307
g_{34}	-0.2252	0.0536
g_{35}	-0.2473	0.0258
g_{44}	1.1107	0.0197
g_{45}	-0.3073	0.0181
g_{55}	1.0165	0.0274
b_1	0.6250	0.0929
b_2	0.7800	0.1133
b_3	0.9240	0.0337
b_4	0.9095	0.0773
b_5	0.8755	0.0745
lambda	-3.1140	0.1728
mu	7.0232	0.0109
rho1	-0.5464	<.0001

*Subscript 1 refers to Private Label, 2 refers to Jif, 3 refers to Peter Pan, 4 refers to Skippy and 5 refers to Other Brands. For instance, g_{12} denotes the price effect of Jif on the volume of Private label.
*The estimates of b_5 and g_{55} are recovered through adding-up restriction as b5=**1**-(b_1+b_2+b_3+b_4+lambda) and g_{55}= **0**-(g_{15}+g_{25}+g_{35}+g_{45}).
*rho1 denotes the autocorrelation coefficient in the error terms, AR(1) process. To insure adding-up, a common rho1 is evident in any demand system.

Table 4.4. Joint Hypothesis Test of Lambda and Mu

Wald Test	Chi-Squared statistic	p-value
H_0: lambda=0,mu=0 (Rotterdam)	8.15	0.0170
H_0: lambda=1,mu=1 (LA/AIDS)	7.62	0.0222
H_0: lambda=1,mu=0 (CBS)	9.33	0.0094
H_0: lambda=0,mu=1 (NBR)	6.41	0.0407

Compensated own-price and cross-price and uncompensated own-price, cross-price, and expenditure elasticities computed at the sample means of the budget shares are presented in Table 4.5 and Table 4.6, respectively. The compensated own-price elasticities reported in Table 4.5 vary from -0.4919 (Skippy) to -0.8512 (Peter Pan). All are highly significant and carry the expected negative sign consistent with demand theory. In addition, all the compensated own-price elasticity estimates are less than unity in absolute values implying inelastic demands; hence, consumers are not very sensitive to price changes for all brands. All the compensated cross-price elasticity estimates are positive suggesting a net substitutability among PB brands with ten out of 20 of them possessing statistical significance. Particularly, significant net substitution relationships are present between Private Label and Jif, Private Label and Peter Pan, Private Label and Other Brands, Jif and Other Brands, and Peter Pan and Skippy. According to the absolute values of the compensated cross-price elasticity estimates, the strongest statistically significant net substitutability is observed between Peter Pan and Skippy (0.3308) and the weakest one is between Other Brands and Private Label (0.1856).

Table 4.5. Compensated Own-Price and Cross-Price Elasticities Associated with the Peanut Butter Brands for the Pre-recall Period (from January 4, 2006 through February 13, 2007)

	PRIVATE LABEL	JIF	PETER PAN	SKIPPY	OTHER BRANDS
PRIVATE LABEL	-0.8238	0.2611	0.2299	0.0890	0.2438
	(<.0001)	(0.0236)	(0.0452)	(0.2410)	(0.0081)
JIF	0.1963	-0.6921	0.1433	0.0258	0.3267
	(0.0236)	(0.0002)	(0.2135)	(0.7321)	(0.0003)
PETER PAN	0.2070	0.1716	-0.8512	0.3308	0.1418
	(0.0452)	(0.2135)	(0.0005)	(0.0151)	(0.3109)
SKIPPY	0.0648	0.0250	0.2677	-0.4919	0.1344
	(0.2410)	(0.7321)	(0.0151)	(0.0002)	(0.1013)
OTHER BRANDS	0.1856	0.3307	0.1199	0.1404	-0.7766
	(0.0081)	(0.0003)	(0.3109)	(0.1013)	(<.0001)

*All elasticities are computed at the sample means of the data.
*p-values are in parentheses.

Table 4.6. Uncompensated Own-Price and Cross-Price Elasticities Associated with the Peanut Butter Brands for the Pre-recall Period (from January 4, 2006 through February 13, 2007)

	PRIVATE LABEL	JIF	PETER PAN	SKIPPY	OTHER BRANDS	EXPENDITURE
PRIVATE LABEL	-0.9405	0.1059	0.1002	-0.0713	0.0905	0.7152
	(<.0001)	(0.3878)	(0.3692)	(0.3425)	(0.3264)	(<.0001)
JIF	0.1181	-0.7961	0.0564	-0.0815	0.2239	0.4792
	(0.1675)	(<.0001)	(0.6085)	(0.2533)	(0.0103)	(<.0001)
PETER PAN	-0.1168	-0.2590	-1.2107	-0.1136	-0.2836	1.9836
	(0.2944)	(0.1003)	(<.0001)	(0.4071)	(0.0636)	(<.0001)
SKIPPY	-0.0895	-0.1803	0.0963	-0.7037	-0.0684	0.9456
	(0.1648)	(0.0441)	(0.3922)	(<.0001)	(0.4526)	(<.0001)
OTHER BRANDS	0.0274	0.1203	-0.0559	-0.0767	-0.9844	0.9693
	(0.7063)	(0.2143)	(0.6353)	(0.3798)	(<.0001)	(<.0001)

*All elasticities are computed at the sample means of the data.
*p-values are in parentheses.

The uncompensated own-price elasticities in Table 4.6 range between -0.7037 (Skippy) and -1.2107 (Peter Pan) and are statistically significant. Particularly, own-price elasticities for Private Label and Other Brands are very close to unity in absolute values suggesting a unitary demand for those brands. The own-price elasticities for Jif and Skippy are less than unity in absolute values implying inelastic demands for those brands. Finally, the demand for Peter Pan is elastic implying a relatively high sensitivity on part of consumers to price changes for this brand.

Out of 20 uncompensated cross-price elasticities, only three are significant and they suggest gross complementarity between Peter Pan and Other Brands, and Skippy and Jif, and a gross substitutability between Jif and Other Brands. However, the substitute/complement label is reserved for compensated cross-price elasticities.

All expenditure elasticities are positive and significant. The expenditure elasticities estimates are 0.7152, 0.4792, 1.9836, 0.9456, and 0.9693 for Private Label, Jif, Peter Pan, Skippy, and Other Brands, respectively. As the total expenditure for the PB category rises, Peter Pan benefits the most, since it is the most expenditure-elastic brand, and Jif benefits the least due to its relatively low expenditure elasticity estimate.

Discussion of Estimation Results for Post-recall Period

Table 4.7 reports Durbin-Watson, R^2s statistics, parameter estimates, and p-values for the Barten model for the post-recall period. The R^2s vary from 0.3425 to 0.8121 meaning that except for the Peter Pan equation, the estimated Barten model provides a good fit to the data. The Durbin-Watson statistics together with the significant rho1 parameter estimate provide sufficient evidence that serial correlation was accounted for in the model. All the parameter estimates are statistically significant.

Table 4.7. Parameter Estimates and Goodness-of-Fit Statistics for the Barten Synthetic Model for the Post-recall Period (from August 22, 2007 through December 30, 2008), N=71

Brand	Durbin-Watson	R-squared
Private Label	2.1883	0.3425
Jif	1.9668	0.6559
Peter Pan	2.2619	0.8121
Skippy	2.0676	0.6066
Other Brands (omitted)	2.4010	0.5822
Parameter	Estimate	p-value
g_{11}	0.9689	0.0044
g_{12}	-0.2004	0.0476
g_{13}	-0.2240	0.0019
g_{14}	-0.2860	0.0018
g_{15}	-0.2585	0.0016
g_{22}	1.1749	0.0098
g_{23}	-0.2810	0.0051
g_{24}	-0.3716	0.0067
g_{25}	-0.3219	0.0088
g_{33}	1.0031	0.0046
g_{34}	-0.2494	0.0104
g_{35}	-0.2486	0.0045
g_{44}	1.2551	0.004
g_{45}	-0.3482	0.0026
g_{55}	1.1772	0.0034
b_1	-1.2568	<.0001
b_2	-1.7385	0.0001
b_3	-1.1442	0.0009
b_4	-1.6256	0.0002
b_5	-1.5285	<.0001
lambda	8.2935	<.0001
mu	7.9695	0.0016
rho1	-0.5413	<.0001

*Subscript 1 refers to Private Label, 2 refers to Jif, 3 refers to Peter Pan, 4 refers to Skippy and 5 refers to all other brands. For instance, g_{12} denotes the price effect of Jif on the volume of Private label.
*The estimates of b_5 and g_{55} are recovered through adding-up restriction as b5=**1**-(b_1+b_2+b_3+b_4+lambda) and g_{55}= **0**-(g_{15}+g_{25}+g_{35}+g_{45}).
*rho1 denotes the autocorrelation coefficient in the error terms, AR(1) process. To insure adding-up, a common rho1 is evident in any demand system.

The general Barten model was best supported by the data. Support for this contention was provided by the significance of the Wald chi-squared statistics for the alternative joint hypothesis tests of lambda and mu as reported in Table 4.8.

Table 4.8. Joint Hypothesis Test of Lambda and Mu

Wald Test	Chi-Squared statistic	p-value
H_0: lambda=0,mu=0 (Rotterdam)	36.79	<.0001
H_0: lambda=1,mu=1 (LA/AIDS)	28.34	<.0001
H_0: lambda=1,mu=0 (CBS)	31.44	<.0001
H_0: lambda=0,mu=1 (NBR)	33.62	<.0001

Table 4.9 presents the compensated own-price and cross-price elasticities calculated using the sample means of the budget shares. All the compensated own-price elasticity estimates are significant, negative indicating ordinary downward-sloping demand equations for all the PB brands, and less than unity in absolute values (except Jif) suggesting inelastic demands for all the brands except Jif.

Only one cross-price elasticity between Private Label and Other Brands is negative, albeit insignificant, while the rest of the off-diagonal elements are positive indicating net substitution relationships between brands. Significant net substitutability is observed between Private Label and Jif, Jif and Peter Pan, Jif and Skippy, Jif and Other Brands, Peter Pan and Skippy, and Peter Pan and Other Brands. The absolute values of the compensated cross-price elasticity estimates show that the strongest significant net substitutability exists between Private Label and Jif (0.6436) and the weakest one exists between Other Brands and Peter Pan (0.1687).

Table 4.9. Compensated Own-Price and Cross-Price Elasticities Associated with the Peanut Butter Brands for the Post-recall Period (from August 22, 2007 through December 30, 2008)

	Private Label	Jif	Peter Pan	Skippy	Other Brands
Private Label	-0.6544 (0.0003)	0.6436 (0.0002)	0.0104 (0.8781)	0.0093 (0.9260)	-0.0089 (0.9311)
Jif	0.4352 (0.0002)	-1.1285 (<.0001)	0.2223 (0.0008)	0.2257 (0.0158)	0.2453 (0.0089)
Peter Pan	0.0095 (0.8781)	0.2991 (0.0008)	-0.8779 (<.0001)	0.3772 (0.0001)	0.1921 (0.0138)
Skippy	0.0066 (0.9260)	0.2385 (0.0158)	0.2961 (0.0001)	-0.5931 (<.0001)	0.0519 (0.5200)
Other Brands	-0.0071 (0.9311)	0.2899 (0.0089)	0.1687 (0.0138)	0.0580 (0.5200)	-0.5095 (<.0001)

*All elasticities are computed at the sample means of the data.
*p-values are in parentheses.

Table 4.10 shows the uncompensated own-price, cross-price, and expenditure elasticities calculated at the sample means of the budget shares. All the own-price elasticity coefficients are negative suggesting the anticipated inverse relationship between price and quantity demanded. As for the magnitudes, own-price elasticities for Private Label, Skippy, and Other Brands are less than one in absolute values revealing inelastic demand relationships, while own-price elasticities for Jif and Peter Pan are greater than one in absolute value implying elastic demand relationships. Out of 20 uncompensated cross-price elasticity estimates, six are significant revealing gross substitutability between Private Label and Jif and gross complementarity between Peter

Pan and Private Label, Peter Pan and Other Brands, Skippy and Private Label, Skippy and Other Brands. All expenditure effects are positive and significant indicating that the quantity demanded of PB went up as real expenditure for PB category increased, *ceteris paribus*. The most expenditure-elastic PB brand is Peter Pan (1.8080) and the least expenditure-elastic PB brand is Private Label (0.4644).

Table 4.10. Uncompensated Own-Price and Cross-Price Elasticities Associated with the Peanut Butter Brands for the Post-recall Period (from August 22, 2007 through December 30, 2008)

	Private Label	Jif	Peter Pan	Skippy	Other Brands	Expenditure
Private Label	-0.7290 (<.0001)	0.5334 (0.0026)	-0.0715 (0.2794)	-0.0951 (0.3356)	-0.1022 (0.3417)	0.4644 (0.0005)
Jif	0.2793 (0.0146)	-1.3590 (<.0001)	0.0510 (0.4155)	0.0075 (0.9326)	0.0502 (0.5931)	0.9709 (<.0001)
Peter Pan	-0.2808 (0.0003)	-0.1301 (0.2085)	-1.1969 (<.0001)	-0.0291 (0.7749)	-0.1712 (0.0625)	1.8080 (<.0001)
Skippy	-0.1634 (0.0394)	-0.0131 (0.9041)	0.1092 (0.1411)	-0.8312 (<.0001)	-0.1610 (0.0746)	1.0594 (<.0001)
Other Brands	-0.1173 (0.1756)	0.1269 (0.2775)	0.0476 (0.4689)	-0.0962 (0.2910)	-0.6474 (<.0001)	0.6864 (<.0001)

*All elasticities are computed at the sample means of the data.
*p-values are in parentheses.

Discussion of Estimation Results across Pre- and Post-recall Periods

Compensated elasticities provide the most accurate picture of substitution among brands. Consequently, the discussion of changes in the magnitudes of price elasticities across the two periods is detailed in terms of compensated price elasticity estimates reported in Tables 4.5 and 4.9. At the same time, the determination of the significance of the changes in the magnitudes of elasticities across the two periods is based on the results of the Wald tests presented in Table 4.11. Associated p-values from testing each element in the matrices from the pre-recall (post-recall) period against its respective counterpart from the post-recall (pre-recall) period are also exhibited in Table 4.11. The null hypothesis in all of the tests is that the two elasticity estimates from the two periods are equal.

The test results in Table 4.11 are presented for both uncompensated and compensated price elasticities as well as expenditure elasticities. However, as mentioned previously, the focus is on compensated price elasticities moving from the pre-recall period to the post-recall period (Test 6 through Test 30). The focus will also be further narrowed down to only those price elasticity estimates, which happened to be significant in either pre- or post-recall period or in both periods.

The first thing to note is that the own-price elasticity estimates in both periods are negative and significant. However, there are changes in the magnitudes of the own-price elasticity estimates. Particularly, the demands for Private Label and Other Brands became more inelastic, the demand for Jif changed from inelastic to elastic, the demand elasticity for Peter Pan virtually did not change, and the demand for Skippy became less inelastic. For all of these changes in magnitudes of own-price elasticities, the null hypothesis is rejected in cases of Jif and Other Brands and it is not rejected in cases of Private Label, Peter Pan, and Skippy. Hence, consumer responsiveness to price changes associated with Jif and Other Brands changed significantly across the two periods while it did not change significantly across the two periods in relation to price changes associated with Private Label, Peter Pan, and Skippy. As such, it can be concluded that the recall resulted in changes in own-price relationships.

Table 4.11. Testing if the Difference in the Respective Pre- and Post-Recall Elasticities is Statistically Significant

	PRE-RECALL			POST-RECALL		
Test	Label	Chi-Squared Statistic	p-value	Label	Chi-Squared Statistic	p-value
Test1	e_ctlbr_pre= 0.464409	4.64	0.0313	e_ctlbr_post= 0.715223	3.92	0.0477
Test2	e_jif_pre = 0.970906	20.36	<.0001	e_jif_post = 0.47918	17.77	<.0001
Test3	e_ppan_pre= 1.807999	0.56	0.4527	e_ppan_post= 1.983629	0.76	0.3834
Test4	e_skippy_pre= 1.059432	0.36	0.5503	e_skippy_post= 0.945631	0.52	0.4713
Test5	e_obrand_pre= .686375	4.07	0.0438	e_obrand_post= 0.969322	4.53	0.0334
Test6	e_ctlbr_ctlbr_C_pre= -0.65443	2.65	0.1034	e_ctlbr_ctlbr_C_post= -0.82378	0.99	0.3196
Test7	e_ctlbr_jif_C_pre= 0.643647	11.68	0.0006	e_ctlbr_jif_C_post= 0.261134	5.52	0.0188
Test8	e_ctlbr_ppan_C_pre= 0.0104	3.84	0.0499	e_ctlbr_ppan_C_post= 0.229856	10.56	0.0012
Test9	e_ctlbr_skippy_C_pre= 0.009289	1.13	0.2881	e_ctlbr_skippy_C_post = 0.088958	0.64	0.4242
Test10	e_ctlbr_obrand_C_pre= -0.00891	8.16	0.0043	e_ctlbr_obrand_C_post = 0.243836	6.07	0.0137
Test11	e_jif_jif_C_pre= -1.12852	6.37	0.0116	e_jif_jif_C_post= -0.69209	7.22	0.0072
Test12	e_jif_ppan_C_pre= 0.222285	0.48	0.4873	e_jif_ppan_C_post= 0.143282	1.55	0.2132
Test13	e_jif_skippy_C_pre= 0.22571	7.11	0.0077	e_jif_skippy_C_post= 0.025808	4.83	0.0280
Test14	e_jif_obrand_C_pre= 0.245318	0.94	0.3323	e_jif_obrand_C_post= 0.326655	0.80	0.3712
Test15	e_ppan_ppan_C_pre= -0.8779	0.01	0.9063	e_ppan_ppan_C_post= -0.85116	0.05	0.8229
Test16	e_ppan_skippy_C_pre= 0.377188	0.12	0.7244	e_ppan_skippy_C_post= 0.330825	0.26	0.6123
Test17	e_ppan_obrand_C_pre= 0.192107	0.13	0.7164	e_ppan_obrand_C_post= 0.141774	0.44	0.5070
Test18	e_skippy_skippy_C_pre = -0.59312	0.69	0.4053	e_skippy_skippy_C_post = -0.49189	0.69	0.4049
Test19	e_skippy_obrand_C_pre = 0.051881	1.05	0.3056	e_skippy_obrand_C_post = 0.134399	1.06	0.3035
Test20	e_obrand_obrand_C_pre = -0.50946	4.93	0.0265	e_obrand_obrand_C_post = -0.77658	5.29	0.0214
Test21	e_jif_ctlbr_C_pre= 0.43521	8.06	0.0045	e_jif_ctlbr_C_post= 0.196343	4.71	0.0300
Test22	e_ppan_ctlbr_C_pre= 0.009464	3.84	0.0500	e_ppan_ctlbr_C_post= 0.206972	10.33	0.0013
Test23	e_skippy_ctlbr_C_pre= 0.006636	1.13	0.2870	e_skippy_ctlbr_C_post = 0.064811	0.67	0.4140
Test24	e_obrand_ctlbr_C_pre= -0.00712	8.19	0.0042	e_obrand_ctlbr_C_post = 0.185607	5.53	0.0187
Test25	e_ppan_jif_C_pre= 0.299142	0.88	0.3491	e_ppan_jif_C_post= 0.171591	2.23	0.1353
Test26	e_skippy_jif_C_pre= 0.238474	8.63	0.0033	e_skippy_jif_C_post= 0.025007	4.93	0.0264
Test27	e_obrand_jif_C_pre= 0.289875	0.23	0.6308	e_obrand_jif_C_post= 0.330699	0.14	0.7041
Test28	e_skippy_ppan_C_pre= 0.296128	0.07	0.7892	e_skippy_ppan_C_post=0.267674	0.16	0.6920
Test29	e_obrand_ppan_C_pre= 0.168677	0.17	0.6767	e_obrand_ppan_C_post= 0.11985	0.54	0.4635
Test30	e_obrand_skippy_C_pre = 0.058023	0.96	0.3275	e_obrand_skippy_C_post = 0.14042	0.84	0.3583

Table 4.11. continued

	PRE-RECALL			POST-RECALL		
Test	Label	Chi-Squared Statistic	p-value	Label	Chi-Squared Statistic	p-value
Test31	e_ctlbr_ctlbr_U_pre= -0.72898	3.97	0.0464	e_ctlbr_ctlbr_U_post= -0.94052	1.51	0.2186
Test32	e_ctlbr_jif_U_pre= 0.533388	12.37	0.0004	e_ctlbr_jif_U_post= 0.105877	6.29	0.0122
Test33	e_ctlbr_ppan_U_pre= -0.07153	2.41	0.1205	e_ctlbr_ppan_U_post= 0.100213	6.86	0.0088
Test34	e_ctlbr_skippy_U_pre= -0.09507	0.10	0.7490	e_ctlbr_skippy_U_post = -0.07127	0.06	0.8081
Test35	e_ctlbr_obrand_U_pre= -0.10222	4.45	0.0348	e_ctlbr_obrand_U_post = 0.090477	3.26	0.0709
Test36	e_jif_jif_U_pre= -1.35903	9.28	0.0023	e_jif_jif_U_post= -0.79611	10.82	0.0010
Test37	e_jif_ppan_U_pre= 0.051	0.00	0.9605	e_jif_ppan_U_post= 0.056425	0.01	0.9305
Test38	e_jif_skippy_U_pre= 0.007538	1.59	0.2068	e_jif_skippy_U_post= -0.08154	1.01	0.3157
Test39	e_jif_obrand_U_pre= 0.050241	4.27	0.0389	e_jif_obrand_U_post= 0.223909	3.45	0.0634
Test40	e_ppan_ppan_U_pre= -1.19687	0.00	0.9512	e_ppan_ppan_U_post= -1.21072	0.01	0.9061
Test41	e_ppan_skippy_U_pre= -0.02909	0.39	0.5341	e_ppan_skippy_U_post= -0.11356	0.70	0.4042
Test42	e_ppan_obrand_U_pre= -0.17116	0.57	0.4522	e_ppan_obrand_U_post= -0.28356	1.55	0.2132
Test43	e_skippy_skippy_U_pre = -0.83118	1.02	0.3126	e_skippy_skippy_U_post = -0.70374	1.09	0.2956
Test44	e_skippy_obrand_U_pre = -0.16098	1.05	0.3052	e_skippy_obrand_U_post = -0.06836	1.09	0.2970
Test45	e_obrand_obrand_U_pre = -0.64737	7.33	0.0068	e_obrand_obrand_U_post = -0.98442	7.70	0.0055
Test46	e_jif_ctlbr_U_pre= 0.279348	3.65	0.0560	e_jif_ctlbr_U_post= 0.118134	2.10	0.1473
Test47	e_ppan_ctlbr_U_pre= -0.28078	2.21	0.1368	e_ppan_ctlbr_U_post= -0.11679	5.06	0.0245
Test48	e_skippy_ctlbr_U_pre= -0.16344	1.35	0.2446	e_skippy_ctlbr_U_post = -0.08953	0.90	0.3417
Test49	e_obrand_ctlbr_U_pre= -0.1173	4.01	0.0454	e_obrand_ctlbr_U_post = 0.027398	2.85	0.0911
Test50	e_ppan_jif_U_pre= -0.13011	0.69	0.4048	e_ppan_jif_U_post= -0.25901	1.58	0.2081
Test51	e_skippy_jif_U_pre= -0.01305	3.66	0.0556	e_skippy_jif_U_post= -0.18027	2.40	0.1213
Test52	e_obrand_jif_U_pre= 0.126918	0.00	0.9447	e_obrand_jif_U_post= 0.120283	0.00	0.9543
Test53	e_skippy_ppan_U_pre= 0.109225	0.01	0.9075	e_skippy_ppan_U_post= 0.096267	0.03	0.8597
Test54	e_obrand_ppan_U_pre= 0.047588	0.78	0.3768	e_obrand_ppan_U_post= -0.05585	2.51	0.1133
Test55	e_obrand_skippy_U_pre = -0.09621	0.05	0.8221	e_obrand_skippy_U_post = -0.07673	0.05	0.8293

*Test 1 through Test 5 refer to testing expenditure elasticities.
*Subscript ctlbr refers to Private Label, ppan refers to Peter Pan, and obrand refers to Other Brands.
* C stands for compensated and U stands for uncompensated.
*Pre stands for pre-recall period and post stands for post-recall period.

The change in consumer responsiveness in relation to Jif can be explained by an increase in average prices for this particular PB brand across the two periods. Perhaps, Procter and Gamble Co., the firm that produces Jif, increased the price for its PB in an anticipation that consumers who abstained from consuming the tainted Peter Pan PB would switch to Jif in a search for an alternative.

In the Private Label row, in the pre-recall period, all brands happen to be significant (except Skippy) and net substitutes for Private Label with Jif as a major competitor. In the same row but in the post-recall period, all the brands, except Other Brands, are net substitutes for Private Label. Jif remains the main competitor for Private Label. The magnitude of the cross-price elasticity between Private Label and Jif increases, but it decreases between Private Label and Peter Pan, and the nature of the relationship changes from net substitutability to net complementarity between Private Label and Other Brands across the two periods. Based on the test results, we conclude that the cross-price elasticity estimates between Private Label and Jif, Private Label and Peter Pan, and Private Label and Other Brands changed across the two sample periods, which means that the recall induced changes in cross-price relationships. The result of Jif as the main competitor for Private Label in both periods is justifiable considering that Jif has the largest market share in the PB market.

In the Jif row, in the pre-recall period all brands are found to be net substitutes for Jif with only Private Label and Other Brands being statistically significant but Other Brands being major competitor of the two. In the Jif row but in the post-recall period, all the brands are found to be significant net substitutes for Jif with major competition coming from Private Label. The value of the cross-price elasticity increases between Jif and Private Label, Jif and Peter Pan, Jif and Skippy, but it decreases between Jif and Other Brands going from the pre-recall period to the post-recall period. The test results indicate that the cross-price elasticity estimate changed significantly between Jif and Private Label and Jif and Skippy with no statistically significant evidence for the change in magnitudes of cross-price elasticity estimates between Jif and Peter Pan and between Jif and Other Brands. These findings further confirm the changes in cross-price relationships brought about by the recall. Of interest is the change of the major competitor to Jif across the recall periods from Other Brands to Private Label. This result could be attributed to consumer perceptions of Private Label to be safer as opposed to PB brands from known manufacturers.

In the row of Peter Pan, in the pre-recall period, Private Label, Jif, Skippy, and Other Brands are found to be net substitutes for Peter Pan with Private Label and Skippy being statistically significant, and Skippy is the major competitor of the two. In the Peter Pan row but in the post-recall period, again, all the brands are found to be net substitutes for Peter Pan with Jif, Skippy, and Other Brands being statistically significant and with major competition still coming from Skippy. The value of the cross-price elasticity between Peter Pan and Private Label goes down, but it goes up between Peter Pan and Jif, between Peter Pan and Skippy, and between Peter Pan and Other Brands reading from the pre-recall to the post-recall periods. However, these changes in the magnitudes across the two recall periods are only statistically significant between Peter Pan and

Private Label, which shows a change in the cross-price relationships caused by the recall.

In the Skippy row, in the pre-recall period, all the brands are net substitutes for Skippy with only Peter Pan being statistically significant. The same net substitutability relationship is found in the post-recall period; however, Jif and Peter Pan are now statistically significant and Peter Pan poses main competition to Skippy. The value of the cross-price elasticity increases between Skippy and Jif and between Skippy and Peter Pan moving from the pre-recall period to the post-recall period. Nonetheless, these changes in the magnitudes across the two recall periods are only statistically significant between Skippy and Jif, which indicates a change in the cross-price relationships due to the recall.

In the Other Brands row, in the pre-recall period, Private Label and Jif are found to be significant and net substitutes for Other Brands with Jif as a major competitor. In the same row but in the post-recall period, Jif and Peter Pan are found to be significant net substitutes for Other Brands with Jif still being the main competitor. The nature of the cross-price relationship between Other Brands and Private Label is complementary, although insignificant, in the post-recall period. The magnitude of the cross-price elasticity between Other Brands and Jif decreases, but it increases between Other Brands and Peter Pan across the two periods. According to the test results, we conclude that the cross-price elasticity estimates between Other Brands and Private Label changed across the two recall periods, which means that the recall induced changes in cross-price relationships.

After the detailed analysis of the magnitudes of compensated cross-price elasticities of PB brands, as well as changes in the magnitudes of those compensated cross-price elasticities across the pre- and the post-recall periods, the major conclusion reached is that after the recall of Peter Pan there were changes in the own-price and cross-price relationships among PB brands. This set of findings also suggests that the recall contributed to the structural change in the demand for PB, because the elasticity estimates must have changed due to the changes in underlying parameter estimates, while the budget shares (market shares), also used in the calculation of the elasticities, remained virtually unchanged across the two recall periods.

Conclusions and Recommendations for Future Research

Employing weekly scanner data from January 4, 2006 through February 13, 2007 (pre-recall period) and from August 22, 2007 through December 30, 2008 (post-recall period), two separate Barten models were estimated, one for the pre-recall period, and one for the post-recall period. Matrices of compensated own-price and cross-price elasticity estimates, as well as uncompensated own-price, cross-price, and expenditure elasticity estimates were obtained for the pre-recall and the post-recall periods. Then the elements of compensated price elasticity matrices for the two periods were compared against each other to identify a possible structural change in the demand for PB initiated by the recall of Peter Pan.

First, the findings of this study showed that the general Barten synthetic model is favored over other forms of differential demand systems for studying the impact of the recall on the demand for PB. Second, the findings of this study indicate that, indeed, there were changes in the own-price and cross-price relationships among PB brands, which suggests that the recall contributed to the structural change in the demand for PB. The findings are substantiated by the statistical tests of the significance of the changes in the magnitudes of the compensated price elasticities across the pre-recall and post-recall periods. In general, most of the elements in the price elasticity matrices for the two recall periods were statistically significant. In addition, they were larger in absolute value in the post-recall period relative to those in the pre-recall period. For instance, across the two recall periods, the demand for Jif went from inelastic to elastic. This finding was anticipated, since being the firm with the largest market shares (22% in the pre-recall period and 24% in the post-recall period), Jif adjusted its production plan in order to operate at the elastic portion of the demand curve, which is in line with profit-maximizing behavior of a firm that has market power.

Third, the results allowed us to detect changes in the cross-price substitution effects among PB brands caused by the recall event. Among quite a few changes, the one that needs to be mentioned is that before the recall of the Peter Pan brand, Skippy was the major competitor to Peter Pan, which became even a more noteworthy competitor after the recall. In addition, the cross-price elasticity of Jif in relation to Skippy went up from the pre-recall period to the post-recall period, which implies strengthening in the competition between these two brands attempting to gain additional markets share that was made available by the weakening of Peter Pan's position in the market because of the recall.

For this kind of analysis, it is appealing to have data sets that extend over numerous years to enhance the representativeness of the data. Given the relatively small number of weekly observations (58 for the pre-recall and 71 for the post-recall) used in this study, it is recommended that future research be conducted using the data sets with greater number of weekly observations for both pre- and post-recall periods.

CHAPTER V

ANALYSIS OF THE FACTORS AFFECTING HOUSEHOLD CHOICE OF PEANUT BUTTER BEFORE AND AFTER THE PETER PAN RECALL

Introduction

The extent of health issues posed by foodborne illnesses varies across different groups of people. While most of the adult population may not experience serious health issues caused by a foodborne illness, other groups of people with compromised immune systems (children, pregnant women, elderly) can sustain serious health damages, which may even lead to lethal outcomes. Consequently, federal and state health regulatory agencies provide preventive measures and recommendations on minimizing the risk of a recall, targeting vulnerable groups of people when notifying consumers of recalls or potential health issues that could arise from the consumption of a particular consumer product. Undertaking a household-level study, which takes into consideration household characteristics in the light of a recall is of utmost significance.

Previous studies have examined the relationships between peanut product consumption and household socio-economic characteristics and consideration of nutritional contents in food purchase using discrete choice models (He, Fletcher, and Rimal 2004; 2005). In particular, He, Fletcher, and Rimal (2004) estimated a probit model to determine key factors dealing with household socio-economic characteristics, consideration of nutritional contents in food choice, and purchasing behavior influencing reduced-fat peanut butter (PB) consumption in addition to regular PB consumption. The data on 991 U.S. households' peanut consumption came from nationwide telephone interviews done by Gallup Corporation in 1997. The binary dependent variable was constructed based on the respondents' answer whether the purchase of reduced-fat PB that they were going to make was in addition to the consumption of regular PB. The findings of the study suggested that the purchase of reduced-fat PB was likely to be in addition to regular PB for the households that have at least one member 17 years old or younger, have married respondents, perceive that PB is expensive, perceive that PB is nutritious, perceive that reduced-fat PB is worse than regular PB, and usually buy the same brand of PB. At the same time, the purchase of reduced-fat PB was less likely to be in addition to regular PB for those households that have educated respondents, have respondents engaged in physical exercises on weekly basis, consider fat in food purchase, and perceive reduced-fat PB to be as good as or better than regular PB.

In another study by He, Fletcher, and Rimal (2005), a multinomial logit model was estimated to investigate the impact of household socio-economic characteristics and consideration of nutritional contents in food purchase on the demand for six major types of snack peanuts: dry-roasted peanuts, salted cocktail peanuts, honey-roasted peanuts, peanuts in a cocktail nut mix, peanuts in a trail mix, and other kinds of snack peanuts. Data on peanut consumption were collected for 2,800 households via a nationwide telephone survey by the Gallup Organization Inc. in 1997. The results showed that age, education, race and income and consideration of cholesterol, sodium, vitamin, and protein significantly affected the demand for various types of snack peanuts.

To the best of our knowledge, among the empirical studies concerning food recalls and using discrete choice models, to date, relatively little attention has been given to recall effects on individuals or households. Taylor (2010) examined the impact of publicly available food safety information on the demand for fresh and frozen meat (beef, veal, and pork) and poultry (chicken and turkey) through the estimation of a multinomial logit model. The study used biweekly data from the Nielsen Homescan panel from January 1998 to December 2005. A commodity-specific food safety index was developed by aggregating the number of newspaper articles regarding food safety issues found in the Lexis-Nexis using the following as keywords: “food safety,” “contamination,” “product recall,” “outbreak,” “salmonella,” “listeria,” “E. coli,” “trichinae,” “staphylococcus,” and “foodborne.” Articles from these search results were further sorted by the terms “beef” or “hamburger,” “pork” or “ham,” and “chicken” or “turkey” or “poultry.” The findings of the study showed that household heads that have a college education, households with elderly heads, and households with children are more likely to avoid buying meat and poultry in the presence of an increasing food safety information in the media.

Based on the case of the 2006 spinach recall, Onyango et al. (2007) conducted a micro-level analysis of the public's perceptions of food safety by estimating a binary choice model. The data used in the study were collected via telephone interviews and included a sample of 1,200 adult Americans. The findings of the study suggested that food safety perceptions are affected by the type of the products being analyzed, the extent of the public's knowledge of food pathogens and illnesses, the trust in private and public institutions dealing with food safety, and a set of socio-economic variables such as income, age, education, gender, and race.

Using the Nielsen Homescan panel data on household purchases, this study empirically examines the effect of socio-economic characteristics of households on the demand for PB in the presence of the recall. In particular, a multinomial logit model is estimated to determine the profile of households that altered their consumption pattern of PB because of the Peter Pan recall. Unlike the market-level analysis of the recall previously considered, this analysis provides a household-level perspective of the impacts of the recall based on scanner data associated with household purchases. The analysis is done both at the PB category and the brand level. The results of this study can be used by PB manufacturers when designing various marketing strategies, such as pricing and positioning, geared towards specific demographic groups.

The rest of Chapter V is organized as follows. The methodology, particularly the use of polychotomous choice models, is discussed in the next section. Data are presented in the subsequent section followed by the discussion of the estimation results. The final section provides conclusions and recommendations for future research.

Methodology

Polychotomous Choice Models

The following discussion on polychotomous choice models is borrowed from Cameron and Trivedi (2005) and Greene (2008). Following the random utility framework, in the general *m*-choice model the utility obtained from choosing alternative *j* is given by the following utility function:

$$U_j = V_j + \varepsilon_j, j = 1,2, \dots, m, \tag{5.1}$$

where V_j represents the systematic component and ε_j denotes the random component. The systematic component V_j for the *i*th individual depends on a vector of characteristics as follows:

$$V_{ij} = x'_{ij}\beta, \tag{5.2}$$

where x_{ij} is a vector of characteristics influencing the choice of alternative *j* made by the individual *i* and β is the vector of parameters to be estimated. In a similar fashion, we may specify a utility function U_k, which represents the utility from making choice *k* from *m* available choices. While these utility levels are not directly observable, the observed choice made between the alternatives *j* and *k* reveals which one of them yields higher utility to the individual. So, if the *i*th individual chooses alternative *j* over alternative *k*, then it must be that $U_j > U_k$. Leaving out the subscript *i* and defining dependent variable *y* as a choice variable, the probability that any consumer choosing alternative *j*, $Pr(y=j)$, is given as follows:

$$Pr[y = j] = Pr\left[U_j \geq U_k, all\ k \neq j\right] = Pr\left[U_k - U_j \leq 0, all\ k \neq j\right] =$$

$$Pr\left[\varepsilon_k - \varepsilon_j \leq V_j - V_k, all\ k \neq j\right] = Pr\left[\tilde{\varepsilon}_{kj} \leq -\tilde{V}_{kj}, all\ k \neq j\right], \tag{5.3}$$

where the tilda and second subscript *j* denotes differencing with respect to reference alternative *j*. Different assumptions concerning the joint distribution of $\varepsilon_1, \varepsilon_2, \dots, \varepsilon_m$ give rise to different models that are consistent with consumer choice theory. Specifically, if the errors take on an extreme value distribution with mean equal to 0 and variance of

$\pi^2/6$, then a multinomial logit model (MNL) is derived. On the other hand, if $\varepsilon_1, \varepsilon_2,\ldots,\varepsilon_m$ are assumed to jointly follow a normal distribution, then the resulting model is the multinomial probit (MNP).

In MNL model, there are *m* choices and the dependent variable *y* takes on integer values 1,2,...,m. Defining p_{ij} as the probability that the *i*th individual (for *i*=1,...,n) chooses alternative *j*, the MNL specifies

$$p_{ij} = \frac{e^{x_i'\beta_j}}{\sum_{l=1}^{m} e^{x_i'\beta_l}}, j = 1, \ldots, m. \quad (5.4)$$

Setting y_{ij} equal to one, if the *i*th observation corresponds to alternative *j*, and setting y_{ij} to zero otherwise, the log-likelihood function for the MNL becomes

$$\log L = \sum_{i=1}^{n} \sum_{j=0}^{k-1} y_{ij} \log P_{ij}, \quad (5.5)$$

where *k* is equal to the number of choices for the dependent variable. To obtain the parameter estimates of β, the log-likelihood function in (5.5) is maximized using an iterative estimation procedure.

In MNL model, the derivation of marginal effects is manageable and is done by taking the partial derivative of p_{ij} with respect to any explanatory variable as follows:

$$\frac{\partial p_{ij}}{\partial x_{ik}} = p_{ij}\left(\delta_{jk} - p_{ik}\right)\beta, \quad (5.6)$$

where $\delta_{jk}$is an indicator variable equal to 1 if *j*=*k* and equal to 0 if $j \neq k$. It needs to be noted that it is possible to obtain opposite signs on marginal effect and the parameter estimate associated with the same variable.

The fundamental problem present in the MNL model is that the odds ratios are unaffected by the characteristics of alternatives other than the pair of choices under consideration. This issue is referred to as the assumption of independence of irrelevant alternatives (IIA) and can be tested (Hausman and McFadden 1984).

For the discussion of a MNP model, consider the expression for *Pr*(*y=1*) in a three-choice model. Using (5.3) and defining $\tilde{\varepsilon}_{31} = \varepsilon_3 - \varepsilon_1$ and $\tilde{\varepsilon}_{21} = \varepsilon_2 - \varepsilon_1$, for a three-choice MNP model

$$Pr[y = 1] = Pr[\tilde{\varepsilon}_{21} \leq -\tilde{V}_{21}, \tilde{\varepsilon}_{31} \leq -\tilde{V}_{31}] = \int_{-\infty}^{-\tilde{V}_{31}} \int_{-\infty}^{-\tilde{V}_{21}} f\left(\tilde{\varepsilon}_{21,}\tilde{\varepsilon}_{31}\right) d\tilde{\varepsilon}_{21}\tilde{\varepsilon}_{31} \qquad (5.7)$$

where $f(\tilde{\varepsilon}_{21}, \tilde{\varepsilon}_{31})$ is a bivariate normal with as many as two free covariance parameters and $\tilde{V}_{21}$ and $\tilde{V}_{31}$ depend on regressors and parameters *β*. This bivariate normal integral can be evaluated numerically. However, the *m*-choice model requires the evaluation of a (*m-1*)-variate integral. With no ordering of alternatives and the relatively more complicated nature of MNP over MNL, a MNL model was chosen for this analysis.

Empirical Specification of the Multinomial Logit Model

A set of socio-economic variables are hypothesized to explain the purchasing behavior of the households across the pre- and the post-recall periods. The purchasing behavior across the pre- and the post-recall periods is characterized by the four choices available to the households: *no buy-no buy*, *buy-no buy*, *no buy-buy*, and *buy-buy*. Mathematically, the empirical specification of the MNL for the general PB category and each of the five PB brands is written as follows:

$$Pr\left(Y_{ij} = j \middle| x\right) = \Phi(\beta_0 + \beta_1 agehh2529 + \beta_2 agehh3034 + \beta_3 agehh3544 +$$

$$\beta_4 agehh4554 + \beta_5 agehh5564 + \beta_6 agehhgt64 + \beta_7 emphhpt +$$

$$\beta_8 emphhft + \beta_9 eduhhhs + \beta_{10} eduhhu + \beta_{11} eduhhpc + \beta_{12} reg\_central +$$

$$\beta_{13} reg\_south + \beta_{14} reg\_west + \beta_{15} race\_black + \beta_{16} race\_oriental + \beta_{17} race\_other + \beta_{18} hisp\_yes + \beta_{19} agepclt6\_only + \beta_{20} agepc6\_12only + \beta_{21} agepc13\_17only + \beta_{22} agepclt6\_6\_12only + \beta_{23} agepclt6\_13\_17only + \beta_{24} agepc6\_12and13\_17only + \beta_{25} agepclt6\_6\_12and13\_17 + \beta_{26} mhonly + \beta_{27} fhonly + \beta_{28} hhsize1 + \beta_{29} hhsize2 + \beta_{30} hhsize3 + \beta_{31} hhsize4 + \beta_{32} hhincome) + \varepsilon_i, \tag{5.8}$$

where Y_{ij} is the choice variable denoting that the *i*th household has available four *j* choices, (*no buy-no buy*, *buy-no buy*, *no buy-buy*, and *buy-buy*), Φ is the cumulative distribution function, X is the vector of socio-economic variables, which enter the model as binary variables except the income variable (*hhincome*), and ε_i is the error term. The process of the construction and the description of the dependent variable as well as the names and the description of the socio-economic variables are provided in the next section.

Data

The data for this analysis were obtained from the Nielsen Homescan Panels for calendar years 2006, 2007 and 2008. Socio-economic variables used in the study pertain to age, employment status, education level, region, race, ethnicity, age and presence of children, the presence of male and/or female household heads, household size, and household income. The categories, variable names, and description of all the explanatory variables are depicted in Table 5.1.

Table 5.1. Explanatory Variables Used in the Multinomial Logit Model, Calendar Years, 2006 to 2008

Category	Variable Name	Description
Age of the household head	agehhlt25	Age of household head less than 25 years (base category)
	agehh2529	Age of household head between 25-29 years
	agehh3034	Age of household head between 30-34 years
	agehh3544	Age of household head between 35-44 years
	agehh4554	Age of household head between 45-54 years
	agehh5564	Age of household head between 55-64 years
	agehhgt64	Age of household head greater than 64 years
Employment status of the household head	emphhnfp	Household head not employed for full pay (base category)
	emphhpt	Household head part-time employed
	emphhft	Household head full-time employed
Education level of the household head	eduhhlths	Education of household head: less than high school (base category)
	eduhhhs	Education of household head: high school only
	eduhhu	Education of household head: undergraduate only
	eduhhpc	Education of household head: some post-college
Region	reg_east	Region: east (base category)
	reg_central	Region: Central (Midwest)
	reg_south	Region: South
	reg_west	Region: West
Race	race_white	Race: white (base category)
	race_black	Race: black
	race_oriental	Race: oriental
	race_other	Race: other (non-black, non-white, non-oriental)
Ethnicity	hisp_no	Non-Hispanic ethnicity (base category)
	hisp_yes	Hispanic ethnicity

Table 5.1 continued

Category	Variable Name	Description
Age and presence of children	agepc_noch_lt18	No child less than 18 years (base category)
	agepclt6_only	Age and presence of children less than 6 years (pre-school)
	agepc6_12only	Age and presence of children between 6-12 years (pre-adolescent)
	agepc13_17only	Age and presence of children between 13-17 years (adolescent)
	agepclt6_6_12only	Age and presence of children less than 6 and 6-12 years
	agepclt6_13_17only	Age and presence of children less than 6 and 13-17 years
	agepc6_12and13_17only	Age and presence of children between 6-12 and 13-17 years
	agepclt6_6_12and13_17	Age and presence of children less than 6, 6-12 and 13-17 years
Presence of male and/or female household heads	fhmh	Household head both male and female (base category)
	mhonly	Household head male only
	fhonly	Household head female only
Household size	hhsize1	Household size: one member
	hhsize2	Household size: two members
	hhsize3	Household size: three members
	hhsize4	Household size: four members
	hhsize5_andm	Household size: five and more members (base category)
Household income	hhincome	Household income

The categories *Age of the household head*, *Employment status of the household head*, and *Education level of the household head* contain information on the age, employment, and education of the female household head. However, in cases where there was no female household head, the age, employment, and education of the male household head were used. The categories *Region*, *Race, Age and presence of children*, *Presence of male and/or female household heads*, and *Household size* are selfexplanatory. The category *Ethnicity* refers to the presence of a Hispanic household. In Nielsen data set, the category *Household income*, which represents household income, was reported as an interval. In this study, for each household, household income is represented as the midpoint of the relevant interval. For example, if household income was reported to be between $8,000 and $9,999, then $9,000 was recorded for that household. Any income level above $200,000 was recorded as $200,000.

The construction of the choice variable (dependent variable) for the multinomial logit model involved several steps. First, from the combined data sets for 2006, 2007, and 2008, information on total ounces of PB purchased by the households that were common to those three years and had bought PB at least once was carved out for further preparation for the PB category and brand analyses. For the PB category analysis, these data on total ounces were aggregated across households. For the PB brand analysis, these data were broken down by brands and then were aggregated across households. Next, depending whether a particular household purchased PB in the pre-recall period (from January 4, 2006 through February 13, 2007) or the post-recall period (August 22, 2007 through December 30, 2008), the corresponding total ounces of PB were divided into pre-recall and post-recall groups.

The choice variable is composed of four categories (outcomes). Choice 1 refers to the case where households did not buy PB in either pre- or post-recall period (*no buy-no buy*); choice 2 represents the case where households bought PB in the pre-recall period but did not buy in the post-recall period (*buy-no buy*); choice 3 corresponds to the case where households did not buy PB in the pre-recall period but bought in the post-recall period (*no buy-buy*); and choice 4 refers to the case where households bought PB in both pre- and post-recall periods (*buy-buy*). No observations exist for the PB category associated with choice 1, since all participant households must have bought at least one brand of PB in either or both periods to be a part of our sample. As such, subsequent tables do not have results associated with choice 1 for the PB category.

To qualify for our sample, the households must have bought PB at least once over the three-year period (2006, 2007, and 2008). As a result of this restriction, there exists the possibility of sample selection bias because of omitting those households that were common across the three years but did not buy PB. In particular, the number of households that are common across the three-year study period is 33,862 and the number of households that bought PB at least once over the study period (the sample used in our analysis) is 29,841. This results in about 12% of households that were left out of our sample. While recognizing the possibility of sample selection bias, a conditional analysis was done (conditional on household behavior associated with buying PB at least once over the study period) where an attempt was made to explain the behavior of those households that are actual PB consumers, which is reflected by the fact that they made at least one purchase of PB over the study period.

For the PB category and for the Peter Pan brand, *a priori*, a decline in the likelihood of purchasing in the post-recall period was expected to be associated with variables accounting for the education level of the household head. This expectation was based on the fact that relatively more knowledgeable household heads make careful decisions when the health of family members may be compromised. In addition, for the

PB category and the Peter Pan brand, a decrease in the likelihood of buying in the post-recall period was anticipated for households with children, either pre-school children, pre-adolescent children, or adolescent children. This anticipation was predicated on the fact that these particular households are more vulnerable due to the presence of children and household heads should exercise more caution when making PB consumption decisions in the presence of the recall. In addition, an increase in the likelihood of buying competing PB brands in the post-recall period was anticipated associated with the *Education level of the household head* and *Age and the presence of children* suggesting that educated household heads and “high-risk” households switch to the consumption of competing PB brands, which were not part of any recall. *A priori*, there were no expectations regarding the sign on the likelihood of purchasing PB in the light of the recall on the rest of socio-demographic variables for the PB category and for the respective brands.

The breakdown of the choice variable associated with the PB category and the five PB brands is exhibited in Table 5.2, which consists of two parts. The first part presents results of the breakdown considering all the choices, while the second part presents results conditional on having purchased the brand at least once, which implies all the choices except choice 1 (*no buy-no buy*). It needs to be pointed out that the results for the PB category are the same for both parts in Table 5.2, since in order to be included in our sample, households were required to have purchased PB at least once over the study period.

According to the first part of Table 5.2, the majority of the households, about 71%, bought PB in both pre- and post-recall periods, about 21% started purchasing PB in the post-recall period after purchasing none in the pre-recall period, and only about 8% of households quit consuming PB in the post-recall period. The number of observations for the PB category is the same as that for the PB brand analysis, 29,841.

As Table 5.2 shows, for the Private Label brand, about 49% of the households did not buy this brand in either recall period, while 21% of the households purchased this brand in both recall periods. In addition, 19% of the households started purchasing the Private Label brand in the post-recall period after purchasing none in the pre-recall period and about 11% of the households quit buying this brand in the post-recall period.

For the Jif brand, households that did not buy this brand at all comprised the largest group, about 44%, and almost 25% of the households purchased this brand in both recall periods. The percent of the households that began purchasing the Jif brand in the post-recall period was 20% and the percent of disloyal households in relation to the Jif brand was 11%.

For the Peter Pan brand, the group of households that did not purchase this brand in either recall period ranked first with 64%, followed by the group of households that started buying this brand in the post recall period, brand-loyal (choice 4) households, and brand-disloyal (choice 2) households with 16%, 12%, and 8%, respectively.

Table 5.2. The Breakdown of the Choice Variable Associated with the Five Peanut Butter Brands and the Peanut Butter Category

	Private Label		Jif		Peter Pan		Skippy		Other Brands		Peanut Butter Category	
Outcomes	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Choice 1[a]	14,579	48.86	13,049	43.73	19,046	63.82	18,048	60.48	22,239	74.52	-	-
Choice 2[b]	3,190	10.69	3,347	11.22	2,388	8.00	2,798	9.38	2,072	6.94	2,458	8.24
Choice 3[c]	5,796	19.42	6,006	20.13	4,835	16.20	4,453	14.92	3,467	11.62	6,275	21.03
Choice 4[d]	6,276	21.03	7,439	24.93	3,572	11.97	4,542	15.22	2,063	6.91	21,108	70.73
Total	29,841	100	29,841	100	29,841	100	29,841	100	29,841	100	29,841	100

Conditional on Having Purchased the Brand (or Excluding Choice 1)

	Private Label		Jif		Peter Pan		Skippy		Other Brands	
Outcomes	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Choice 2	3,190	20.90	3,347	19.93	2,388	22.12	2,798	23.73	2,072	27.26
Choice 3	5,796	37.98	6,006	35.77	4,835	44.79	4,453	37.76	3,467	45.61
Choice 4	6,276	41.12	7,439	44.30	3,572	33.09	4,542	38.51	2,063	27.14
Total	15,262	100	16,792	100	10,795	100	11,793	100	7,602	100

[a]Choice 1=*no buy-no buy*.
[b]Choice 2=*buy-no buy*.
[c]Choice 3=*no buy-buy*.
[d]Choice 4=*buy-buy*.

For the Skippy brand, households that did not purchase this brand either in the pre-recall period or the post-recall period led the way with 60% followed by brand-loyal (choice 4) households and the households that began to purchase this brand in the post-recall period with 15%. Finally, 9% of the households were disloyal (choice 2) with respect to the Skippy brand.

For the column of Other Brands, the dominant group was associated with the households that did not buy this brand in either recall period, 75%, followed by the households that bought this brand only in the post-recall period with about 12%. The groups of brand-disloyal (choice 2) and brand-loyal households comprised 7% each.

As the second part of Table 5.2 shows, Other Brands enjoyed the largest share of disloyal households (choice 2), 27.26%, followed by Skippy, Peter Pan, Private Label, and Jif with 23.73%, 22.12%, 20.9%, and 19.93%, respectively. Moving from the pre-recall period to the post-recall period, Other Brands led the way in terms of gaining new consumers (choice 3) with 45.61% followed by Peter Pan, Private Label, Skippy, and Jif with 44.79%, 37.98%, 37.76%, and 35.77%, respectively. Finally, across the pre- and the post-recall periods, Jif ranked first in terms of loyal households (choice 4) with 44.30% followed by Private Label, Skippy, Peter Pan, and Other Brands with 41.12%, 38.51%, 33.09%, and 27.14%, respectively.

Table 5.3 shows the percentage breakdown of the choice variable by explanatory variables for the PB category and for the five PB brands. The discussion of the results shown in Table 5.3 for the PB category is done in terms of actual percentages. However, to pinpoint differences among PB brands by various variables, the discussion of the percentages presented in Table 5.3 is done through a series of bar charts at the PB brand level. For descriptive purposes, household income is broken down into three groups: low income, which includes households with an annual income below $30,000, medium income, which includes households whose income ranges from $30,000 through $80,000, and high income, which includes households with an annual income over $80,000.

Peanut Butter Category

In the *Age of the household head* category, about 80% of households heads selecting choice 2, about 75% of household heads selecting choice 3, and about 79% of household heads selecting choice 4 are 45 years old or more. In the *Employment status of the household head* category, about 46% of households picking choice 2 have heads who are employed full-time, about 47% of households picking choice 3 have heads who are employed full-time, and about 41% of households displaying demand behavior consistent with choice 4 have heads who are employed full-time.

Table 5.3. The Breakdown of the Choice Variable by Explanatory Variable for the Five Peanut Butter Brands and the Peanut Butter Category

	Private Lable				Jif				Peter Pan			
	Choice 1 = no buy-no buy	Choice 2 = buy-no buy	Choice 3 = no buy-buy	Choice 4 = buy-buy	Choice 1 = no buy-no buy	Choice 2 = buy-no buy	Choice 3 = no buy-buy	Choice 4 = buy-buy	Choice 1 = no buy-no buy	Choice 2 = buy-no buy	Choice 3 = no buy-buy	Choice 4 = buy-buy
Age of the household head												
agehhlt25	0.16	0.13	0.16	0.06	0.11	0.09	0.18	0.15	0.16	0.17	0.04	0.08
agehh2529	1.27	0.97	1.59	0.97	1.26	1.14	1.52	1.01	1.24	1.34	1.39	0.95
agehh3034	3.59	3.42	4.07	3.00	3.31	3.02	4.25	3.60	3.61	3.69	4.05	2.38
agehh3544	17.02	15.64	18.29	17.05	15.73	16.37	18.36	18.91	17.11	16.42	17.50	17.16
agehh4554	29.20	28.59	29.23	26.40	28.30	28.17	29.79	28.16	28.53	28.18	28.67	28.78
agehh5564	26.82	25.64	26.09	25.78	26.63	27.10	26.32	25.47	26.46	26.42	25.73	26.43
agehhgt64	21.95	25.61	20.58	26.74	24.65	24.11	19.58	22.69	22.90	23.79	22.63	24.22
Employment status of the household head												
emphhpt	14.62	16.93	16.72	17.16	15.60	14.58	16.25	16.37	15.86	16.25	15.41	15.76
emphhft	45.29	40.66	42.55	36.92	42.18	41.95	44.89	41.39	43.04	44.10	41.37	40.12
emphhnfp	40.09	42.41	40.73	45.92	42.23	43.47	38.86	42.24	41.10	39.66	43.23	44.12
Education level of the household head												
eduhhlths	2.70	3.64	2.90	4.37	3.38	2.90	3.05	3.11	2.95	3.35	3.70	3.67
eduhhhs	26.85	27.55	27.36	29.49	25.84	28.44	27.29	30.49	26.16	26.97	29.87	32.47
eduhhu	59.37	57.74	58.95	56.18	59.18	58.17	59.34	56.55	59.60	58.04	57.13	54.37
eduhhpc	11.07	11.07	10.78	9.96	11.59	10.49	10.32	9.85	11.29	11.64	9.31	9.49
Region												
reg_East	16.56	16.14	16.15	17.69	19.66	15.15	15.88	12.76	16.81	15.49	16.90	16.46
reg_Central	24.99	25.36	27.88	27.74	22.20	26.17	27.09	32.40	26.93	21.73	29.76	20.21
reg_South	37.57	36.55	36.53	36.79	34.49	38.24	39.01	39.59	29.31	53.52	43.39	59.07
reg_West	20.87	21.94	19.44	17.78	23.64	20.44	18.02	15.26	26.95	9.25	9.95	4.26

Table 5.3 continued

	Private Labels				Jif				Peter Pan			
	Choice 1 = no buy-no buy	Choice 2 = buy-no buy	Choice 3 = no buy-buy	Choice 4 = buy-buy	Choice 1 = no buy-no buy	Choice 2 = buy-no buy	Choice 3 = no buy-buy	Choice 4 = buy-buy	Choice 1 = no buy-no buy	Choice 2 = buy-no buy	Choice 3 = no buy-buy	Choice 4 = buy-buy
Race												
race_White	83.36	85.05	86.47	89.18	83.62	83.63	85.20	89.37	84.33	84.46	87.22	89.00
race_Black	9.51	8.24	6.92	5.40	8.54	9.14	8.41	6.25	8.08	10.26	7.49	6.86
race_Oriental	2.60	2.10	2.35	1.35	2.68	2.87	2.21	1.18	2.77	1.38	1.51	0.95
race_Other	4.53	4.61	4.26	4.06	5.17	4.36	4.18	3.20	4.83	3.89	3.78	3.19
Ethnicity												
hisp_yes	5.42	5.96	4.73	4.67	6.05	5.74	5.01	3.56	5.73	5.57	3.99	3.61
hisp_no	94.58	94.04	95.27	95.33	93.95	94.26	94.99	96.44	94.27	94.43	96.01	96.39
Age and presence of children												
agepclt6_only	2.81	2.35	3.40	2.10	2.68	2.30	3.20	2.62	2.77	2.18	3.25	2.18
agepc6_12only	4.98	4.83	5.18	6.04	4.46	5.11	5.58	6.33	5.01	5.70	5.48	5.71
agepc13_17only	7.25	7.71	7.47	8.11	6.63	7.62	8.21	8.50	7.29	7.66	7.78	8.31
agepclt6_6_12only	2.03	1.91	2.55	2.68	1.92	1.88	2.36	2.92	2.12	2.39	2.79	2.16
agepclt6_13_17only	0.42	0.38	0.48	0.43	0.45	0.30	0.35	0.51	0.36	0.34	0.68	0.53
agepc6_12and13_17only	3.04	3.42	4.38	4.81	3.28	3.53	4.35	4.05	3.52	4.36	3.78	4.20
agepclt6_6_12and13_17	0.48	0.47	0.74	0.64	0.46	0.60	0.73	0.59	0.53	0.29	0.68	0.78
agepc_noch_lt18	78.99	78.93	75.79	75.19	80.11	78.67	75.22	74.49	78.40	77.09	75.55	76.12
Presence of male and/or female household heads												
fhonly	25.65	28.53	23.41	22.69	27.83	26.29	23.44	20.31	26.11	24.83	23.10	20.94
mhonly	8.73	8.93	8.39	9.11	10.90	8.34	8.19	5.69	9.44	7.83	8.11	6.69
fhmh	65.61	62.54	68.20	68.20	61.27	65.37	68.36	74.00	64.45	67.34	68.79	72.37

Table 5.3 continued

	Private Label				Jif				Peter Pan			
	Choice 1 = no buy-no buy	Choice 2 = buy-no buy	Choice 3 = no buy-buy	Choice 4 = buy-buy	Choice 1 = no buy-no buy	Choice 2 = buy-no buy	Choice 3 = no buy-buy	Choice 4 = buy-buy	Choice 1 = no buy-no buy	Choice 2 = buy-no buy	Choice 3 = no buy-buy	Choice 4 = buy-buy
Household size												
HHSize1	24.60	27.05	22.79	22.99	28.77	24.77	22.11	17.52	25.82	22.99	22.07	19.06
HHSize2	44.46	42.07	42.36	41.63	41.90	43.14	42.46	46.11	42.43	44.18	43.78	45.88
HHSize3	14.43	13.23	15.37	14.12	13.40	14.13	15.53	15.43	14.32	14.36	14.48	14.92
HHSize4	10.76	11.10	11.84	12.92	9.93	11.26	12.39	13.47	11.06	11.81	12.18	12.37
HHSize5_andm	5.75	6.55	7.64	8.33	5.99	6.69	7.51	7.47	6.38	6.66	7.49	7.75
Household income (mean)												
hhincome_low	19,869	19,270	19,649	19,446	19,309	19,439	20,112	20,089	19,507	20,065	19,632	20,084
hhincome_med	48,773	47,715	47,993	47,371	47,680	48,302	48,571	48,767	48,277	48,261	47,922	48,200
hhincome_high	105,866	105,445	102,560	102,983	105,586	104,929	103,622	104,265	105,849	103,492	101,821	102,786

	Skippy				Other Brand				Peanut Butter Category		
	Choice 1 = no buy-no buy	Choice 2 = buy-no buy	Choice3 = no buy-buy	Choice4 = buy-buy	Choice1 = no buy-no buy	Choice 2 = buy-no buy	Choice3 = no buy-buy	Choice4 = buy-buy	Choice 2 = buy-no buy	Choice3 = no buy-buy	Choice4 = buy-buy
Age of the household head											
agehhlt25	0.16	0.18	0.09	0.07	0.14	0.10	0.17	0.05	0.20	0.21	0.10
agehh2529	1.35	0.82	1.46	0.81	1.25	0.92	1.47	0.97	0.94	2.04	1.03
agehh3034	3.48	3.54	3.89	3.43	3.48	3.57	4.15	3.15	3.82	4.45	3.24
agehh3544	16.93	15.44	18.50	17.57	17.20	16.26	18.81	14.30	14.61	18.57	16.99
agehh4554	28.63	28.45	28.81	28.05	28.70	26.98	30.29	25.64	29.45	30.20	27.96
agehh5564	26.58	26.41	25.69	25.94	26.31	26.50	26.13	26.76	26.93	26.44	26.23
agehhgt64	22.87	25.16	21.56	24.13	22.92	25.68	18.98	29.13	24.04	18.10	24.45
Employment status of the household head											
emphhpt	15.07	16.40	16.64	17.57	15.51	16.65	16.64	16.72	13.47	14.98	16.33
emphhft	42.96	41.67	43.05	40.64	43.18	40.83	43.58	35.09	45.85	46.93	40.79
emphhnfp	41.97	41.92	40.31	41.79	41.31	42.52	39.78	48.18	40.68	38.09	42.88

Table 5.3 continued

	Skippy				Other Brand				Peanut Butter Category		
	Choice 1 = no buy-no buy	Choice 2 = buy-no buy	Choice3 = no buy-buy	Choice4 = buy-buy	Choice1 = no buy-no buy	Choice 2 = buy-no buy	Choice3 = no buy-buy	Choice4 = buy-buy	Choice 2 = buy-no buy	Choice3 = no buy-buy	Choice4 = buy-buy
Education level of the household head											
eduhhlths	3.34	3.25	2.90	2.86	3.21	3.09	3.17	3.15	3.05	2.79	3.33
eduhhhs	27.96	27.38	26.23	27.52	28.50	26.21	24.29	24.62	24.94	25.53	28.50
eduhhu	57.76	58.51	60.43	59.18	58.13	59.17	60.43	57.83	59.80	60.29	57.74
eduhhpc	10.94	10.86	10.44	10.44	10.17	11.53	12.11	14.40	12.21	11.39	10.43
Region											
reg_East	13.12	19.80	20.37	25.25	16.30	19.02	16.73	18.27	17.33	16.43	16.67
reg_Central	26.09	24.98	26.23	27.17	26.85	23.79	24.95	23.32	20.91	26.06	26.82
reg_South	46.10	26.02	29.08	15.96	36.76	37.74	40.35	34.51	37.10	36.83	37.17
reg_West	14.68	29.20	24.32	31.62	20.09	19.45	17.97	23.90	24.65	20.69	19.34
Race											
race_White	85.27	83.45	85.18	87.14	85.08	86.05	85.69	87.30	76.48	82.39	87.29
race_Black	8.90	7.97	7.12	5.37	8.44	6.85	7.59	5.28	14.36	9.88	6.71
race_Oriental	1.63	3.25	3.12	3.15	2.31	2.12	1.90	2.13	3.34	2.73	1.96
race_Other	4.21	5.33	4.58	4.34	4.18	4.97	4.82	5.28	5.82	5.00	4.04
Ethnicity											
hisp_yes	4.81	6.08	5.43	5.86	5.02	5.45	5.54	6.06	7.32	5.53	4.83
hisp_no	95.19	93.92	94.57	94.14	94.98	94.55	94.46	93.94	92.68	94.47	95.17
Age and presence of children											
agepclt6_only	2.70	2.18	3.03	2.86	2.69	2.46	3.40	2.28	2.20	3.81	2.47
agepc6_12only	4.88	5.50	5.97	5.70	5.24	5.55	5.13	4.85	4.03	4.78	5.50
agepc13_17only	7.32	7.26	7.41	8.61	7.75	7.00	7.38	5.82	5.94	6.80	7.92
agepclt6_6_12only	2.10	2.32	2.31	2.77	2.23	2.51	2.37	2.08	1.42	2.07	2.41
agepclt6_13_17only	0.40	0.21	0.67	0.44	0.46	0.19	0.49	0.19	0.20	0.51	0.43
agepc6_12and13_17only	3.46	3.43	4.18	4.45	3.69	3.09	4.10	3.93	2.03	3.38	4.01
agepclt6_6_12and13_17	0.52	0.64	0.63	0.64	0.51	0.58	0.95	0.48	0.41	0.62	0.56
agepc_noch_lt18	78.63	78.45	75.79	74.53	77.42	78.62	76.18	80.37	83.77	78.02	76.71

Table 5.3 continued

	Skippy				Other Brand				Peanut Butter Category		
	Choice 1 = no buy-no buy	Choice 2 = buy-no buy	Choice3 = no buy-buy	Choice4 = buy-buy	Choice1 = no buy-no buy	Choice 2 = buy-no buy	Choice3 = no buy-buy	Choice4 = buy-buy	Choice 2 = buy-no buy	Choice3 = no buy-buy	Choice4 = buy-buy
Presence of male and/or female household heads											
fhonly	26.10	26.55	23.40	20.61	24.84	26.11	24.78	24.58	33.69	26.96	23.27
mhonly	9.10	8.90	8.40	7.71	8.56	9.60	9.11	9.60	12.37	10.61	7.80
fhmh	64.80	64.55	68.20	71.69	66.60	64.29	66.11	65.83	53.95	62.42	68.94
Household size											
HHSize1	25.84	25.23	21.69	19.33	23.89	25.68	24.11	25.84	34.70	27.30	22.02
HHSize2	43.16	42.85	43.81	43.00	43.25	42.52	41.39	46.39	39.95	41.07	44.22
HHSize3	14.16	13.19	15.16	15.50	14.59	14.09	14.77	12.36	12.25	14.82	14.55
HHSize4	10.69	11.72	11.77	14.02	11.65	11.29	11.48	9.50	8.91	10.10	12.16
HHSize5_andm	6.15	7.01	7.57	8.15	6.62	6.42	8.25	5.91	4.19	6.71	7.05
Household income (mean)											
hhincome_low	19,463	19,913	19,975	20,064	19,705	19,481	19,229	19,804	18,829	19,431	19,813
hhincome_med	47,935	47,782	49,130	48,663	48,221	48,514	47,958	48,184	47,720	48,136	48,282
hhincome_high	103,965	105,687	105,034	106,358	104,489	104,889	104,916	107,064	107,394	103,763	104,757

*See Table 5.1 for the categories, variable names, and description of all the variables.

In the *Education level of the household head* category, about 28% of households exhibiting demand behavior consistent with choice 2 have heads whose education level is high school or less, about 28% of households exhibiting demand behavior consistent with choice 3 have heads whose education level is at most high school, and about 32% of households associated with choice 4 have heads whose education level is at most high school. At the same time, about 72% of households exhibiting demand behavior consistent with choices 2 and 3 have heads who completed at least an undergraduate degree, and about 68% of households displaying demand behavior consistent with choice 4 have heads with at least an undergraduate education.

In the *Region* category, for choice 2, about 17%, 21%, 37%, and 25% of households come from the East, the Midwest, the South, and the West, respectively. In the same category, for choice 3, about 16%, 26%, 37%, and 21% of households are from the East, the Midwest, the South, and the West, respectively. Finally, considering choice 4, about 17%, 27%, 37%, and 19% of the respondent households come from the East, the Midwest, the South, and the West, respectively.

The majority of households across all the choices are white. The average percentage of households for this racial category for choice 2, choice 3, and choice 4 is 76%, 82%, and 87%, respectively. The percentage of households with non-Hispanic ethnicity is about 93% for choice 2, 94% for choice 3, and 95% for choice 4. The majority of households across all the choices have no children less than 18 years of age. The percentage of households with no children less than 18 years of age for choices 2, 3, and 4 is about 84%, 78%, and 77%, respectively.

In the *Presence of male and/or female household heads* category*,* across all the choices, the group where both male and female heads are present comprises the majority. Particularly for choice 2, households with both female and male as heads comprise about 54%. That number for households associated with choice 3 is about 62% and for households associated with choice 4; this percentage is about 69%.

In the *Household size* category, the households with two members are the prevalent. For choice 2 and choice 3, the households with two members account for about 40% and 41%, respectively, and for choice 4, the households with two members account for about 44%.

Low-income households associated with choice 2, choice 3, and choice 4 have an average income level of $18,829, $19,431, and $19,813, respectively. Medium-income households exhibiting demand behavior consistent with choice 2, choice 3, and choice 4 have an average income level of $47,720, $48,136, and $48,282, respectively. Finally, high-income households whose demand behavior is consistent with choice 2, choice 3, and choice 4 have an average income of $107,394, $103,763, and $104,757, respectively.

Peanut Butter Brands

The results for PB brands in Table 5.3 are presented using bar charts associated with choice 2 and choice 3, omitting choice 1 and choice 4. That is, in this descriptive analysis, interest lies in the switch in the decision to buy or not to buy associated with the recall. In addition, the discussion is focused on Peter Pan for choice 2 (*buy-no buy*) as well as on Jif and Skippy for choice 3 (*no buy-buy*).

Figure 5.1 indicates that as the age of the household head goes above 45, more than 78% of households discontinue their consumption of the Peter Pan PB in the post-recall period. Figure 5.2 shows that more than 75% and 76% of households that started buying Jif and Skippy in the post-recall period but did not buy these brands in the pre-recall period have heads aged 45 and older, respectively.

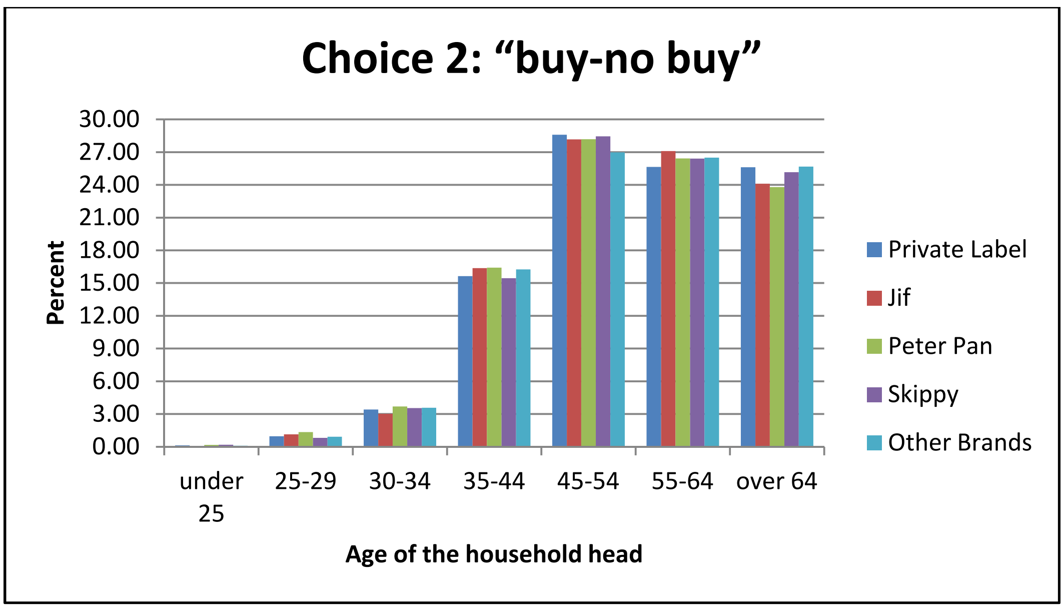

Figure 5.1. Percentage of households associated with choice 2 by age of household head for peanut butter brands in the United States, over calendar years 2006-2008

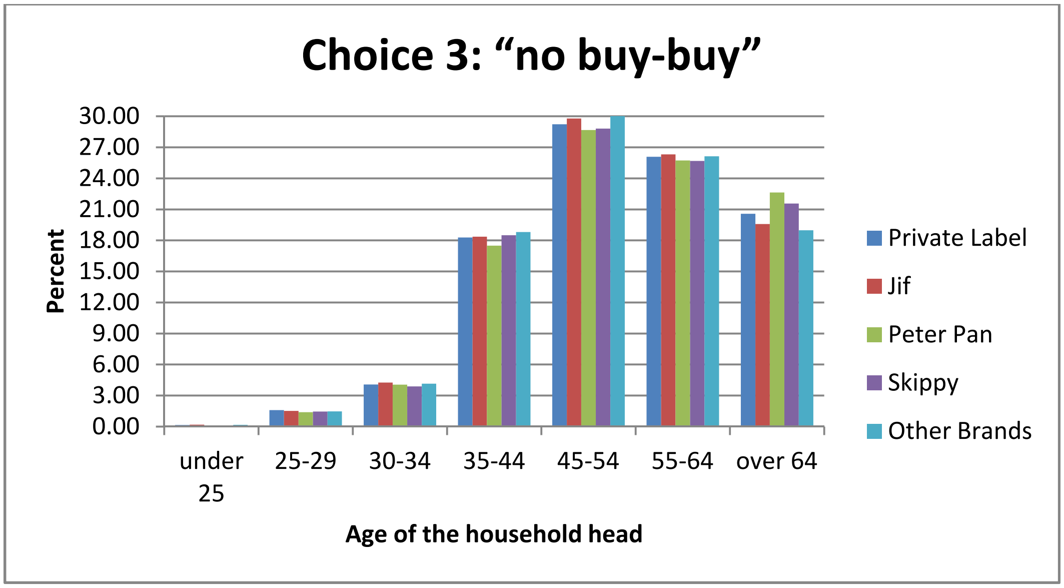

Figure 5.2. Percentage of households associated with choice 3 by age of household head for peanut butter brands in the United States, over calendar years 2006-2008

Figure 5.3 suggests that about 44% and 40% of households that quit consuming the Peter Pan PB in the post-recall period have heads employed full-time and not employed for full pay, respectively. Figure 5.4 suggests that about 45% and 39% of households with heads employed full-time and heads not employed for full pay began consuming Jif in the post-recall period. In addition, in Figure 5.4, about 43% and 40% of households with heads employed full-time and heads not employed for full pay, respectively, began purchasing Skippy in the post-recall period.

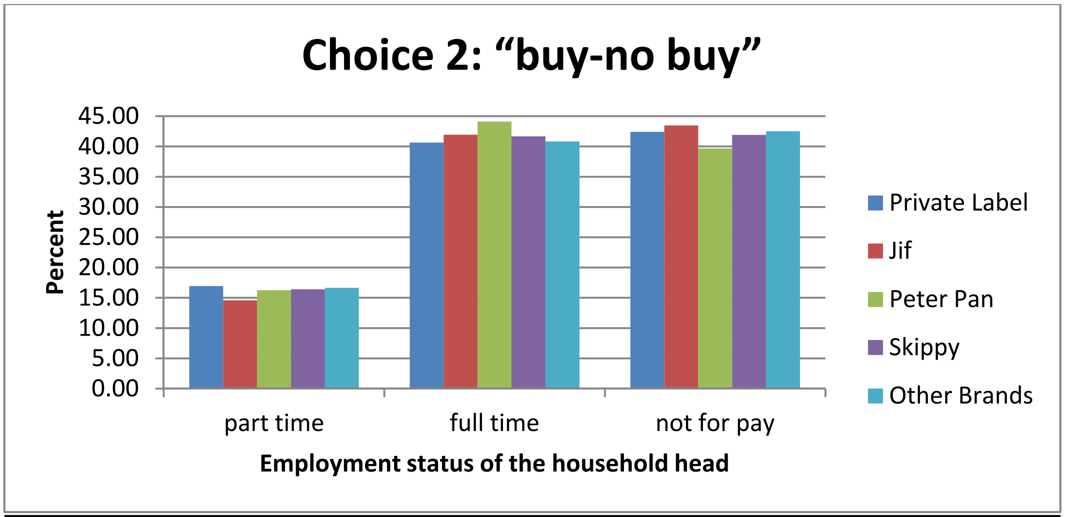

Figure 5.3. Percentage of households associated with choice 2 by employment status of household head for peanut butter brands in the United States, over calendar years 2006-2008

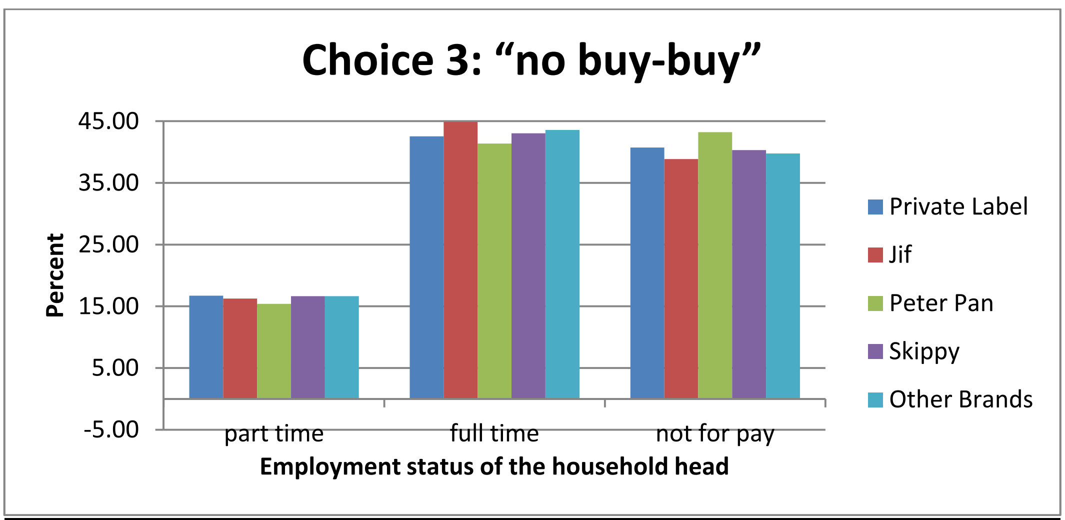

Figure 5.4. Percentage of households associated with choice 3 by employment status of the household head for peanut butter brands in the United States, over calendar years 2006-2008

Figure 5.5 shows around 70% of households that stopped buying Peter Pan in the post-recall period have heads with at least an undergraduate degree. Figure 5.6 indicates that about 70% and 71% of households with heads who have at least an undergraduate degree started purchasing Jif and Skippy, respectively, in the post-recall period.

As Figure 5.7 suggests about 53% of households from the West and about 22% from the Midwest quit buying Peter Pan in the post-recall period. Figure 5.8 suggests that 39% of households from the South and 27% of households from the Midwest started buying Jif in the post-recall period. In addition, Figure 5.8 shows that 29% of households from the South and 26% of households from the Midwest began purchasing Skippy in the post-recall period.

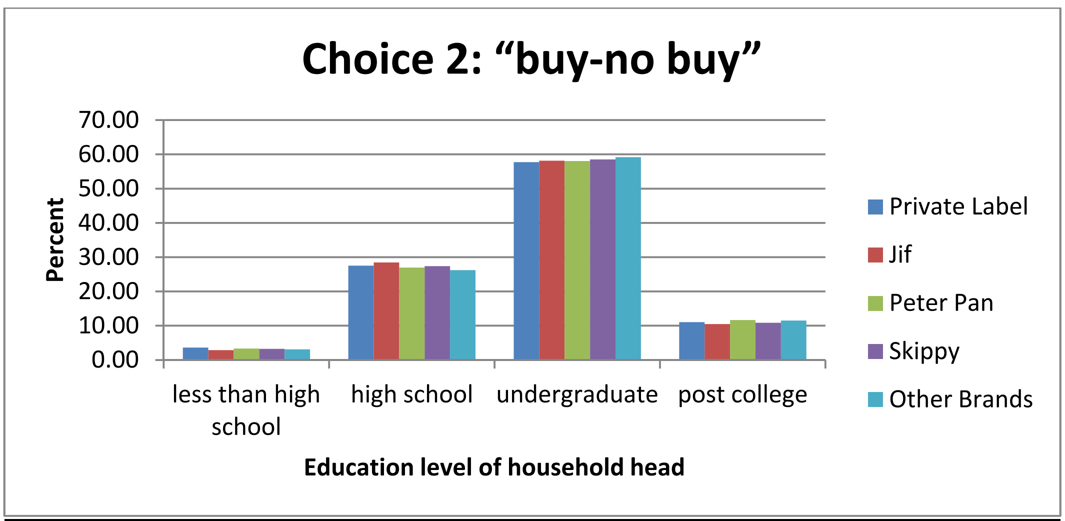

Figure 5.5. Percentage of households associated with choice 2 by education level of the household head for peanut butter brands in the United States, over calendar years 2006-2008

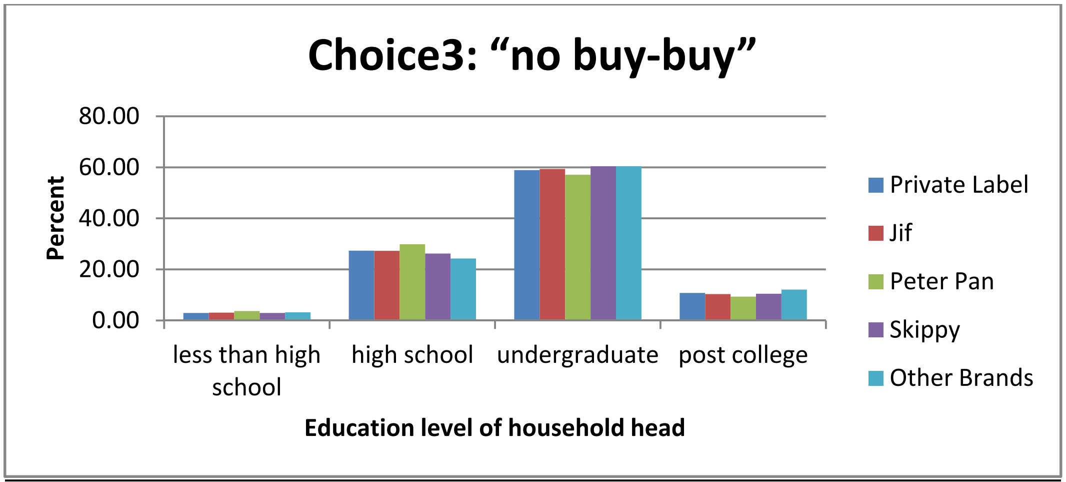

Figure 5.6. Percentage of households associated with choice 3 by education level of the household head for peanut butter brands in the United States, over calendar years 2006-2008

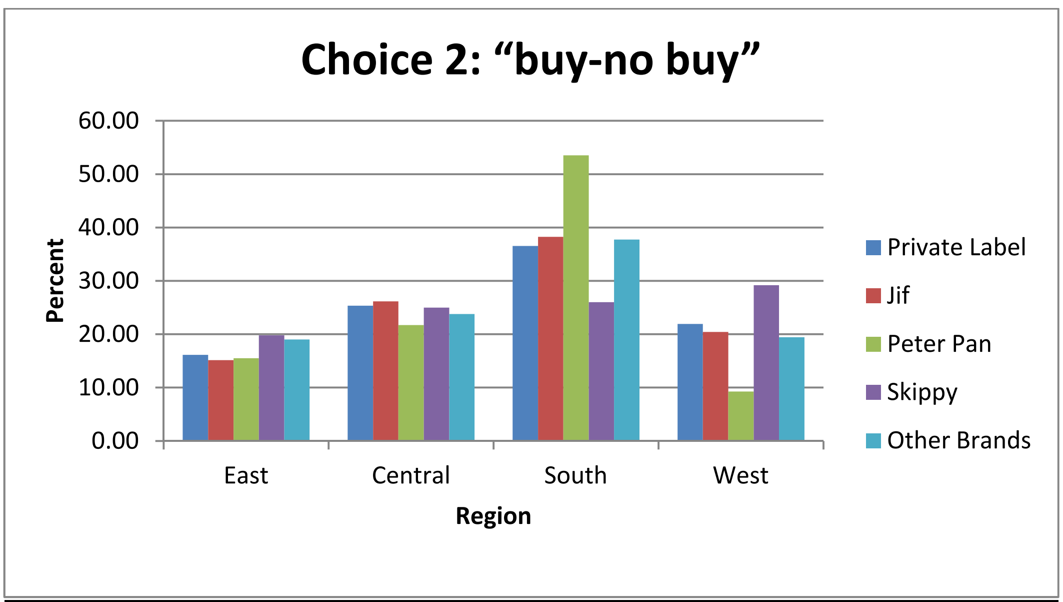

Figure 5.7. Percentage of households associated with choice 2 by region for peanut butter brands in the United States, over calendar years 2006-2008

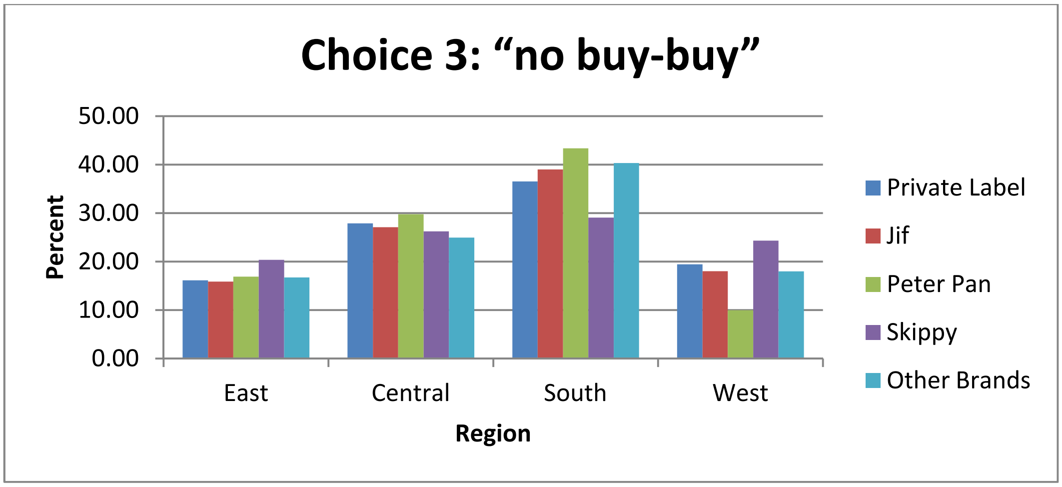

Figure 5.8. Percentage of households associated with choice 3 by region for peanut butter brands in the United States, over calendar years 2006-2008

Figure 5.9 indicates that the majority (84%) of households that quit purchasing Peter Pan in the post-recall period were white. As Figure 5.10 shows, 85% of white households began buying both Jif and Skippy in the post-recall period. Figure 5.11 suggests that 94% of households giving up buying Peter Pan in the post-recall period were non-Hispanic. Figure 5.12 suggests that about 95% of households that began buying Jif and Skippy in the post-recall period were non-Hispanic.

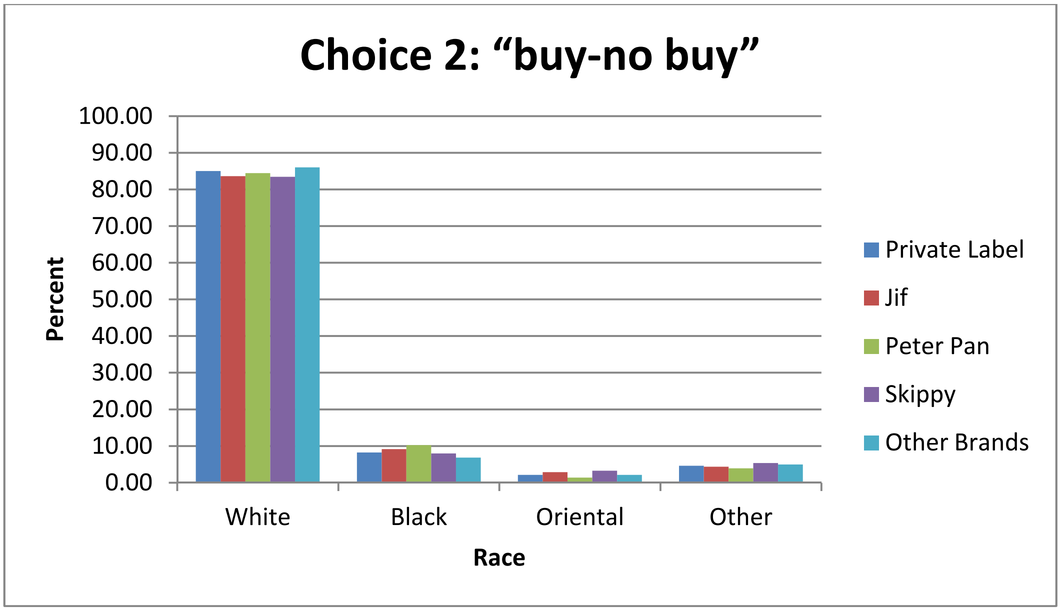

Figure 5.9. Percentage of households associated with choice 2 by race for peanut butter brands in the United States, over calendar years 2006-2008

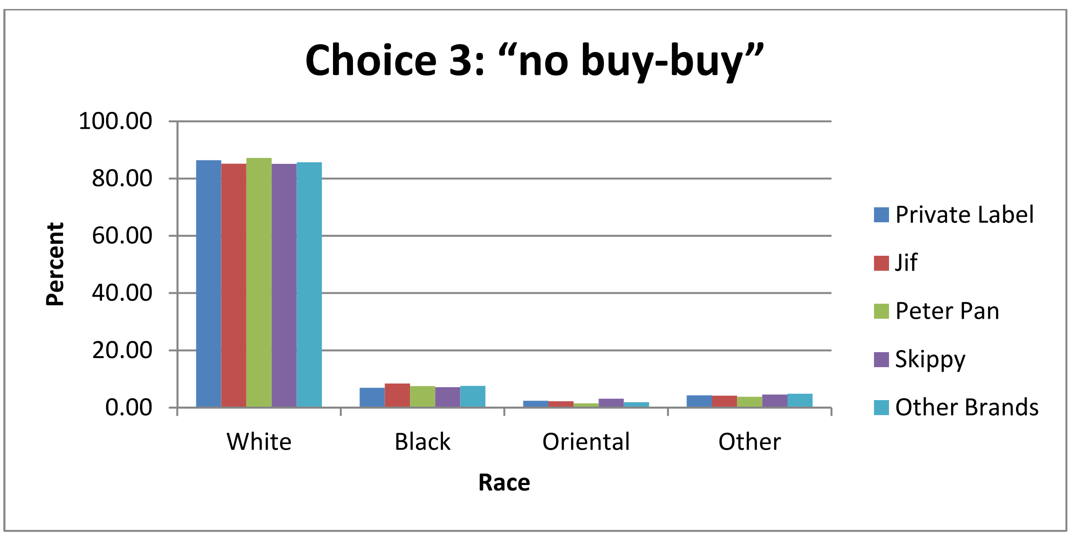

Figure 5.10. Percentage of households associated with choice 3 by race for peanut butter brands in the United States, over calendar years 2006-2008

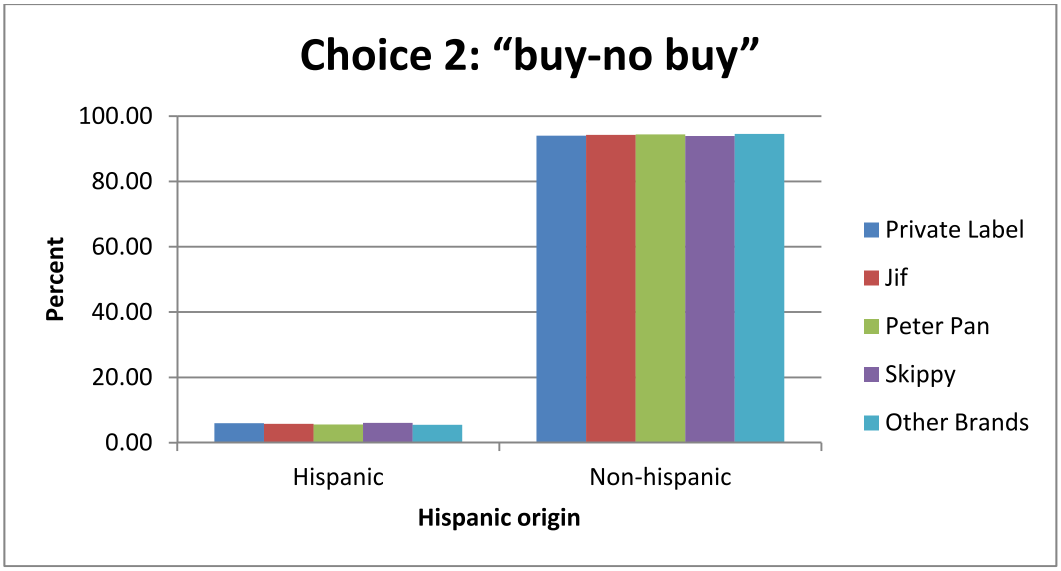

Figure 5.11. Percentage of households associated with choice 2 by Hispanic origin for peanut butter brands in the United States, over calendar years 2006-2008

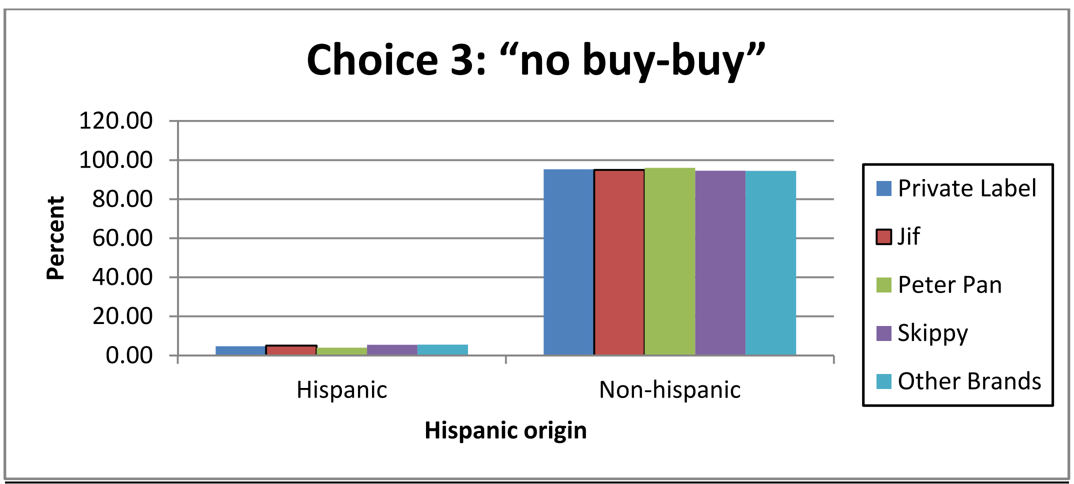

Figure 5.12. Percentage of households associated with choice 3 by Hispanic origin for peanut butter brands in the United States, over calendar years 2006-2008

Figure 5.13 suggests that 77% of households that discontinued buying Peter Pan in the post-recall period had no children less than 18 years of age. Figure 5.14 suggests that 75% and 76% of households that started buying Jif and Skippy, respectively, in the post-recall period, had no children less than 18 years of age.

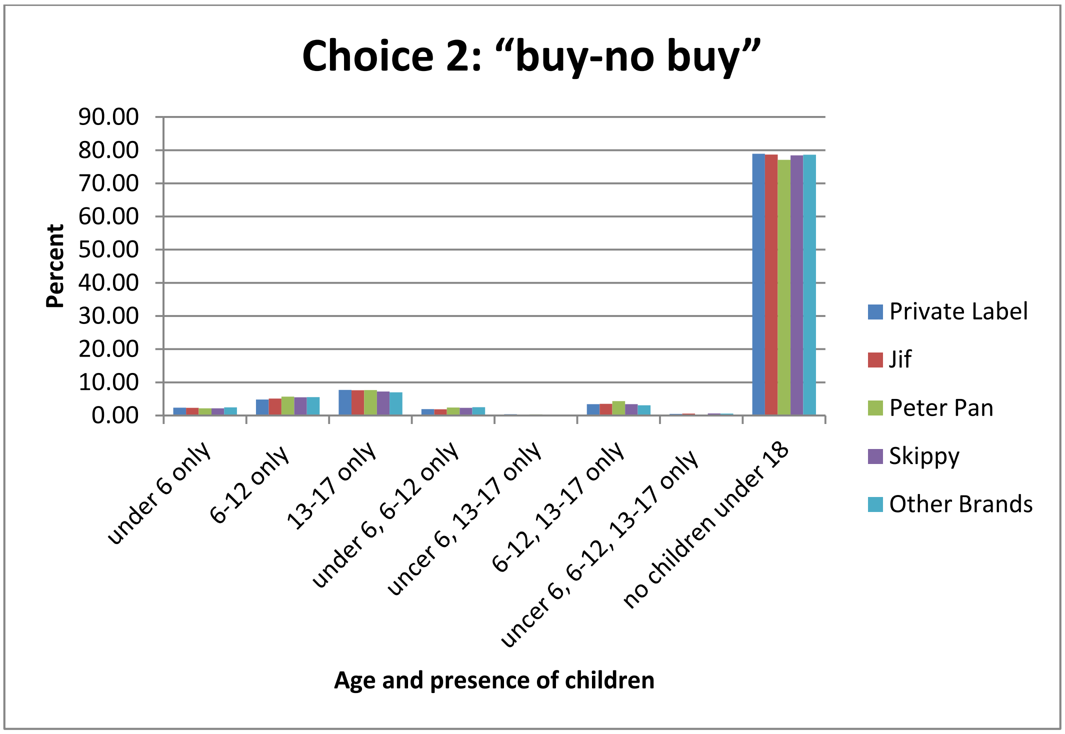

Figure 5.13. Percentage of households associated with choice 2 by the age and presence of children in households for peanut butter brands in the United States, over calendar years 2006-2008

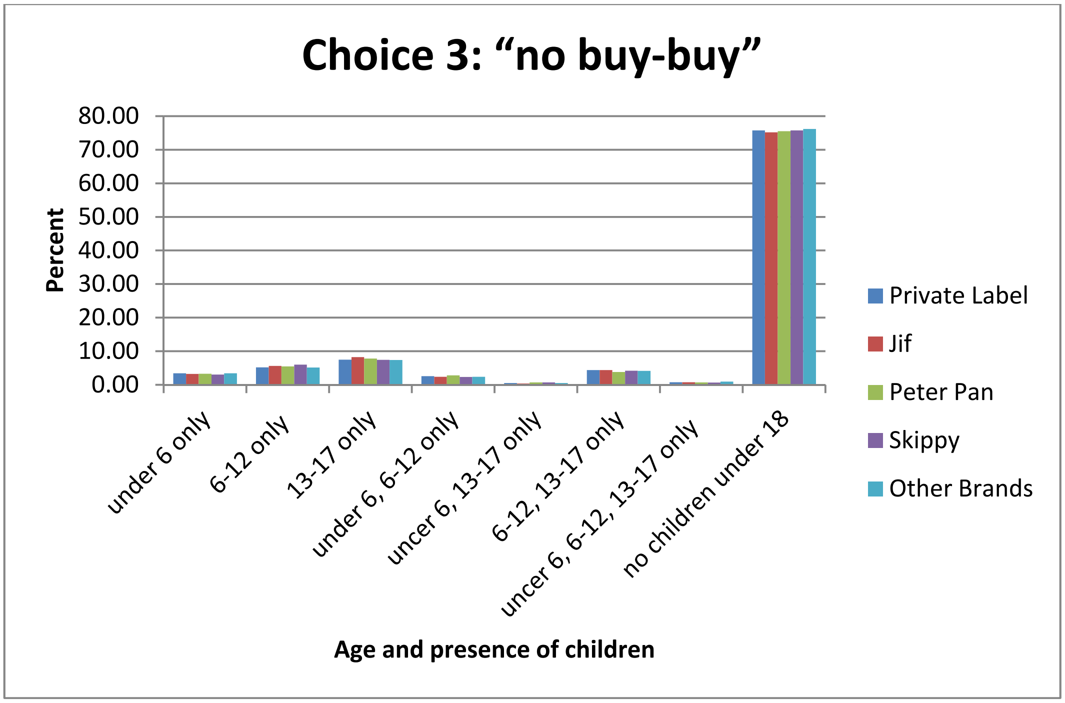

Figure 5.14. Percentage of households associated with choice 3 by the age and presence of children in households for peanut butter brands in the United States, over calendar years 2006-2008

Figure 5.15 shows that 67% of households that had male and female heads discontinued purchasing Peter Pan in the post-recall period. Figure 5.16 suggests that 68% of households with both male and female heads began purchasing both Jif and Skippy in the post-recall period.

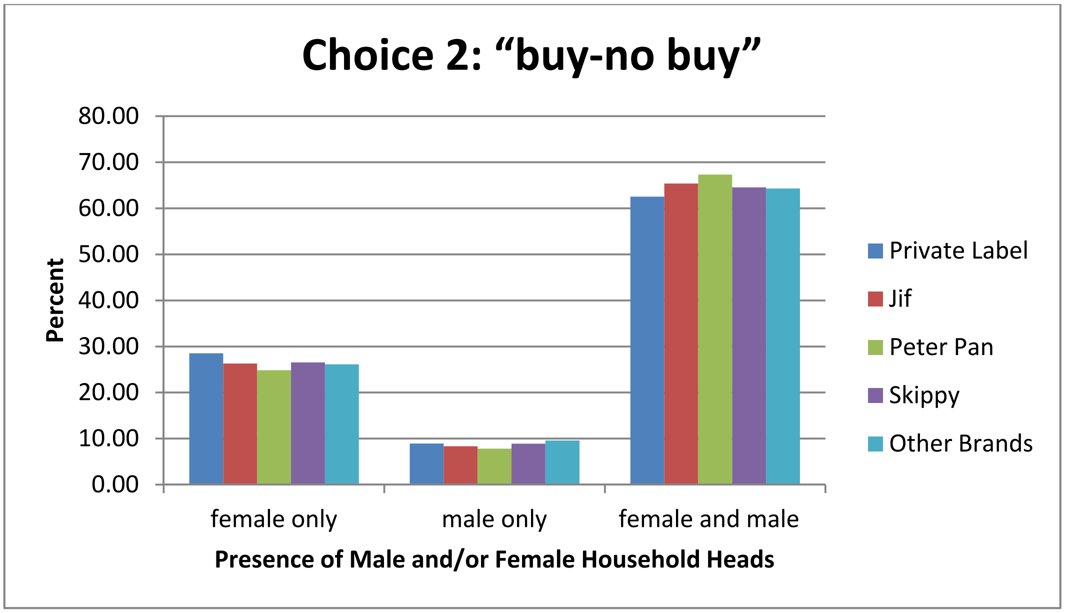

Figure 5.15. Percentage of households associated with choice 2 by presence of male and/or female household heads for peanut butter brands in the United States, over calendar years 2006-2008

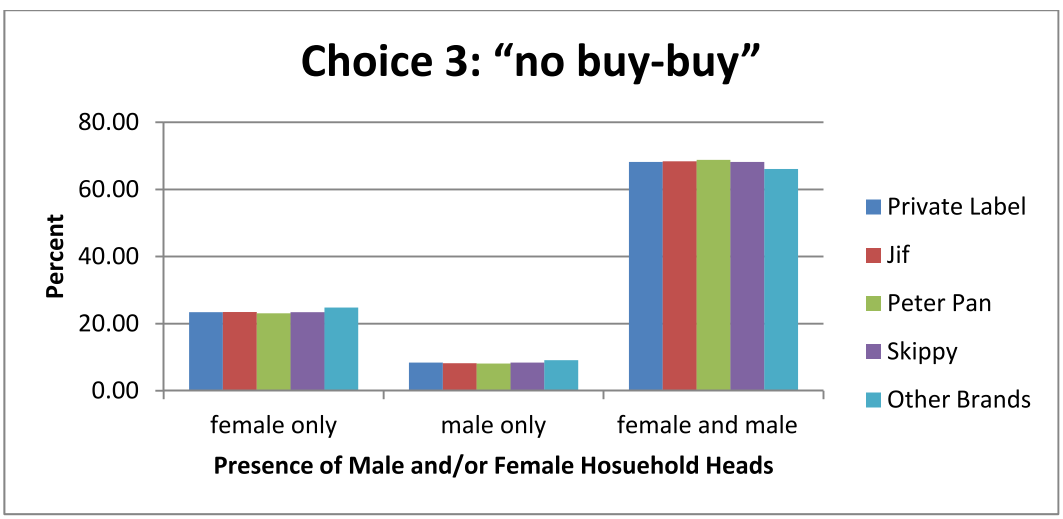

Figure 5.16. Percentage of households associated with choice 3 by presence of male and/or female household heads for peanut butter brands in the United States, over calendar years 2006-2008

Figure 5.17 indicates that about 44% of households that quit purchasing Peter Pan in the post-recall period had two members. Figure 5.18 indicates that 42% and 44% of households that started purchasing Jif and Skippy, respectively, in the post-recall period had two members.

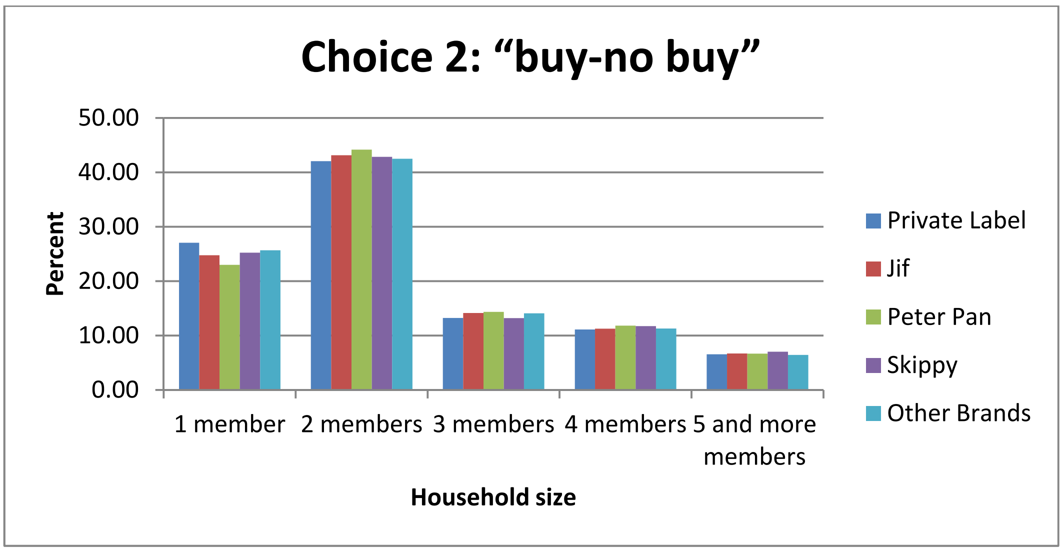

Figure 5.17. Percentage of households associated with choice 2 by the size of household for peanut butter brands in the United States, over calendar years 2006-2008

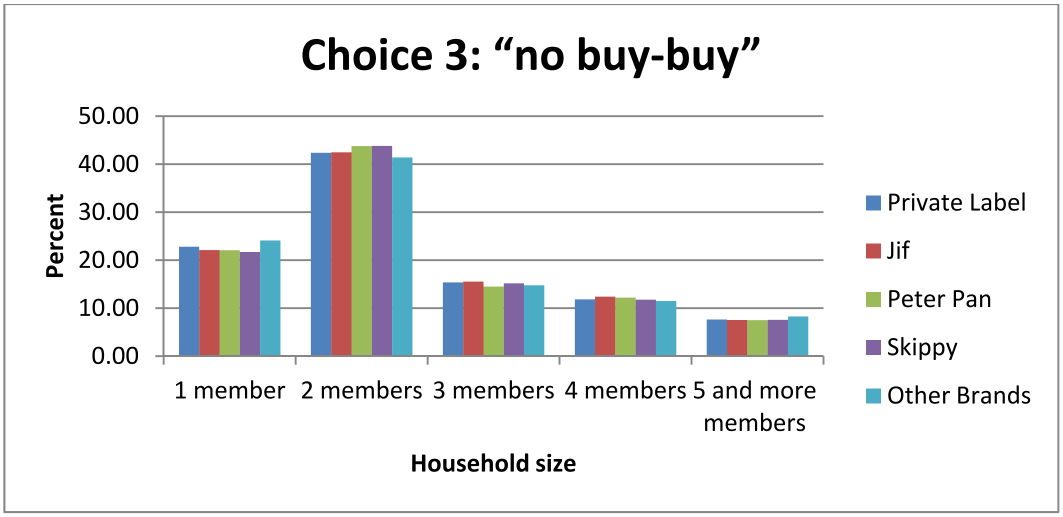

Figure 5.18. Percentage of households associated with choice 3 by the size of household for peanut butter brands in the United States, over calendar years 2006-2008

Figure 5.19 shows that the average income of households that quit buying Peter Pan in the post-recall period was $20,065, $48,261, and $10,349 for the low-, medium-, and high-income households, respectively. Figure 5.20 suggests that the average income of households that began purchasing Jif in the post-recall period was $20,112, $48,571, and $103,622 for the low-, medium-, and high-income households, respectively. In addition, Figure 5.20 indicates that the average income of households that started buying Skippy in the post-recall period was $19,975, $49,130, and $105,034 for the low-, medium-, and high-income households, respectively.

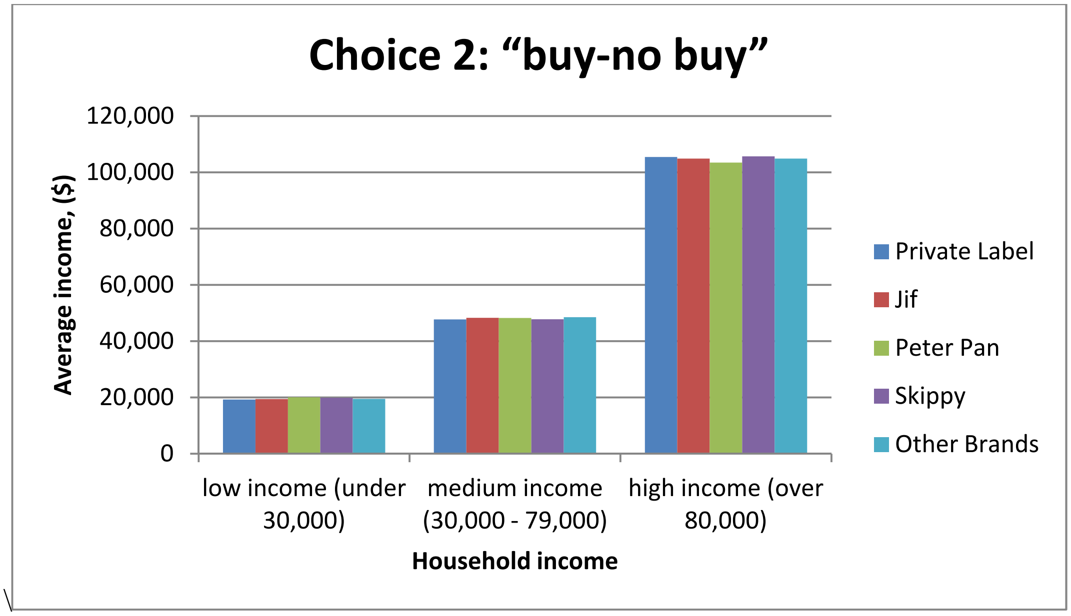

Figure 5.19. Average income of households associated with choice 2 for peanut butter brands in the United States, over calendar years 2006-2008

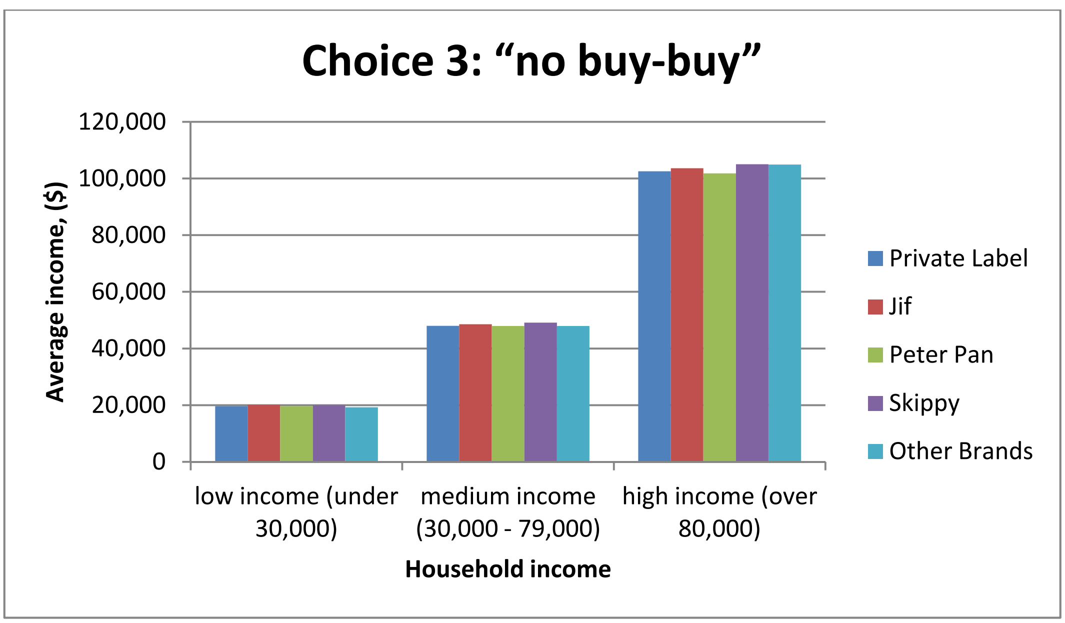

Figure 5.20. Average income of households associated with choice 3 for peanut butter brands in the United States, over calendar years 2006-2008

Estimation Results

Test of Independence of Irrelevant Alternatives (IIA)

The Hausman-McFadden (1984) test conducts pairwise comparisons of estimated coefficients of the full model versus those estimates obtained from the restricted models where at least one choice alternative has been omitted (Long and Freese 2001). The null hypothesis for this test is that alternative *j* versus alternative *k* are independent of other alternatives (or IIA holds). Tests of the IIA for the PB category and for all PB brands are given in Table 5.4. As the results reveal, with one exception (choice 2 of Skippy), the tests support the null hypothesis that IIA holds.

Parameter Estimates

The estimated coefficients and the associated p-values from the multinomial logit model corresponding to the three choices for the PB category and the four choices across all PB brands are reported in Table 5.5. The level of significance chosen for the analysis is 0.05. Choice 4 (*buy-buy*) serves as the reference group for the PB category, and choice 1 (*no buy-no buy*) serves as the reference group for the PB brand analysis. Attention is centered only on statistically significant coefficients. McFadden's R^2 estimates range from 0.01 to 0.05, which are plausible for a cross-sectional data analysis using polychotomous choice models.

Table 5.4. Hausman tests of the IIA assumption, n=29,841

	Private Label			Jif			Peter Pan		
	chi2	P>chi2	evidence	chi2	P>chi2	evidence	chi2	P>chi2	evidence
Choices									
1	-4.11	1	accept Ho	-9.53	1	accept Ho	0.21	1	accept Ho
2	6.89	1	accept Ho	-3.90	1	accept Ho	-6.51	1	accept Ho
3	5.70	1	accept Ho	-10.69	1	accept Ho	-9.11	1	accept Ho
4	2.15	1	accept Ho	-1.22	1	accept Ho	-1.60	1	accept Ho

	Skippy			Other Brands			Peanut Butter Category		
	chi2	P>chi2	evidence	chi2	P>chi2	evidence	chi2	P>chi2	evidence
Choices									
1	3.09	1	accept Ho	-109.35	1	accept Ho	-	-	-
2	124.86	0	reject Ho	-0.16	1	accept Ho	-1.54	1	accept Ho
3	-0.47	1	accept Ho	-1.04	1	accept Ho	-7.12	1	accept Ho
4	-1.40	1	accept Ho	0.07	1	accept Ho	-2.56	1	accept Ho

*Note that even if chi2 < 0 the asymptotic assumptions of the test are nevertheless satisfied.
*Hausman and McFadden (1984) noted that a possible negative result for a chi-squared statistic is evidence that the IIA is not violated.
*Degrees of freedom is 32 for the PB category and is 64 for all tests associated with PB brands.

Parameter Estimates Associated with Peanut Butter Category

For the PB category, the likelihood of the households exhibiting demand behavior associated with choice 3 declines as the age of the household heads increases starting from 55 relative to the households with heads less than 25 years of age. The findings for the *Region* suggest that, for the PB category, compared to the households from the East, households from the Midwest are less likely to display demand behavior associated with choice 2, while the households from the West are more likely to purchase PB in the pre-recall period only. The results for *Race* suggest that for the PB category, black, oriental, and other households are more likely to exhibit demand behavior consistent with choice 2 and with choice 3 compared to white households. Hispanic households are more likely to exhibit demand behavior consistent with choice 2 relative to non-Hispanic households.

Table 5.5. Multinomial Logit Parameter Estimates and Associated p-values

Variables	Private Label Coefficients Choice 2[b]	Private Label Coefficients Choice 3[c]	Private Label Coefficients Choice 4[d]	Jif Coefficients Choice 2	Jif Coefficients Choice 3	Jif Coefficients Choice 4	Peter Pan Coefficients Choice 2	Peter Pan Coefficients Choice 3	Peter Pan Coefficients Choice 4
Age of the household head									
agehh2529	0.0504	0.2573	0.6753	0.1296	-0.3941	-0.7030	-0.0219	1.4231	0.2606
	(0.930)	(0.535)	(0.233)	(0.844)	(0.349)	(0.102)	(0.970)	(0.057)	(0.687)
agehh3034	0.2642	0.1824	0.7550	0.1443	-0.3048	-0.3615	-0.0503	1.5193*	0.1935
	(0.633)	(0.651)	(0.172)	(0.823)	(0.455)	(0.383)	(0.928)	(0.040)	(0.759)
agehh3544	0.2133	0.1691	0.9447	0.2330	-0.4426	-0.2963	-0.1437	1.4817*	0.5639
	(0.697)	(0.670)	(0.085)	(0.715)	(0.271)	(0.468)	(0.793)	(0.044)	(0.364)
agehh4554	0.2975	0.1676	0.9934	0.1934	-0.5118	-0.4323	-0.0532	1.5430*	0.6566
	(0.586)	(0.673)	(0.070)	(0.761)	(0.203)	(0.290)	(0.922)	(0.036)	(0.291)
agehh5564	0.2672	0.1347	1.0933*	0.2405	-0.5170	-0.4132	-0.0082	1.5039*	0.6569
	(0.625)	(0.734)	(0.046)	(0.706)	(0.198)	(0.312)	(0.988)	(0.041)	(0.290)
agehhgt64	0.3817	0.0377	1.2160*	0.2105	-0.6649	-0.3875	0.1481	1.5108*	0.7716
	(0.485)	(0.925)	(0.026)	(0.741)	(0.099)	(0.343)	(0.787)	(0.040)	(0.215)
Employment status of the household head									
emphhpt	0.1515*	0.0891	0.0975*	-0.1153	0.0332	-0.0134	0.1506*	-0.0567	0.0135
	(0.011)	(0.063)	(0.035)	(0.058)	(0.492)	(0.768)	(0.026)	(0.262)	(0.815)
emphhft	-0.0266	-0.0232	-0.0403	-0.0233	0.0693	0.0111	0.2088*	0.0158	0.0589
	(0.609)	(0.568)	(0.318)	(0.647)	(0.092)	(0.775)	(0.000)	(0.712)	(0.231)
Education level of the household head									
eduhhhs	-0.2122	-0.0453	-0.3107*	0.2594*	0.0899	0.1864*	-0.0688	-0.0932	0.0207
	(0.060)	(0.643)	(0.000)	(0.029)	(0.339)	(0.033)	(0.594)	(0.316)	(0.846)
eduhhu	-0.1806	0.0126	-0.2486*	0.1703	0.0119	0.0243	-0.0511	-0.1552	-0.1410
	(0.104)	(0.896)	(0.003)	(0.147)	(0.898)	(0.779)	(0.687)	(0.091)	(0.182)
eduhhpc	-0.0280	0.1354	-0.0415	0.1077	-0.1193	-0.0681	0.0345	-0.2333*	-0.1624
	(0.824)	(0.208)	(0.668)	(0.413)	(0.254)	(0.488)	(0.809)	(0.028)	(0.182)

Table 5.5. continued

Variables	Private Label Coefficients Choice 2[b]	Coefficients Choice 3[c]	Coefficients Choice 4[d]	Jif Coefficients Choice 2	Coefficients Choice 3	Coefficients Choice 4	Peter Pan Coefficients Choice 2	Coefficients Choice 3	Coefficients Choice 4
Region									
reg_central	0.0354	0.1122*	0.0065	0.4293*	0.4091*	0.7994*	-0.1523*	0.0629	-0.2974*
	(0.571)	(0.022)	(0.891)	(0.000)	(0.000)	(0.000)	(0.034)	(0.205)	(0.000)
reg_south	0.0099	0.0110	-0.0741	0.3659*	0.3566*	0.6068*	0.6737*	0.3920*	0.7492*
	(0.867)	(0.814)	(0.099)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
reg_west	0.0900	-0.0209	-0.1911*	0.1274	-0.0156	0.0753	-0.9732*	-0.9744*	-1.7743*
	(0.167)	(0.692)	(0.000)	(0.051)	(0.768)	(0.152)	(0.000)	(0.000)	(0.000)
Race									
race_black	-0.1708*	-0.3596*	-0.6098*	0.0447	-0.0832	-0.3864*	0.0394	-0.2193*	-0.4196*
	(0.018)	(0.000)	(0.000)	(0.521)	(0.150)	(0.000)	(0.602)	(0.000)	(0.000)
race_oriental	-0.1322	-0.0759	-0.4972*	0.1245	-0.2416*	-0.8499*	-0.3882*	-0.2771*	-0.6569*
	(0.335)	(0.465)	(0.000)	(0.301)	(0.023)	(0.000)	(0.036)	(0.034)	(0.000)
race_other	-0.0855	-0.0468	-0.1097	-0.1716	-0.1747	-0.2838*	-0.2028	-0.0075	-0.1562
	(0.443)	(0.604)	(0.223)	(0.122)	(0.052)	(0.002)	(0.125)	(0.939)	(0.192)
Ethnicity									
hisp_yes	0.1487	-0.1734*	-0.1155	0.0314	-0.1755*	-0.4671*	0.1402	-0.2857*	-0.3497*
	(0.136)	(0.042)	(0.169)	(0.751)	(0.034)	(0.000)	(0.216)	(0.003)	(0.002)

Table 5.5. continued.

Variables	Private Label Coefficients Choice 2[b]	Private Label Coefficients Choice 3[c]	Private Label Coefficients Choice 4[d]	Jif Coefficients Choice 2	Jif Coefficients Choice 3	Jif Coefficients Choice 4	Peter Pan Coefficients Choice 2	Peter Pan Coefficients Choice 3	Peter Pan Coefficients Choice 4
Age and presence of children									
agepclt6_only	-0.1534	0.0910	-0.1829	-0.2543	-0.0143	-0.1121	-0.1703	0.2724*	-0.0593
	(0.293)	(0.385)	(0.117)	(0.080)	(0.894)	(0.292)	(0.314)	(0.015)	(0.679)
agepc6_12only	-0.0472	-0.0298	0.2145*	0.0044	0.0701	0.2201*	0.1724	0.1495	0.1454
	(0.667)	(0.727)	(0.009)	(0.968)	(0.412)	(0.006)	(0.142)	(0.093)	(0.148)
agepc13_17only	0.0276	-0.0392	0.1029	0.0076	0.0702	0.1175	0.0659	0.0971	0.0768
	(0.767)	(0.598)	(0.155)	(0.935)	(0.342)	(0.092)	(0.527)	(0.211)	(0.378)
agepclt6_6_12only	-0.1717	0.0549	0.1845	-0.2319	-0.0418	0.1979	0.1649	0.2857*	0.0504
	(0.317)	(0.666)	(0.137)	(0.175)	(0.749)	(0.097)	(0.360)	(0.028)	(0.749)
agepclt6_13_17only	-0.2960	-0.0248	-0.1730	-0.6528	-0.4744	-0.0796	-0.0475	0.6441*	0.3436
	(0.372)	(0.918)	(0.482)	(0.066)	(0.075)	(0.722)	(0.904)	(0.005)	(0.227)
agepc6_12and13_17only	-0.0218	0.2121*	0.3059*	-0.1179	0.1014	0.0258	0.2890*	0.1084	0.1347
	(0.876)	(0.046)	(0.003)	(0.387)	(0.338)	(0.800)	(0.048)	(0.337)	(0.284)
agepclt6_6_12and13_17	-0.2191	0.2068	0.0635	0.0383	0.2688	0.0924	-0.4741	0.2944	0.3793
	(0.479)	(0.339)	(0.774)	(0.893)	(0.223)	(0.675)	(0.254)	(0.195)	(0.129)
Presence of male and/or female household heads									
fhonly	0.0850	-0.1613*	-0.2665*	-0.0103	-0.0874	-0.2003*	-0.1321	-0.1808*	-0.2539*
	(0.230)	(0.006)	(0.000)	(0.885)	(0.132)	(0.000)	(0.105)	(0.003)	(0.000)
mhonly	0.0807	-0.0619	0.0639	-0.1910*	-0.2088*	-0.5096*	-0.1725	-0.1146	-0.2521*
	(0.382)	(0.414)	(0.387)	(0.039)	(0.005)	(0.000)	(0.110)	(0.152)	(0.009)

Table 5.5. continued

Variables	Private Label Coefficients Choice 2[b]	Coefficients Choice 3[c]	Coefficients Choice 4[d]	Jif Coefficients Choice 2	Coefficients Choice 3	Coefficients Choice 4	Peter Pan Coefficients Choice 2	Coefficients Choice 3	Coefficients Choice 4
Household size									
hhsize1	-0.3907*	-0.2907*	-0.6191*	-0.3142*	-0.2158	-0.3305*	-0.1532	-0.1467	-0.4198*
	(0.005)	(0.009)	(0.000)	(0.023)	(0.053)	(0.002)	(0.330)	(0.211)	(0.002)
hhsize2	-0.3548*	-0.2659*	-0.5377*	-0.1990	-0.0981	-0.0388	-0.0431	-0.0352	-0.2158*
	(0.002)	(0.004)	(0.000)	(0.081)	(0.283)	(0.654)	(0.738)	(0.712)	(0.044)
hhsize3	-0.3113*	-0.1307	-0.3482*	-0.1366	-0.0269	-0.0030	-0.0623	-0.0783	-0.1797
	(0.006)	(0.135)	(0.000)	(0.217)	(0.759)	(0.971)	(0.615)	(0.390)	(0.081)
hhsize4	-0.1284	-0.1340	-0.1483	-0.0124	0.0015	0.0818	-0.0158	-0.0282	-0.0819
	(0.216)	(0.096)	(0.053)	(0.904)	(0.986)	(0.281)	(0.889)	(0.734)	(0.385)
Household income									
hhincome	-0.000005*	-0.000005*	-0.00001*	0.00000005	0.000002*	0.000002*	-0.000002*	-0.000004*	-0.000003*
	(0.000)	(0.000)	(0.000)	(0.933)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)
constant	-1.1050	-0.4986	-0.4984	-1.7728*	-0.4627	-0.5799	-1.9775*	-2.4169*	-1.7882*
	(0.051)	(0.230)	(0.372)	(0.007)	(0.270)	(0.171)	(0.001)	(0.001)	(0.005)
McFadden's R^2	0.01			0.02			0.05		
Wald chi2	1046.2900			1351.5100			2996.5500		
Prob > chi2	0.000			0.000			0.000		
Log likelihood	-36335.43			-37402.87			-29466.80		
Number of obs	29,841			29,841			29,841		

Table 5.5. continued

Variables	Skippy Coefficients Choice 2	Skippy Coefficients Choice 3	Skippy Coefficients Choice 4	Other Brands Coefficients Choice 2	Other Brands Coefficients Choice 3	Other Brands Coefficients Choice 4	Peanut Butter Category Coefficients Choice 2	Peanut Butter Category Coefficients Choice 3
Age of the household head								
agehh2529	-0.5678	0.6876	0.3725	0.0185	-0.0595	0.8289	-0.6485	0.0421
	(0.294)	(0.218)	(0.564)	(0.981)	(0.900)	(0.427)	(0.237)	(0.909)
agehh3034	-0.1711	0.6207	0.7025	0.3402	-0.0235	0.9340	-0.3636	-0.2761
	(0.736)	(0.257)	(0.262)	(0.646)	(0.959)	(0.363)	(0.479)	(0.443)
agehh3544	-0.2844	0.6067	0.7591	0.2819	-0.0914	0.8857	-0.6952	-0.4765
	(0.568)	(0.264)	(0.222)	(0.701)	(0.840)	(0.385)	(0.169)	(0.179)
agehh4554	-0.1631	0.5726	0.7915	0.2911	-0.1166	1.0030	-0.6329	-0.5671
	(0.743)	(0.291)	(0.202)	(0.691)	(0.796)	(0.325)	(0.210)	(0.109)
agehh5564	-0.0905	0.6005	0.9462	0.3596	-0.2069	1.0544	-0.7374	-0.6940*
	(0.856)	(0.268)	(0.127)	(0.624)	(0.646)	(0.301)	(0.144)	(0.050)
agehhgt64	0.0422	0.6291	1.1156	0.4703	-0.4118	1.1909	-0.8102	-1.0175*
	(0.932)	(0.246)	(0.072)	(0.522)	(0.362)	(0.243)	(0.109)	(0.004)
Employment status of the household head								
emphhpt	0.0835	0.0616	0.0771	0.0820	0.0358	-0.0308	-0.1070	-0.0530
	(0.184)	(0.234)	(0.138)	(0.239)	(0.522)	(0.655)	(0.124)	(0.243)
emphhft	0.0053	-0.0191	-0.0302	-0.0390	-0.0760	-0.3124*	0.0045	0.0106
	(0.922)	(0.667)	(0.506)	(0.521)	(0.111)	(0.000)	(0.937)	(0.779)

Table 5.5. continued

Variables	Skippy Coefficients Choice 2	Skippy Coefficients Choice 3	Skippy Coefficients Choice 4	Other Brands Coefficients Choice 2	Other Brands Coefficients Choice 3	Other Brands Coefficients Choice 4	Peanut Butter Category Coefficients Choice 2	Peanut Butter Category Coefficients Choice 3
Education level of the household head								
eduhhhs	0.0074	0.0312	0.0777	-0.0145	-0.1601	-0.0542	0.0091	0.0308
	(0.952)	(0.764)	(0.463)	(0.917)	(0.145)	(0.696)	(0.944)	(0.732)
eduhhu	0.0050	0.1007	0.1029	0.1213	0.0391	0.1663	0.0233	0.0492
	(0.967)	(0.325)	(0.325)	(0.374)	(0.716)	(0.221)	(0.856)	(0.579)
eduhhpc	-0.0752	-0.0580	-0.0606	0.2275	0.2123	0.5500*	0.0445	0.0345
	(0.577)	(0.615)	(0.606)	(0.136)	(0.077)	(0.000)	(0.755)	(0.727)
Region								
reg_central	-0.4405*	-0.4324*	-0.6117*	-0.2663*	-0.0997	-0.2400*	-0.2487*	-0.0007
	(0.000)	(0.000)	(0.000)	(0.000)	(0.085)	(0.001)	(0.000)	(0.987)
reg_south	-0.9824*	-0.9015*	-1.7124*	-0.1174	0.0731	-0.1799*	-0.0855	-0.0088
	(0.000)	(0.000)	(0.000)	(0.073)	(0.174)	(0.008)	(0.176)	(0.839)
reg_west	0.2434*	0.0346	0.0849	-0.2142*	-0.1438*	0.0017	0.1557*	0.0703
	(0.000)	(0.522)	(0.088)	(0.004)	(0.022)	(0.981)	(0.024)	(0.148)
Race								
race_black	0.0679	-0.1046	-0.2598*	-0.2416*	-0.1953*	-0.4318*	0.8594*	0.3886*
	(0.379)	(0.113)	(0.000)	(0.009)	(0.005)	(0.000)	(0.000)	(0.000)
race_oriental	0.4372*	0.3679*	0.2018	-0.0735	-0.2409	-0.1489	0.6529*	0.3094*
	(0.001)	(0.001)	(0.066)	(0.650)	(0.074)	(0.359)	(0.000)	(0.001)
race_other	0.1024	-0.0447	-0.2270*	0.1821	0.0633	0.1762	0.2880*	0.1979*
	(0.363)	(0.645)	(0.024)	(0.152)	(0.536)	(0.158)	(0.012)	(0.014)
Ethnicity								
hisp_yes	0.1150	0.0468	0.1710	0.0274	0.0298	0.1547	0.4264*	0.0448
	(0.278)	(0.603)	(0.057)	(0.821)	(0.755)	(0.187)	(0.000)	(0.559)

Table 5.5. continued

Variables	Skippy Coefficients Choice 2	Skippy Coefficients Choice 3	Skippy Coefficients Choice 4	Other Brands Coefficients Choice 2	Other Brands Coefficients Choice 3	Other Brands Coefficients Choice 4	Peanut Butter Category Coefficients Choice 2	Peanut Butter Category Coefficients Choice 3
Age and presence of children								
agepclt6_only	-0.2407	0.0026	-0.0362	-0.0840	0.0543	0.0902	-0.1527	0.2343*
	(0.126)	(0.982)	(0.764)	(0.620)	(0.654)	(0.613)	(0.356)	(0.014)
agepc6_12only	0.0924	0.1432	0.0617	0.0464	-0.1632	0.2218	-0.3060*	-0.2143*
	(0.406)	(0.110)	(0.502)	(0.707)	(0.102)	(0.095)	(0.016)	(0.008)
agepc13_17only	-0.0624	-0.0431	0.0397	-0.1064	-0.1765*	0.0153	-0.2458*	-0.1801*
	(0.528)	(0.594)	(0.616)	(0.340)	(0.042)	(0.900)	(0.024)	(0.010)
agepclt6_6_12only	0.0523	0.0256	0.1944	0.0893	-0.2171	0.2526	-0.4357*	-0.2719*
	(0.758)	(0.855)	(0.150)	(0.630)	(0.145)	(0.214)	(0.036)	(0.026)
agepclt6_13_17only	-0.6984	0.4904*	0.0225	-0.8800	-0.1893	-0.4461	-0.6720	0.0804
	(0.112)	(0.037)	(0.935)	(0.092)	(0.494)	(0.396)	(0.157)	(0.713)
agepc6_12and13_17only	-0.1380	0.0820	0.0466	-0.2227	-0.1383	0.3998*	-0.5481*	-0.2026*
	(0.339)	(0.472)	(0.680)	(0.181)	(0.258)	(0.015)	(0.002)	(0.046)
agepclt6_6_12and13_17	0.1122	0.0884	0.0997	0.0910	0.2750	0.2923	-0.1742	-0.0537
	(0.698)	(0.713)	(0.681)	(0.786)	(0.222)	(0.423)	(0.631)	(0.794)
Presence of male and/or female household heads								
fhonly	0.1542*	0.0794	-0.0451	0.1048	0.0447	-0.1040	0.3800*	0.1788*
	(0.039)	(0.201)	(0.489)	(0.212)	(0.507)	(0.250)	(0.000)	(0.001)
mhonly	0.0965	0.0666	-0.0040	0.1759	0.0689	0.0054	0.4195*	0.2534*
	(0.318)	(0.408)	(0.962)	(0.099)	(0.427)	(0.961)	(0.000)	(0.000)

Table 5.5. continued

Variables	Skippy Coefficients Choice 2	Coefficients Choice 3	Coefficients Choice 4	Other Brands Coefficients Choice 2	Coefficients Choice 3	Coefficients Choice 4	Peanut Butter Category Coefficients Choice 2	Coefficients Choice 3
Household size								
hhsize1	-0.3793*	-0.2966*	-0.5116*	-0.1702	-0.2798*	0.3473	0.4792*	0.2160*
	(0.008)	(0.013)	(0.000)	(0.299)	(0.027)	(0.052)	(0.003)	(0.036)
hhsize2	-0.2524*	-0.0779	-0.2840*	-0.1306	-0.2659*	0.2918*	0.2222	0.0525
	(0.034)	(0.427)	(0.003)	(0.338)	(0.010)	(0.048)	(0.120)	(0.539)
hhsize3	-0.2672*	-0.0599	-0.1467	-0.0832	-0.2205*	0.1021	0.1281	0.0268
	(0.021)	(0.523)	(0.113)	(0.528)	(0.026)	(0.472)	(0.361)	(0.743)
hhsize4	-0.0592	-0.0880	-0.0019	-0.0403	-0.2272*	-0.0348	0.1471	-0.1487
	(0.577)	(0.307)	(0.982)	(0.740)	(0.013)	(0.787)	(0.269)	(0.051)
Household income								
hhincome	0.000002*	0.000003*	0.000005*	-0.0000001	-0.000001*	0.0000003	0.000001	0.000001*
	(0.000)	(0.000)	(0.000)	(0.890)	(0.050)	(0.685)	(0.11)	(0.041)
constant	-1.2933*	-1.7067*	-1.6836*	-2.5547*	-1.2844*	-3.5568*	-1.9539*	-0.8073*
	(0.013)	(0.002)	(0.008)	(0.001)	(0.006)	(0.001)	(0.000)	(0.030)
McFadden's R^2	0.04			0.01			0.02	
Wald chi2	2730.6500			382.4900			923.69	
Prob > chi2	(0.000)			(0.000)			(0.000)	
Log likelihood	-31354.24			-24849.41			-22767.56	
Number of obs	29,841			29,841			29,841	

[a]Comparison group is choice 1=*no buy-no buy*
[b]Choice 2=*buy-no buy*
[c]Choice 3=*no buy-buy*
[d]Choice 4=*buy-buy*
*Values in the parentheses are p-values
*Statistically significant at the 0.05 level
*See Table 5.1 for the categories, variable names, and description of all the variables

For the PB category, households with pre-school (less than 6 years of age) children only are more likely to display demand behavior consistent with choice 3 compared to households with no children. This result is contrary to our expectations. Households with pre-adolescent (between 6-12 years of age) children only and households with adolescent (between 13-17 years of age) children only are less likely to exhibit demand behavior consistent with choice 2 and with choice 3 compared to households with no children. Households with pre-school and pre-adolescent children only and households with pre-adolescent and adolescent children only are less likely to exhibit demand behavior consistent with choice 2 and with choice 3 compared to households with no children.

Regarding *Presence of male and/or female household heads*, the results for the PB category indicate that households with male heads only and households with female heads only are more likely to exhibit demand behavior associated with choice 2 and with choice 3 relative to households with both heads present. One-member households are more likely to display demand behavior consistent with choice 2 and with choice 3 relative to households with five and more members. Finally, as income increases, households are more likely to exhibit demand behavior consistent with choice 3.

Parameter Estimates Associated with Peanut Butter Brands

According to the results in Table 5.5, for Private Label, relative to households with heads less than 25 years of age, the likelihood of the households displaying demand behavior consistent with choice 4 (*buy-buy*) increases as the age of the household heads goes up starting from 55. For Peter Pan, relative to households with heads less than 25 years of age, households with heads who are 30 years old or above are more likely to exhibit demand behavior consistent with choice 3 (*no buy-buy*).

As for the *Employment status of the household head*, for Private Label, households with heads employed part-time are more likely to exhibit demand behavior associated with choice 2 (*buy-no buy*) and with choice 4 compared to households with heads not employed for full pay. For Peter Pan, households with heads employed part-time and households with heads employed full-time are more likely to discontinue buying this brand in the post-recall period relative to households with heads not employed for full pay. For Other Brands, households with heads employed full-time are less likely to buy this brand in both recall periods compared to households with heads not employed for full pay.

As for the *Education level of the household head*, for Private Label, households with heads who have high school education only and households with heads who have an undergraduate degree only are less likely to purchase this brand in both recall periods relative to households with heads who have less than high school education. This is inconsistent with our expectations. For Jif, households with heads who have high school education only are more likely to exhibit demand behavior consistent with choice 2 and with choice 4 compared to households with heads who have less than high school education. For Peter Pan, households with heads who have post-college education only are less likely to start buying this brand in the post-recall period relative to households that have heads with less than high school education, as was hypothesized. For Other

Brands, households with heads who have post-college education only are more likely to purchase this brand in both recall periods compared to households with heads who have less than high school education.

The results for the *Region* indicate that, for Private Label, relative to households from the East, households from the Midwest are more likely to exhibit demand behavior consistent with choice 3 and households from the West are less likely to exhibit demand behavior consistent with choice 4. For Jif, compared to households from the East, households from the Midwest and the South are more likely to display demand behavior consistent with choice 2, with choice 3, and with choice 4. For Peter Pan, relative to households from the East, households from the Midwest are less likely to exhibit demand behavior associated with choice 2 and choice 4 and households from the West are less likely to exhibit demand behavior associated with choice 2, choice 3, and choice 4. In addition, for Peter Pan, households from the South are more likely to exhibit demand behavior associated with choice 2, choice 3, and choice 4 compared to households from the East. For Skippy, compared to households from the East, households from the Midwest and households from the South are less likely to exhibit demand behavior corresponding to choice 2, choice 3, and choice 4, and households from the West are more likely to discontinue buying the Skippy PB in the post-recall period. For Other Brands, relative to households from the East, households from the Midwest are less likely to exhibit demand behavior consistent with choice 2 and with choice 4, households from the South are less likely to exhibit demand behavior consistent with choice 4, and households from the West are less likely to exhibit demand behavior consistent with choice 2 and with choice 3.

The findings for the *Race* category show that for Private Label, relative to white households, black households are less likely to exhibit demand behavior consistent with choice 2, with choice 3, and with choice 4, and oriental households are less likely to exhibit demand behavior consistent with choice 4. For Jif, compared to white households, black, oriental, and other households are less likely to exhibit demand behavior consistent with choice 4, and oriental households are less likely to exhibit demand behavior consistent with choice 3. For Peter Pan, compared to white households, black households are less likely to display demand behavior consistent with choice 3 and with choice 4, and oriental households are less likely to display demand behavior corresponding to choice 2, choice 3, and choice 4. For Skippy, relative to white households, black and other households are less likely to purchase this brand in both recall periods, and oriental households are more likely to display demand behavior consistent with choice 2 and with choice 3. For Other brands, black households are less likely to exhibit demand behavior associated with choice 2, choice 3, and choice 4 compared to white households. Compared to non-Hispanic households, Hispanic households are less likely to exhibit demand behavior consistent with choice 3 for Private Label, and with choice 3 and with choice 4 for Jif and Peter Pan.

For Private Label, households with pre-adolescent children only are more likely to purchase this brand in both recall periods relative to households with no children. In addition, for Private Label, households with pre-adolescent and adolescent children only are more likely to exhibit demand behavior consistent with choice 3 and with choice 4 compared to households with no children. For Jif, households with pre-adolescent children only are more likely to buy this brand in both recall periods relative to households with no children. For Peter Pan, households with pre-adolescent and adolescent children only are more likely to discontinue buying this brand in the post-recall period relative to households with no children. In addition, for Peter Pan, relative to households with no children, households with pre-school children only, households with pre-school and pre-adolescent children only, and households with pre-school and adolescent children only are more likely to exhibit demand behavior consistent with choice 3. For Skippy, households with pre-school and adolescent children only are more likely to exhibit demand behavior consistent with choice 3 compared to households with no children. For Other Brands, relative to households with no children, households with adolescent children only are less likely to display demand behavior consistent with choice 3, and households with pre-adolescent and adolescent children only are more likely to buy this brand in both recall periods.

The results for *Presence of male and/or female household heads* suggest that for Private Label, households with female head only are less likely to exhibit demand behavior consistent with choice 3 and with choice 4 relative to households with both heads present. For Jif, relative to households with both heads present, households with female head only are less likely to buy this brand in both recall periods, and households with male head only are less likely to exhibit demand behavior corresponding to choice 2, choice 3, and choice 4. For Peter Pan, compared to households with both heads present, households with female head only are less likely to exhibit demand behavior consistent with choice 3 and with choice 4 and households with male head only are less likely to purchase this brand in both recall periods. For Skippy, households with female head only are more likely to stop buying this brand in the post-recall period compared to households with both heads present.

The results for *Household size* suggest that for Private Label, relative to households with five and more members, as the number of the household size increases up to three members, the likelihood of the households to display demand behavior associated with choice 2 and choice 4 increases. In addition, for Private Label, compared to households with five and more members, the likelihood of the households to display demand behavior consistent with choice 3 increases, as the number of household size goes up to two members. For Jif, one-member households are less likely to display demand behavior consistent with choice 2 and with choice 4 compared to households with five and more members. For Peter Pan, compared to households with five and more members, households with one member and households with two members are less likely to purchase this brand in both recall periods. For Skippy, compared to households with five and more members, one-member, two-member, and three-member households are less likely to show demand behavior consistent with choice 2, one-member households are less likely to show demand behavior associated with choice 3, and one-member and two-member households are less likely to show demand behavior associated with choice 4. For Other Brands, relative to households with five and more members, as the household size increases up to three members, the likelihood of households to display demand behavior consistent with choice 3 increases; however, it slightly decreases when the household size becomes four. In addition, for Other Brands, relative to households with five and more members, households with two members are more likely to show demand behavior consistent with choice 4.

The *Household income* variable is statistically significant and negative across choice 2, choice 3, and choice 4 for Private Label and Peter Pan, and associated with choice 3 for Other Brands suggesting a decreasing likelihood of exhibiting demand behavior consistent with choice 2, choice 3, and choice 4 concerning Private Label and Peter Pan, and a decreasing likelihood of exhibiting demand behavior consistent with choice 3 for Other Brands. *Household income* variable is statistically significant and positive across choice 2, choice 3, and choice 4 for Skippy and across choice 3 and choice 4 for Jif indicating an increasing likelihood of displaying demand behavior consistent with choice 2, choice 3, and choice 4 for Skippy and an increasing likelihood of displaying demand behavior consistent with choice 3 and choice 4 regarding Jif.

Marginal Effects Relative to Reference Groups

The marginal effects, showing changes in probabilities of observing a particular choice of demand behavior resulting from unit changes in the explanatory variables are presented in Table 5.6. As in the case of the parameter estimates, the cut-off level of significance is 0.05 and the values in the parentheses are p-values. Except the *hhincome* variable, the marginal effect is for discrete change of dummy variable from 0 to 1. We were unable to get the p-values associated with marginal effects for the choice 3 of

Skippy. Only statistically significant marginal effects are interpreted relative to corresponding reference groups. The corresponding reference groups are: age of household head less than 25 years old, household head not employed for full pay, household head with less than high school education, East, white, non-Hispanic, no child less than 18 years of age, households with both male and female heads, and household size with five and more members.

Marginal Effects Associated with Peanut Butter Category Relative to Reference Groups

The probability of purchasing PB only in the post-recall period (choice 3) decreases by 0.0952 and 0.1343 for households with heads between 55 and 64 years of age and for households with heads aged 64 and older, respectively. In addition, the probability of not purchasing PB in either period (choice 4) increases by 0.1329 and 0.1725 for households with heads between 55 and 64 years of age and households with heads aged 64 and older, respectively.

The probability of buying PB only in the pre-recall period (choice 2) decreases by 0.0168 for the households from the Midwest. For the households from the West, the probability of buying PB only in the pre-recall period and the probability of not buying PB in either period increases by 0.0103 and decreases by 0.0194, respectively.

Table 5.6. Multinomial Logit Marginal Effects Relative to Reference Groups

	Private Label				Jif			
Variables	Choice(1)	Choice(2)	Choice(3)	Choice(4)	Choice(1)	Choice(2)	Choice(3)	Choice(4)
agehh2529	-0.1014	-0.0178	0.0054	0.1138	0.0924	0.0430	-0.0375	-0.0978*
	(0.266)	(0.707)	(0.937)	(0.337)	(0.317)	(0.604)	(0.485)	(0.048)
agehh3034	-0.1137	0.0004	-0.0148	0.1281	0.0544	0.0338	-0.0351	-0.0530
	(0.193)	(0.994)	(0.811)	(0.275)	(0.536)	(0.657)	(0.502)	(0.366)
agehh3544	-0.1319	-0.0088	-0.0239	0.1646	0.0545	0.0452	-0.0594	-0.0404
	(0.132)	(0.860)	(0.688)	(0.146)	(0.529)	(0.544)	(0.234)	(0.520)
agehh4554	-0.1380	-0.0006	-0.0254	0.1641	0.0784	0.0451	-0.0642	-0.0593
	(0.109)	(0.991)	(0.669)	(0.118)	(0.359)	(0.519)	(0.220)	(0.343)
agehh5564	-0.1468	-0.0063	-0.0355	0.1885	0.0734	0.0504	-0.0666	-0.0572
	(0.091)	(0.901)	(0.543)	(0.083)	(0.392)	(0.483)	(0.196)	(0.358)
agehhgt64	-0.1616	0.0013	-0.0584	0.2187	0.0837	0.0498	-0.0867	-0.0468
	(0.064)	(0.980)	(0.288)	(0.054)	(0.333)	(0.497)	(0.072)	(0.457)
emphhpt	-0.0264*	0.0108	0.0068	0.0088	0.0040	-0.0117*	0.0088	-0.0011
	(0.003)	(0.062)	(0.342)	(0.216)	(0.659)	(0.033)	(0.236)	(0.890)
emphhft	0.0077	-0.0012	-0.0015	-0.0050	-0.0063	-0.0043	0.0113	-0.0008
	(0.316)	(0.805)	(0.805)	(0.414)	(0.415)	(0.376)	(0.068)	(0.907)
eduhhhs	0.0460*	-0.0126	0.0092	-0.0426*	-0.0409*	0.0194	-0.0011	0.0226
	(0.010)	(0.196)	(0.527)	(0.000)	(0.019)	(0.112)	(0.939)	(0.141)
eduhhu	0.0336	-0.0122	0.0158	-0.0373*	-0.0121	0.0161	-0.0032	-0.0008
	(0.055)	(0.234)	(0.255)	(0.003)	(0.477)	(0.147)	(0.820)	(0.957)
eduhhpc	-0.0081	-0.0047	0.0244	-0.0116	0.0119	0.0162	-0.0182	-0.0099
	(0.681)	(0.670)	(0.148)	(0.406)	(0.539)	(0.244)	(0.224)	(0.547)
reg_central	-0.0135	0.0008	0.0169*	-0.0043	-0.1413*	0.0089	0.0117	0.1207*
	(0.140)	(0.884)	(0.024)	(0.547)	(0.000)	(0.148)	(0.120)	(0.000)

Table 5.6 continued

	Private Label				Jif			
Variables	Choice(1)	Choice(2)	Choice(3)	Choice(4)	Choice(1)	Choice(2)	Choice(3)	Choice(4)
reg_south	0.0058	0.0023	0.0045	-0.0126	-0.1140*	0.0110	0.0178*	0.0852*
	(0.507)	(0.668)	(0.521)	(0.064)	(0.000)	(0.056)	(0.012)	(0.000)
reg_west	0.0155	0.0135*	0.0020	-0.0311*	-0.0132	0.0114	-0.0092	0.0111
	(0.116)	(0.034)	(0.796)	(0.000)	(0.171)	(0.089)	(0.247)	(0.236)
race_black	0.1011*	0.0021	-0.0310*	-0.0722*	0.0434*	0.0169*	0.0024	-0.0627*
	(0.000)	(0.760)	(0.000)	(0.000)	(0.000)	(0.022)	(0.781)	(0.000)
race_oriental	0.0596*	-0.0019	0.0077	-0.0654*	0.0893*	0.0412*	-0.0110	-0.1194*
	(0.003)	(0.882)	(0.632)	(0.000)	(0.000)	(0.006)	(0.481)	(0.000)
race_other	0.0200	-0.0048	-0.0013	-0.0138	0.0546*	-0.0060	-0.0113	-0.0374*
	(0.237)	(0.627)	(0.920)	(0.293)	(0.001)	(0.561)	(0.393)	(0.008)
hisp_yes	0.0187	0.0218*	-0.0251*	-0.0154	0.0602*	0.0197	-0.0092	-0.0707*
	(0.232)	(0.040)	(0.029)	(0.208)	(0.000)	(0.067)	(0.454)	(0.000)
agepclt6_only	0.0157	-0.0124	0.0255	-0.0288	0.0252	-0.0206	0.0087	-0.0133
	(0.451)	(0.310)	(0.131)	(0.074)	(0.229)	(0.082)	(0.599)	(0.443)
agepc6_12only	-0.0179	-0.0087	-0.0127	0.0393*	-0.0306	-0.0075	-0.0004	0.0385*
	(0.267)	(0.357)	(0.293)	(0.005)	(0.055)	(0.438)	(0.976)	(0.007)
agepc13_17only	-0.0084	0.0011	-0.0108	0.0181	-0.0193	-0.0042	0.0053	0.0182
	(0.545)	(0.897)	(0.308)	(0.118)	(0.165)	(0.624)	(0.635)	(0.129)
agepclt6_6_12only	-0.0167	-0.0202	0.0040	0.0329	-0.0090	-0.0256	-0.0124	0.0469*
	(0.495)	(0.129)	(0.831)	(0.112)	(0.716)	(0.053)	(0.500)	(0.031)
agepclt6_13_17only	0.0341	-0.0221	0.0085	-0.0205	0.0778	-0.0442*	-0.0547	0.0212
	(0.468)	(0.377)	(0.818)	(0.552)	(0.100)	(0.049)	(0.086)	(0.599)

Table 5.6 continued

	Private Label				Jif			
Variables	Choice(1)	Choice(2)	Choice(3)	Choice(4)	Choice(1)	Choice(2)	Choice(3)	Choice(4)
agepc6_12and13_17only	-0.0515*	-0.0134	0.0210	0.0438*	-0.0066	-0.0143	0.0183	0.0026
	(0.011)	(0.242)	(0.201)	(0.012)	(0.744)	(0.220)	(0.266)	(0.879)
agepclt6_6_12and13_17	-0.0176	-0.0243	0.0364	0.0056	-0.0366	-0.0054	0.0407	0.0013
	(0.684)	(0.281)	(0.302)	(0.868)	(0.394)	(0.832)	(0.260)	(0.971)
fhonly	0.0367*	0.0177*	-0.0169*	-0.0376*	0.0294*	0.0064	-0.0043	-0.0315*
	(0.001)	(0.011)	(0.046)	(0.000)	(0.007)	(0.357)	(0.617)	(0.001)
mhonly	-0.0051	0.0078	-0.0138	0.0111	0.0810*	-0.0021	-0.0074	-0.0715*
	(0.714)	(0.384)	(0.200)	(0.339)	(0.000)	(0.808)	(0.508)	(0.000)
hhsize1	0.1089*	-0.0185	-0.0153	-0.0752*	0.0705*	-0.0175	-0.0123	-0.0408*
	(0.000)	(0.117)	(0.339)	(0.000)	(0.001)	(0.157)	(0.449)	(0.017)
hhsize2	0.0979*	-0.0167	-0.0133	-0.0678*	0.0228	-0.0166	-0.0094	0.0032
	(0.000)	(0.109)	(0.315)	(0.000)	(0.187)	(0.124)	(0.485)	(0.825)
hhsize3	0.0631*	-0.0190*	-0.0016	-0.0425*	0.0094	-0.0126	-0.0012	0.0044
	(0.000)	(0.039)	(0.903)	(0.000)	(0.576)	(0.199)	(0.928)	(0.749)
hhsize4	0.0346*	-0.0063	-0.0125	-0.0158	-0.0084	-0.0036	-0.0036	0.0155
	(0.024)	(0.488)	(0.268)	(0.149)	(0.585)	(0.708)	(0.758)	(0.226)
hhincome	0.000002*	-0.0000001	-0.0000003*	-0.000001*	-0.0000004*	-0.00000009	0.0000002	0.0000003*
	(0.000)	(0.113)	(0.004)	(0.000)	(0.001)	(0.235)	(0.072)	(0.003)

Table 5.6 continued

	Peter Pan				Skippy			
Variables	Choice(1)	Choice(2)	Choice(3)	Choice(4)	Choice(1)	Choice(2)	Choice(3)	Choice(4)
agehh2529	-0.2299	-0.0280	0.2731	-0.0152	-0.0899	-0.0488*	0.1062	0.0324
	(0.118)	(0.358)	(0.134)	(0.781)	(0.389)	(0.041)		(0.716)
agehh3034	-0.2421	-0.0309	0.2957	-0.0227	-0.1242	-0.0309	0.0735	0.0816
	(0.097)	(0.282)	(0.098)	(0.648)	(0.215)	(0.315)		(0.430)
agehh3544	-0.2326	-0.0353	0.2521	0.0157	-0.1195	-0.0394	0.0693	0.0896
	(0.075)	(0.237)	(0.110)	(0.804)	(0.219)	(0.211)		(0.352)
agehh4554	-0.2354	-0.0309	0.2402	0.0261	-0.1194	-0.0316	0.0607	0.0904
	(0.051)	(0.356)	(0.087)	(0.673)	(0.202)	(0.382)		(0.307)
agehh5564	-0.2341*	-0.0279	0.2357	0.0264	-0.1419	-0.0289	0.0584	0.1124
	(0.045)	(0.406)	(0.101)	(0.675)	(0.134)	(0.423)		(0.233)
agehhgt64	-0.2509*	-0.0201	0.2356	0.0355	-0.1700	-0.0224	0.0540	0.1384
	(0.042)	(0.563)	(0.111)	(0.596)	(0.076)	(0.542)		(0.175)
emphhpt	-0.0031	0.0119*	-0.0097	0.0009	-0.0172	0.0053	0.0052	0.0067
	(0.725)	(0.022)	(0.131)	(0.861)	(0.056)	(0.324)		(0.261)
emphhft	-0.0164*	0.0145*	-0.0015	0.0034	0.0040	0.0011	-0.0019	-0.0032
	(0.030)	(0.001)	(0.793)	(0.428)	(0.600)	(0.805)		(0.530)
eduhhhs	0.0120	-0.0039	-0.0120	0.0039	-0.0099	-0.0008	0.0023	0.0084
	(0.462)	(0.659)	(0.311)	(0.677)	(0.573)	(0.935)		(0.491)
eduhhu	0.0287	-0.0006	-0.0183	-0.0098	-0.0183	-0.0023	0.0108	0.0098
	(0.079)	(0.947)	(0.134)	(0.291)	(0.285)	(0.817)		(0.400)
eduhhpc	0.0323	0.0066	-0.0279*	-0.0109	0.0148	-0.0047	-0.0052	-0.0049
	(0.071)	(0.532)	(0.024)	(0.262)	(0.443)	(0.663)		(0.705)

Table 5.6 continued

Variables	Peter Pan Choice(1)	Peter Pan Choice(2)	Peter Pan Choice(3)	Peter Pan Choice(4)	Skippy Choice(1)	Skippy Choice(2)	Skippy Choice(3)	Skippy Choice(4)
reg_central	0.0193*	-0.0093	0.0152*	-0.0252*	0.1131*	-0.0232*	-0.0367	-0.0532*
	(0.024)	(0.054)	(0.026)	(0.000)	(0.000)	(0.000)		(0.000)
reg_south	-0.1289*	0.0388*	0.0313*	0.0588*	0.2653*	-0.0474*	-0.0666	-0.1513*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		(0.000)
reg_west	0.2275*	-0.0413*	-0.0864*	-0.0998*	-0.0252*	0.0202*	-0.0010	0.0060
	(0.000)	(0.000)	(0.000)	(0.000)	(0.008)	(0.000)		(0.283)
race_black	0.0452*	0.0086	-0.0232*	-0.0305*	0.0258*	0.0107	-0.0095	-0.0270*
	(0.000)	(0.134)	(0.002)	(0.000)	(0.020)	(0.125)		(0.000)
race_oriental	0.0839*	-0.0183	-0.0236	-0.0420*	-0.0803*	0.0324*	0.0391	0.0088
	(0.000)	(0.077)	(0.126)	(0.000)	(0.000)	(0.013)		(0.479)
race_other	0.0204	-0.0123	0.0038	-0.0119	0.0154	0.0126	-0.0030	-0.0250*
	(0.218)	(0.124)	(0.777)	(0.211)	(0.353)	(0.218)		(0.010)
hisp_yes	0.0413*	0.0170	-0.0330*	-0.0254*	-0.0260	0.0070	0.0006	0.0184
	(0.006)	(0.068)	(0.002)	(0.001)	(0.101)	(0.447)		(0.096)
agepclt6_only	-0.0208	-0.0142	0.0437*	-0.0087	0.0156	-0.0183	0.0043	-0.0015
	(0.320)	(0.152)	(0.013)	(0.452)	(0.444)	(0.092)		(0.909)
agepc6_12only	-0.0351*	0.0096	0.0161	0.0095	-0.0244	0.0050	0.0165	0.0029
	(0.026)	(0.285)	(0.199)	(0.312)	(0.128)	(0.599)		(0.779)
agepc13_17only	-0.0191	0.0029	0.0113	0.0049	0.0042	-0.0051	-0.0055	0.0064
	(0.160)	(0.699)	(0.289)	(0.537)	(0.761)	(0.514)		(0.485)
agepclt6_6_12only	-0.0446	0.0077	0.0388	-0.0019	-0.0226	0.0014	-0.0018	0.0229
	(0.066)	(0.572)	(0.052)	(0.887)	(0.354)	(0.920)		(0.177)

Table 5.6 continued

	Peter Pan				Skippy			
Variables	Choice(1)	Choice(2)	Choice(3)	Choice(4)	Choice(1)	Choice(2)	Choice(3)	Choice(4)
agepclt6_13_17only	-0.1025*	-0.0150	0.0984*	0.0191	-0.0307	-0.0496*	0.0841	-0.0038
	(0.034)	(0.502)	(0.019)	(0.499)	(0.516)	(0.007)		(0.899)
agepc6_12and13_17only	-0.0366	0.0200	0.0085	0.0081	-0.0045	-0.0128	0.0118	0.0054
	(0.069)	(0.104)	(0.579)	(0.489)	(0.822)	(0.226)		(0.676)
agepclt6_6_12and13_17	-0.0444	-0.0326	0.0408	0.0362	-0.0235	0.0072	0.0078	0.0085
	(0.304)	(0.067)	(0.248)	(0.198)	(0.583)	(0.777)		(0.764)
fhonly	0.0420*	-0.0053	-0.0186*	-0.0182*	-0.0131	0.0129*	0.0090	-0.0088
	(0.000)	(0.338)	(0.017)	(0.002)	(0.230)	(0.049)		(0.217)
mhonly	0.0365*	-0.0087	-0.0096	-0.0182*	-0.0118	0.0075	0.0074	-0.0031
	(0.005)	(0.206)	(0.347)	(0.013)	(0.403)	(0.375)		(0.738)
hhsize1	0.0494*	-0.0060	-0.0116	-0.0317*	0.0896*	-0.0211*	-0.0229	-0.0457*
	(0.011)	(0.570)	(0.437)	(0.002)	(0.000)	(0.048)		(0.000)
hhsize2	0.0201	-0.0010	-0.0008	-0.0183*	0.0454*	-0.0166	-0.0007	-0.0281*
	(0.218)	(0.912)	(0.950)	(0.046)	(0.007)	(0.084)		(0.009)
hhsize3	0.0230	-0.0021	-0.0070	-0.0138	0.0325*	-0.0188*	-0.0013	-0.0124
	(0.138)	(0.801)	(0.548)	(0.093)	(0.042)	(0.025)		(0.206)
hhsize4	0.0091	-0.0002	-0.0023	-0.0066	0.0117	-0.0037	-0.0103	0.0023
	(0.523)	(0.984)	(0.829)	(0.396)	(0.427)	(0.660)		(0.807)
hhincome	0.0000007*	-0.0000001	-0.0000004*	-0.0000002*	-0.0000008*	0.0000001	0.0000003	0.0000004*
	(0.000)	(0.148)	(0.000)	(0.005)	(0.000)	(0.199)		(0.000)

Table 5.6 continued

	Other Brands				Peanut Butter Category		
Variables	Choice(1)	Choice(2)	Choice(3)	Choice(4)	Choice(2)	Choice(3)	Choice(4)
agehh2529	-0.0553	-0.0039	-0.0147	0.0739	-0.0359	0.0152	0.0206
	(0.634)	(0.934)	(0.741)	(0.552)	(0.095)	(0.809)	(0.759)
agehh3034	-0.0833	0.0171	-0.0152	0.0814	-0.0194	-0.0379	0.0572
	(0.473)	(0.769)	(0.724)	(0.515)	(0.486)	(0.454)	(0.329)
agehh3544	-0.0648	0.0141	-0.0196	0.0703	-0.0362	-0.0638	0.1001
	(0.526)	(0.790)	(0.644)	(0.497)	(0.151)	(0.187)	(0.072)
agehh4554	-0.0670	0.0143	-0.0228	0.0756	-0.0334	-0.0791	0.1125
	(0.487)	(0.779)	(0.597)	(0.422)	(0.252)	(0.114)	(0.055)
agehh5564	-0.0694	0.0193	-0.0322	0.0823	-0.0378	-0.0952*	0.1329*
	(0.487)	(0.715)	(0.437)	(0.409)	(0.174)	(0.046)	(0.018)
agehhgt64	-0.0760	0.0276	-0.0517	0.1001	-0.0382	-0.1343*	0.1725*
	(0.483)	(0.626)	(0.170)	(0.370)	(0.150)	(0.001)	(0.001)
emphhpt	-0.0059	0.0052	0.0032	-0.0025	-0.0066	-0.0070	0.0136
	(0.440)	(0.259)	(0.571)	(0.538)	(0.155)	(0.334)	(0.094)
emphhft	0.0239*	-0.0005	-0.0051	-0.0183*	0.0002	0.0017	-0.0018
	(0.000)	(0.898)	(0.289)	(0.000)	(0.970)	(0.785)	(0.790)
eduhhhs	0.0169	0.0006	-0.0154	-0.0021	0.0001	0.0050	-0.0051
	(0.250)	(0.950)	(0.143)	(0.804)	(0.987)	(0.738)	(0.752)
eduhhu	-0.0178	0.0067	0.0018	0.0094	0.0009	0.0077	-0.0086
	(0.221)	(0.436)	(0.870)	(0.253)	(0.923)	(0.592)	(0.586)
eduhhpc	-0.0627*	0.0103	0.0152	0.0372*	0.0026	0.0050	-0.0076
	(0.001)	(0.340)	(0.249)	(0.004)	(0.797)	(0.760)	(0.670)

Table 5.6 continued

	Other Brands				Peanut Butter Category		
Variables	Choice(1)	Choice(2)	Choice(3)	Choice(4)	Choice(2)	Choice(3)	Choice(4)
reg_central	0.0333*	-0.0146*	-0.0063	-0.0124*	-0.0168*	0.0037	0.0131
	(0.000)	(0.000)	(0.268)	(0.003)	(0.000)	(0.623)	(0.108)
reg_south	0.0084	-0.0072	0.0098	-0.0110*	-0.0059	-0.0001	0.0060
	(0.251)	(0.075)	(0.075)	(0.007)	(0.177)	(0.990)	(0.443)
reg_west	0.0226*	-0.0121*	-0.0127*	0.0021	0.0103*	0.0091	-0.0194*
	(0.005)	(0.006)	(0.034)	(0.643)	(0.047)	(0.257)	(0.030)
race_black	0.0473*	-0.0115*	-0.0146*	-0.0212*	0.0709*	0.0477*	-0.1185*
	(0.000)	(0.024)	(0.024)	(0.000)	(0.000)	(0.000)	(0.000)
race_oriental	0.0303	-0.0023	-0.0211	-0.0069	0.0515*	0.0394*	-0.0909*
	(0.065)	(0.819)	(0.067)	(0.447)	(0.000)	(0.022)	(0.000)
race_other	-0.0246	0.0110	0.0035	0.0101	0.0187*	0.0287*	-0.0474*
	(0.096)	(0.231)	(0.741)	(0.241)	(0.050)	(0.045)	(0.003)
hisp_yes	-0.0121	0.0008	0.0016	0.0098	0.0347*	-0.0008	-0.0339*
	(0.368)	(0.921)	(0.872)	(0.225)	(0.000)	(0.950)	(0.019)
agepclt6_only	-0.0053	-0.0060	0.0056	0.0057	-0.0138	0.0438*	-0.0300
	(0.770)	(0.546)	(0.661)	(0.626)	(0.159)	(0.013)	(0.114)
agepc6_12only	-0.0016	0.0031	-0.0177*	0.0161	-0.0168*	-0.0295*	0.0463*
	(0.910)	(0.702)	(0.046)	(0.098)	(0.021)	(0.013)	(0.001)
agepc13_17only	0.0190	-0.0054	-0.0163*	0.0027	-0.0137*	-0.0251*	0.0388*
	(0.106)	(0.417)	(0.037)	(0.725)	(0.038)	(0.017)	(0.001)
agepclt6_6_12only	-0.0021	0.0062	-0.0228	0.0187	-0.0232*	-0.0365*	0.0597*
	(0.920)	(0.626)	(0.067)	(0.228)	(0.030)	(0.036)	(0.002)
agepclt6_13_17only	0.0690	-0.0379*	-0.0111	-0.0200	-0.0370*	0.0222	0.0148
	(0.055)	(0.017)	(0.666)	(0.390)	(0.043)	(0.565)	(0.718)

Table 5.6 continued

	Other Brands				Peanut Butter Category		
Variables	Choice(1)	Choice(2)	Choice(3)	Choice(4)	Choice(2)	Choice(3)	Choice(4)
agepc6_12and13_17only	-0.0025	-0.0141	-0.0153	0.0319*	-0.0296*	-0.0253	0.0548*
	(0.890)	(0.108)	(0.165)	(0.024)	(0.000)	(0.097)	(0.001)
agepclt6_6_12and13_17	-0.0461	0.0019	0.0271	0.0171	-0.0108	-0.0062	0.0170
	(0.240)	(0.930)	(0.315)	(0.535)	(0.628)	(0.850)	(0.649)
fhonly	-0.0044	0.0070	0.0045	-0.0071	0.0259*	0.0233*	-0.0492*
	(0.639)	(0.212)	(0.514)	(0.182)	(0.000)	(0.010)	(0.000)
mhonly	-0.0159	0.0114	0.0056	-0.0011	0.0288*	0.0356*	-0.0644*
	(0.195)	(0.136)	(0.537)	(0.876)	(0.001)	(0.003)	(0.000)
hhsize1	0.0120	-0.0102	-0.0284*	0.0266*	0.0335*	0.0276	-0.0612*
	(0.508)	(0.293)	(0.013)	(0.043)	(0.016)	(0.117)	(0.002)
hhsize2	0.0144	-0.0076	-0.0279*	0.0212*	0.0151	0.0050	-0.0202
	(0.331)	(0.374)	(0.006)	(0.025)	(0.142)	(0.719)	(0.207)
hhsize3	0.0168	-0.0041	-0.0213*	0.0086	0.0090	0.0023	-0.0113
	(0.228)	(0.610)	(0.016)	(0.362)	(0.397)	(0.865)	(0.470)
hhsize4	0.0222	-0.0008	-0.0211*	-0.0004	0.0135	-0.0261*	0.0125
	(0.075)	(0.922)	(0.009)	(0.963)	(0.200)	(0.025)	(0.378)
hhincome	0.00000009	0.000000001	-0.0000001	0.00000003	0.0000001	0.0000001	-0.0000002*
	(0.323)	(0.978)	(0.098)	(0.592)	(0.267)	(0.091)	(0.025)

*We were unable to obtain p-values associated with choice 3 of Skippy.
*See Table 5.1 for the categories, variable names, and description of all the variables.

For black households, the probability of exhibiting demand behavior consistent with choice 2 and with choice 3 increases by 0.0709 and 0.0477, respectively, and the probability of displaying choice 4 demand behavior decreases by 0.1185. For oriental households, the probability of exhibiting choice 2 and choice 3 demand behavior increases by 0.0515 and 0.0394, respectively, and the probability of displaying choice 4 demand behavior decreases by 0.0909. For other households, the probability of showing choice 2 and choice 3 demand behavior increases by 0.0187 and 0.0287, respectively, and the probability of showing choice 4 demand behavior decreases by 0.0474.

For Hispanic households, the probability of purchasing PB only in the pre-recall period increases by 0.0347 and the probability of not purchasing PB in either period decreases by 0.0339. The probability of buying PB only in the post-recall period for households with pre-school children only increases by 0.0438. The probability of exhibiting demand behavior corresponding to choice 2, choice 3, and choice 4 for the households with pre-adolescent children only decreases by 0.0168, 0.0295, and increases by 0.0463, respectively. The probability of displaying demand behavior consistent with choice 2 and with choice 3 for the households with adolescent children only decreases by 0.0137 and 0.0251, respectively, and for the same households, the probability of showing demand behavior associated with choice 4 increases by 0.0388. The probability of exhibiting demand behavior associated with choice 2 and choice 3 for the households with pre-school and pre-adolescent children only decreases by 0.0232 and 0.0365, respectively, and for the same households, the probability of displaying demand behavior associated with choice 4 increases by 0.0597. The probability of purchasing PB only in the pre-recall period for the households with pre-school and adolescent children only declines by 0.0370. Finally, the probability of displaying demand behavior regarding PB corresponding to choice 2 and choice 4 for the households with pre-adolescent and adolescent children only declines by 0.0296 and increases by 0.0548, respectively.

The probability that female-headed households will display demand behavior consistent with choice 2 and with choice 3 increases by 0.0259 and 0.0233, respectively, and the probability that the same households will display demand behavior associated with choice 4 declines by 0.0492. The probability that male-headed households will exhibit demand behavior corresponding to choice 2 and choice 3 increases by 0.0288 and 0.0356, respectively, and the probability that the same households will exhibit demand behavior corresponding to choice 4 goes down by 0.0644.

The probability that one-member households will buy PB only in the pre-recall period increases by 0.0335 and the probability that they will purchase PB in both periods goes down by 0.0612. The probability that households with four members will purchase PB only in the post-recall period goes down by 0.0261. Finally, as household income increases, the probability that households will buy PB in both periods declines by 0.0000002.

Marginal Effects Associated with Peanut Butter Brands Relative to Reference Groups

The probability of buying the Jif PB in both periods (choice 4) decreases by 0.0978 for the households with heads between 25 and 29 years of age. The probability of not buying the Peter Pan PB in either period declines by 0.2341 and 0.2509 for the households with heads aged between 55 and 64 and for households with heads aged 64 and older. The probability of quitting buying the Skippy PB in the post-recall period (choice 2) declines by 0.0488 for the households headed by the decision-makers between 25 and 29 years of age.

The probability of not purchasing the Private Label PB in either period declines by 0.0264 for the households with heads employed part-time. The probability to discontinue purchasing the Jif PB in the post-recall period declines by 0.0117 for the households with heads employed part-time. The probability of not buying the Peter Pan PB in either period declines by 0.0164 for the households with heads employed full-time. In addition, the probability of buying the Peter Pan PB only in the pre-recall period (choice 2) increases by 0.0119 and 0.0145 for the households with heads employed part-time and full-time, respectively. For the households with full-time employed heads, the probability of not purchasing the Other Brands PB in either period goes up by 0.0239. At the same time, for the households with full-time employed heads, the probability of buying the Other Brands PB in both periods (choice 4) decreases by 0.0183.

For households with heads who have high school education only, the probability of not purchasing the Private Label PB in either period goes up by 0.0460. The probability of buying the Private Label PB in both periods declines by 0.0426 and 0.0373 for the households with heads who have high school education only and for the households with heads who have undergraduate education only, respectively. The probability of not purchasing the Jif PB in either period goes down by 0.0409 for households with heads who have high school education only. For the households with heads who have some post-college education, the probability of not buying the Peter Pan PB in the pre-recall period but starting to buy it in the post-recall period (choice 3) declines by 0.0279. For households with heads who have some post-college education, the probability of not purchasing the Other Brands PB in the pre- or the post-recall period declines by 0.0627 and for the same households the probability of buying the Other Brands PB in both periods increases by 0.0372.

For the Private Label PB, for the households from the West, the probability of exhibiting choice 2 demand behavior increases by 0.0135 and the probability of exhibiting choice 4 demand behavior declines by 0.0311. In addition, for the Private Label PB brand, for the households from the Midwest (Central part), the probability of displaying demand behavior consistent with choice 3 increases by 0.0169. For the Jif PB, the probability of not buying this brand in either pre- or post-recall period declines by 0.1413 and 0.1140 for the households from the Midwest and the South, respectively. In addition, for the Jif PB, the probability increases by 0.0178 for exhibiting choice 3 demand behavior for the households from the South. Finally, for the Jif PB, the probability of purchasing PB in both periods increases by 0.1207 and 0.0852 for the households from the Midwest and the South, respectively.

For the Peter Pan PB, the probability of not buying PB in either period increases by 0.0193 and 0.2275 for the households from the Midwest and the West, respectively, and it decreases by 0.1289 for the households from the South. The probability of quitting the purchase of the Peter Pan PB in the post-recall period increases by 0.0388 for the households from the South and decreases by 0.0413 for the households from the West. The probability of exhibiting demand behavior consistent with choice 3 with respect to the Peter Pan PB increases by 0.0152 and 0.0313 for the households from the Midwest and the South, respectively, and it decreases by 0.0864 for the households from the West. Finally, the probability of buying the Peter Pan PB in both periods decreases by 0.0252 and 0.0998 for the households from the Midwest and the West, respectively, and it increases by 0.0588 for the households from the South.

For the Skippy PB, the probability of displaying choice 1 demand behavior increases by 0.1131 and 0.2653 for the households from the Midwest and the South, respectively, and decreases by 0.0252 for the households from the West. The probability of exhibiting demand behavior in line with choice 2 with respect to the Skippy PB decreases by 0.0232 and 0.0474 for the households from the Midwest and the South, respectively, and increases by 0.0202 for the households from the West. Finally, the probability of purchasing the Skippy PB in both periods (choice 4) decreases by 0.0532 and 0.1513 for the households from the Midwest and the South, respectively. The probability of not buying the Other Brands PB in either period increases by 0.0333 and 0.0226 for the households from the Midwest and the West, respectively. The probability of discontinuing the purchase of the Other Brands PB in the post-recall period decreases by 0.0146 and 0.0121 for the households from the Midwest and the West, respectively. The probability of displaying demand behavior consistent with choice 3 declines by 0.0127 for the households from the West. Finally, the probability of purchasing the Other Brands PB in both periods declines by 0.0124 and 0.011 for the households from the Midwest and the South, respectively.

For black and oriental households, the probability of not purchasing the Private Label PB in either period increases by 0.1011 and 0.0596, respectively. For black households, the probability of displaying choice 3 demand behavior with respect to the Private Label PB declines by 0.031. For black and oriental households, the probability of buying the Private Label PB in both periods declines by 0.0722 and 0.0654, respectively. The probability of showing choice 1 demand behavior with regards to the Jif PB increases by 0.0434, 0.0893, and 0.0546 for black, oriental, and other households, respectively. The probability of displaying choice 2 demand behavior with respect to the Jif PB increases by 0.0169 and 0.0412 for black and oriental households, respectively. and, the probability of exhibiting choice 4 demand behavior with regards to the Jif PB decreases by 0.0627, 0.1194, and 0.0374 for black, oriental, and other households, respectively. For black and oriental households, the probability of showing choice 1 demand behavior with respect to the Peter Pan PB increases by 0.0452 and 0.0839, respectively, and the probability of displaying choice 4 demand behavior with regards to the Peter Pan PB decreases by 0.0305 and 0.0420, respectively. The probability that black households will start buying the Peter Pan PB in the post-recall period declines by 0.0232. With regards to the Skippy PB, the probability of observing demand behavior consistent with choice 1 on part of black and oriental households increases by 0.0258 and decreases by 0.0803, respectively. The probability that oriental households will display choice 2 demand behavior regarding the Skippy PB increases by 0.0324. In addition, the probability of observing choice 4 demand behavior on part of black and other households with respect to the Skippy PB declines by 0.0270 and 0.0250, respectively. Finally, for the Other Brands PB, the probability of observing choice 2, choice 3, and choice 4 demand behavior on part of black households decreases by 0.0115, 0.0146, and 0.0212, respectively, and it increases for choice 1 demand behavior by 0.0473.

For the Private Label PB, the probability of Hispanic households displaying choice 2 and choice 3 demand behavior increases by 0.0218 and decreases by 0.0251, respectively. For the Jif PB, the probability of Hispanic households exhibiting choice 1 and choice 4 demand behavior increases by 0.0602 and decreases by 0.0707, respectively. For the Peter Pan PB, the probability of Hispanic households showing choice 1, choice 3, and choice 4 demand behavior increases by 0.0413, decreases by 0.0330, and decreases by 0.0254, respectively.

For the Private Label PB, the probability of not buying in the pre- and the post-recall periods decreases by 0.0515 for the households with pre-adolescent and adolescent children only. The probability that the households with pre-adolescent children only and the households with pre-adolescent and adolescent children only will exhibit demand behavior consistent with choice 4 with regards to the Private Label PB increases by 0.0393 and 0.0438, respectively. The probability of not purchasing the Jif PB in the post-recall period declines by 0.0442 for the households with pre-school and adolescent children only. In addition, with respect to the Jif PB, the probability of showing demand behavior consistent with choice 4 increases by 0.0385 and 0.0469 for the households with pre-adolescent children only and the households with pre-school and pre-adolescent children only, respectively. The probability that the households with pre-adolescent children only and the households with pre-school and adolescent children only will display demand behavior consistent with choice 1 regarding the Peter Pan PB declines by 0.0351 and 0.1025, respectively. In addition, the probability of exhibiting demand behavior consistent with choice 3 with respect to the Peter Pan PB increases by 0.0437 and 0.0984 for the households with pre-school children only and the households with pre-school and adolescent children only, respectively. For the Skippy PB, the probability of showing demand behavior consistent with choice 2 declines by 0.0496 for the households with pre-school and adolescent children only. The probability of exhibiting demand behavior associated with choice 2 for the Other Brands PB declines by 0.0379 for the households with pre-school and adolescent children only. The probability of displaying demand behavior consistent with choice 3 for the Other Brands PB declines by 0.0177 and 0.0163 for the households with pre-adolescent children only and the households with adolescent children only, respectively. Finally, the probability that the households with pre-adolescent and adolescent children only will display demand behavior consistent with choice 4 for the Other Brands PB increases by 0.0319.

For the Private Label PB, for households with female head, the probability of displaying demand behavior associated with choice 1 and choice 2 increases by 0.0367 and 0.0177, respectively, and it decreases by 0.0169 and 0.0376 for choice 3 and choice 4, respectively. For the Jif PB, the probability of showing demand behavior associated with choice 1 increases by 0.0294 and 0.081 for the households with female head only and the households with male head only, respectively. In addition, the probability those households with female head only and households with male head only will buy the Jif PB in both periods declines by 0.0315 and 0.0715, respectively. The probability that households with female head only and households with male head only will not buy the Peter Pan PB in the pre- and the post-recall periods increases by 0.0420 and 0.0365, respectively. At the same time, the probability that households with female head only and households with male head only will buy the Peter Pan PB in both periods declines by 0.0182. Finally, the probability that the households with female head only will not purchase the Peter Pan PB in the pre-recall period but will purchase it in the post-recall period declines by 0.0186. The probability of exhibiting demand behavior consistent with choice 2 with respect to the Skippy PB increases by 0.0129 for the households with female head only.

As the household size increases up to four members, the probability of not buying the Private Label PB in either period declines. The probability of buying the Private Label PB only in the pre-recall period declines by 0.019 for the households with three members. For the Private Label PB, as the household size goes up to three, the probability of exhibiting demand behavior associated with choice 4 increases. The probability of displaying demand behavior consistent with choice 1 and with choice 4, with respect to the Jif PB, increases by 0.0705 and decreases by 0.0408, respectively, for one-member households. The probability of exhibiting demand behavior consistent with choice 1 and with choice 4 with respect to the Peter Pan PB increases by 0.0494 and decreases by 0.0317, respectively, for one-member households.

As the household size goes up to three, the probability of not buying the Skippy PB in either period declines. The probability of quitting the purchase of the Skippy PB in the post-recall period goes down by 0.0211 and 0.0188 for one-member and three-member households, respectively. The probability of buying the Skippy PB in both periods decreases by 0.0457 and 0.0281 for one- and two-member households, respectively. For the Other Brands PB, the probability of exhibiting demand behavior consistent with choice 3 increases with an increase in the household size. In addition, for the Other Brands PB, the probability of displaying demand behavior associated with choice 4 increases by 0.0266 and 0.0212 for the households with one member and the households with two members, respectively.

As household incomes go up, for the Private Label PB the probability of not purchasing in the pre- and the post-recall periods increases by 0.000002, the probability of not buying in the pre- but buying in the post-recall period decreases by 0.0000003, and the probability for buying in both periods declines by 0.000001. For the Jif PB, as household income goes up, the probability of not buying in the pre- and the post-recall periods declines by 0.0000004 and the probability of purchasing in both periods increases by 0.0000003. As household incomes increase, for the Peter Pan PB the probability of not buying in the pre- and the post-recall periods increases by 0.0000007, the probability of not buying in the pre-recall period but buying in the post-recall period declines by 0.0000004, and the probability of buying in both periods declines by 0.0000002. For the Skippy PB, with an increase in household income the probability of not buying in either period declines by 0.0000008, and the probability of buying in both recall periods goes up by 0.0000004.

Evaluation of Predictive Ability of Multinomial Logit Models for the Peanut Butter Brands and Category

The predictive ability of the multinomial logit model is assessed with the help of prediction-success tables as in Capps et al. (1999). A prediction-success table is a contingency table that shows the relationship between the actual outcomes that are known *a priori* and the predicted outcomes generated by the model. A prediction is labeled as a success where the predicted outcome coincides with the actual outcome for a given choice alternative. For instance, if the predicted probabilities of the household i associated with choice 1, choice 2, choice 3, and choice 4 are 0.1, 0.3, 0.2, and 0.4, respectively, then the predicted outcome for this household i is choice 4 since it has the highest probability associated with it, and, if the actual outcome for the same household is choice 4, then the prediction is a success. Dividing the total number of correct choice outcomes by the total number of corresponding actual choice outcomes and expressing it in percentage terms yields a number that describes the predictive ability of the model associated with that particular choice outcome. In addition, dividing the sum of all correct outcomes across all the choice outcomes by the total number of actual choice outcomes and expressing it in percentage terms determines the overall predictive ability of the model.

Following the method described above for putting together a conventional prediction-success table for the multinomial model, we encountered a problem where one of the predicted choice outcomes dominated the other outcomes. In particular, for the PB brands that dominant choice outcome was 1 (*no buy-no buy*, more than 90%) and for the PB category it was 4 (*buy-buy*, above 99%). To fix this problem, instead of choosing an outcome that has the highest associated probability generated by the model as a final predicted outcome, the percentage of observed frequencies associated with each choice presented in Table 5.2 were used as cut-off points in determining the predicted outcomes conditional upon the choice (Alviola and Capps 2010). To illustrate, for choice 1 of Private Label, the actual four outcomes were divided into two groups of 1s and 0s where each observation that was 1 took on a value of 1 and 0 otherwise. As such, 0s reflected outcomes associated with choice 2, choice 3, and choice 4. For the predicted outcomes, if the predicted probability was greater or equal to 0.4886 (observed frequency associated with choice 1 of Private Label) then the predicted outcome was 1, otherwise 0. It needs to be pointed out that with this decision rule it is possible for the same household to be correctly classified for each of the choice.

Following this approach, Table 5.7 depicts two-way contingency tables conditional on choice developed for all PB brands and PB category. The focus of the discussion of the results reported in Table 5.7 is on percent of correct classifications associated with 1s. As Table 5.7 shows, for Private Label, the multinomial logit model successfully classified 52% of all choice 1 observations, 53% of all choice 2 observations, 54% of all choice 3 observations, and 62% of all choice 4 observations. For Jif, the multinomial model correctly classified 58% of all choice 1 observations, 53% of all choice 2 observations, and 59% of all choice 3 and of all choice 4 observations. For Peter Pan, the multinomial model correctly predicted 55% of all choice 1 observations, 60% of all choice 2 observations, 75% of all choice 3 observations, and 70% of all choice 4 observations. For Skippy, the multinomial model successfully predicted 59% of all choice 1 observations, 57% of all choice 2 observations, 59% of all choice 3 observations, and 73% of all choice 4 observations. For Other Brands, the model successfully predicted 53% of all choice 1 observations, 55% of all choice 2 and of all choice 3 observations, and 58% of all choice 4 observations. For PB category, the model successfully classified 57% of all choice 2 observations, 52% of all choice 3 observations, and 64% of all choice 4 observations.

Table 5.7. Conditional Prediction-Success Table: Peanut Butter Brands and Category over All Choices

PRIVATE LABEL

Actual choice 1	Predicted choice 1: 0	1	Total	% Correct Classification	Actual choice 2	Predicted choice 2: 0	1	Total	% Correct Classification
0	9,121	6,141	15,262	59.8	0	14,751	11,900	26,651	55.3
1	6,981	7,598	14,579	52.1	1	1,510	1,680	3,190	52.7
Total	16,102	13,739	29,841	56.0	Total	16,261	13,580	29,841	55.1

Actual choice 3	Predicted choice 3: 0	1	Total	% Correct Classification	Actual choice 4	Predicted choice 4: 0	1	Total	% Correct Classification
0	12,584	11,461	24,045	52.3	0	12,411	11,154	23,565	52.7
1	2,681	3,115	5,796	53.7	1	2,378	3,898	6,276	62.1
Total	15,265	14,576	29,841	52.6	Total	14,789	15,052	29,841	54.7

JIF

Actual choice 1	Predicted choice 1: 0	1	Total	% Correct Classification	Actual choice 2	Predicted choice 2: 0	1	Total	% Correct Classification
0	9,591	7,201	16,792	57.1	0	13,694	12,800	26,494	51.7
1	5,481	7,568	13,049	58.0	1	1,561	1,786	3,347	53.4
Total	15,072	14,769	29,841	57.5	Total	15,255	14,586	29,841	51.9

Actual choice 3	Predicted choice 3: 0	1	Total	% Correct Classification	Actual choice 4	Predicted choice 4: 0	1	Total	% Correct Classification
0	11,318	12,517	23,835	47.5	0	12,987	9,415	22,402	58.0
1	2,465	3,541	6,006	59.0	1	3,039	4,400	7,439	59.1
Total	13,783	16,058	29,841	49.8	Total	16,026	13,815	29,841	58.3

Peter Pan

Actual choice 1	Predicted choice 1: 0	1	Total	% Correct Classification	Actual choice 2	Predicted choice 2: 0	1	Total	% Correct Classification
0	7,516	3,279	10,795	69.6	0	16,181	11,272	27,453	58.9
1	8,628	10,418	19,046	54.7	1	961	1,427	2,388	59.8
Total	16,144	13,697	29,841	60.1	Total	17,142	12,699	29,841	59.0

Actual choice 3	Predicted choice 3: 0	1	Total	% Correct Classification	Actual choice 4	Predicted choice 4: 0	1	Total	% Correct Classification
0	9,578	15,428	25,006	38.3	0	15,040	11,229	26,269	57.3
1	1,198	3,637	4,835	75.2	1	1,069	2,503	3,572	70.1
Total	10,776	19,065	29,841	44.3	Total	16,109	13,732	29,841	58.8

Table 5.7 continued

SKIPPY

	Predicted choice 1					Predicted choice 2					Predicted choice 3					Predicted choice 4			
Actual choice 1	0	1	Total	% Correct Classification	Actual choice 2	0	1	Total	% Correct Classification	Actual choice 3	0	1	Total	% Correct Classification	Actual choice 4	0	1	Total	% Correct Classification
0	7,623	4,170	11,793	64.6	0	15,602	11,441	27,043	57.7	0	13,098	12,290	25,388	51.6	0	13,517	11,782	25,299	53.4
1	7,328	10,720	18,048	59.4	1	1,215	1,583	2,798	56.6	1	1,833	2,620	4,453	58.8	1	1,218	3,324	4,542	73.2
Total	14,951	14,890	29,841	61.5	Total	16,817	13,024	29,841	57.6	Total	14,931	14,910	29,841	52.7	Total	14,735	15,106	29,841	56.4

OTHER BRANDS

	Predicted choice 1					Predicted choice 2					Predicted choice 3					Predicted choice 4			
Actual choice 1	0	1	Total	% Correct Classification	Actual choice 2	0	1	Total	% Correct Classification	Actual choice 3	0	1	Total	% Correct Classification	Actual choice 4	0	1	Total	% Correct Classification
0	4,076	3,526	7,602	53.6	0	14,269	13,500	27,769	51.4	0	14,167	12,207	26,374	53.7	0	14,954	12,824	27,778	53.8
1	10,481	11,758	22,239	52.9	1	934	1,138	2,072	54.9	1	1,553	1,914	3,467	55.2	1	861	1,202	2,063	58.3
Total	14,557	15,284	29,841	53.1	Total	15,203	14,638	29,841	51.6	Total	15,720	14,121	29,841	53.9	Total	15,815	14,026	29,841	54.1

PEANUT BUTTER CATEGORY

	Predicted choice 2					Predicted choice 3					Predicted choice 4			
Actual choice 2	0	1	Total	% Correct Classification	Actual choice 3	0	1	Total	% Correct Classification	Actual choice 4	0	1	Total	% Correct Classification
0	16,831	10,552	27,383	61.5	0	13,841	9,725	23,566	58.7	0	4,371	4,362	8,733	50.1
1	1,049	1,409	2,458	57.3	1	3,000	3,275	6,275	52.2	1	7,557	13,551	21,108	64.2
Total	17,880	11,961	29,841	61.1	Total	16,841	13,000	29,841	57.4	Total	11,928	17,913	29,841	60.1

*No results for choice 1 of PB category because of the absence of choice 1 for PB category.

Conclusions and Recommendations for Future Research

The empirical findings of this study show that a large number of household socio-economic characteristics affect households' demand behavior with respect to PB as a category and PB brands in the light of the recall. In particular, for PB category, compared to the households with heads aged less than 25, the likelihood of the households displaying demand behavior consistent with choice 3 decreases as the age of the household heads increases beginning from 55. Households from the Midwest are less likely to exhibit demand behavior consistent with choice 2, and the households from the West are more likely to buy PB in the pre-recall period only, relative to the households from the East. Relative to white households, black, oriental, and other households are more likely to display demand behavior associated with choice 2 and choice 3. Compared to non-Hispanic households, Hispanic households are more likely to display demand behavior associated with choice 2.

For the PB category, relative to households with no children, households with pre-school children only are more likely to show demand behavior associated with choice 3. Compared to households with no children, households with pre-adolescent children only and households with adolescent children only are less likely to show demand behavior associated with choice 2 and choice 3. Relative to households with no children, households with pre-school and pre-adolescent children only and households with pre-adolescent and adolescent children only are less likely to show demand behavior associated with choice 2 and choice 3. Relative to households with both heads present, households with male heads only and households with female heads only are more likely to display demand behavior consistent with choice 2 and with choice 3. One-member households are more likely to exhibit demand behavior associated with choice 2 and choice 3 compared to households with five and more members. Finally, as income goes up, households are more likely to display demand behavior consistent with choice 3.

As for the PB brand analysis, for Peter Pan, households with heads who are 30 years old or above are more likely to display demand behavior associated with choice 3 compared to households with heads less than 25 years of age. For Peter Pan, compared to households with heads not employed for full pay, households with heads employed part-time and households with heads employed full-time are more likely to quit purchasing Peter Pan in the post-recall period. For Jif, relative to households with heads who have less than high school education, households with heads who have high school education only are more likely to show demand behavior associated with choice 2 and choice 4. For Peter Pan, compared to households that have heads with less than high school education, households with heads who have post-college education only are less likely to start purchasing this brand in the post-recall period.

For Jif, households from the Midwest and the South are more likely to exhibit demand behavior associated with choice 2 , choice 3, and choice 4 relative to households from the East. For Peter Pan, households from the Midwest are less likely to display demand behavior consistent with choice 2 and with choice 4 and households from the West are less likely to show demand behavior consistent with choice 2, with choice 3, and with choice 4 compared to households from the East. In addition, for Peter Pan, relative to households from the East, households from the South are more likely to display demand behavior consistent with choice 2, with choice 3, and with choice 4. For Skippy, households from the Midwest and households from the South are less likely to display demand behavior consistent with choice 2, with choice 3, and with choice 4, and households from the West are more likely to quit purchasing the Skippy PB in the post-recall period relative to households from the East.

For Jif, black, oriental, and other households are less likely to display demand behavior associated with choice 4, and oriental households are less likely to show demand behavior associated with choice 3 relative to white households. For Peter Pan, black households are less likely to exhibit demand behavior associated with choice 3 and choice 4, and oriental households are less likely to show demand behavior corresponding to choice 2, choice 3, and choice 4 relative to white households. For Skippy, black and other households are less likely to buy this brand in both recall periods, and oriental households are more likely to exhibit demand behavior associated with choice 2 and choice 3 compared to white households. Hispanic households are less likely to display demand behavior associated with choice 3 and choice 4 for Jif and Peter Pan relative to non-Hispanic households.

For the Jif PB, compared to households with no children, households with pre-adolescent children only are more likely to purchase this brand in both recall periods. For the Peter Pan PB, compared to households with no children, households with pre-adolescent and adolescent children only are more likely to quit purchasing this brand in the post-recall period. In addition, for Peter Pan, households with pre-school children only, households with pre-school and pre-adolescent children only, and households with pre-school and adolescent children only are more likely to show demand behavior associated with choice 3 compared to households with no children. For the Skippy PB, relative to households with no children, households with pre-school and adolescent children only are more likely to show demand behavior associated with choice 3.

For the Jif PB, households with female head only are less likely to purchase this brand in both recall periods, and households with male head only are less likely to display demand behavior corresponding to choice 2, choice 3, and choice 4 compared to households with both heads present. For Peter Pan, households with female head only are less likely to display demand behavior consistent with choice 3 and with choice 4 and households with male head only are less likely to buy this brand in both recall periods relative to households with both heads present. For the Skippy PB, relative to households with both heads present, households with female head only are more likely to discontinue purchasing this brand in the post-recall period. For Jif, relative to households with five and more members, one-member households are less likely to show demand behavior consistent with choice 2 and with choice 4. For Peter Pan, households with one member and households with two members are less likely to buy this brand in both recall periods relative to households with five and more members. For Skippy, relative to households with five and more members, one-member, two-member, and three-member households are less likely to exhibit demand behavior consistent with choice 2, one-member households are less likely to display demand behavior consistent with choice 3, and one-member and two-member households are less likely to display demand behavior consistent with choice 4.

Household income is statistically significant and negative across choice 2, choice 3, and choice 4 for the Peter Pan PB implying a decreasing likelihood of displaying demand behavior consistent with choice 2, with choice 3, and with choice 4 with respect to the Peter Pan PB. *Household income* is statistically significant and positive across choice 2, choice 3, and choice 4 for the Skippy PB and across choice 3 and choice 4 for the Jif PB suggesting an increasing likelihood of exhibiting demand behavior associated with choice 2, choice 3, and choice 4 for the Skippy PB and an increasing likelihood of exhibiting demand behavior associated with choice 3 and choice 4 with respect to the Jif PB.

The research findings obtained in this study are significant in helping to understand the PB market better by revealing the type of independent variables explaining a specific demand behavior associated with the purchase of PB. These results need to be considered when devising marketing strategies targeting specific demographic groups. Future research should attempt to incorporate calendar year 2009 into the analysis, which will provide more insights into the households' post-recall purchase behavior associated with PB.

CHAPTER VI

A MICROECONOMETRIC ANALYSIS OF THE RECALL EFFECTS ON THE DEMAND FOR PEANUT BUTTER IN THE UNITED STATES USING THE NIELSEN HOMESCAN PANEL

Introduction

The Heckman sample selection model has been used to study the demand for various products, such as fish (Cheng and Capps 1988), cheese (Gould and Lin 1994), and alcohol (Nayga and Capps 1994). Of note is the study by Rimal and Fletcher (2002), where they estimated double hurdle, Tobit, and Complete Dominance models to study the effect of household socio-economic factors and nutritional considerations on market participation- and purchase-level decisions concerning snack peanuts. The data for this analysis were from a survey of 2,880 U.S. households conducted by Gallup in 1997. According to the maximum likelihood ratio tests, the double hurdle model was preferred over Tobit and Complete Dominance models. In addition, the findings indicated that income, children in the household, geographic location, and household meal planners' exercise habits were key factors affecting the participation decision in the snack peanut market. At the same time, race, education, nutritional considerations in food purchase decisions, exercise habits of household meal planners, age, geographic location, family size, children in the household, residence, and gender all had a statistically significant impact on purchase decision. This study uses Heckman's procedure to determine the key factors affecting both the likelihood of purchasing peanut butter (PB) and the change in the quantity purchased of PB both at the product category level and at the brand level in the presence of the recall that took place in February 2007.

In particular, by estimating a Heckman sample selection model employing the ACNielsen Homescan panel data on household purchases, this study empirically investigates the impact of various socio-economic variables on the probability of households purchasing PB both in the pre-recall and in the post-recall periods. In addition, for those households that made purchases of PB in both periods, this study assesses the influence of different socio-economic variables on the change in the quantity purchased of PB across the pre- and the post-recall periods. The analysis presented in this study is conducted both at the PB category and at the brand level utilizing household level data, thus, providing a household-level perspective on the PB recall analysis.

The findings of this study are important to PB producing firms in developing production plans and designing marketing strategies to target specific demographic groups. In addition, the results of the study can be used to design education programs geared towards specific demographic groups to enhance their awareness of food recalls and to help them adjust their consumption patterns to mitigate potentially adverse consequences of product contamination. Finally, own-price elasticity estimates provided in this study can help PB manufacturing firms in designing pricing strategies in the short run.

The remainder of Chapter VI proceeds as follows. The methodology of the Heckman sample selection model is provided in the next section along with the empirical specifications of the appropriate models. Data are described in the subsequent section. In the ensuing section, the estimation results are presented. Conclusions and recommendations for future research are discussed in the final section.

Methodology

Heckman Sample Selection Model

When dealing with micro-level data, researchers commonly encounter situations where households did not report purchases of products over the sample period, which gives rise to multiple zero consumption levels (Park and Capps 2002). The ACNielsen Homescan scanner data for household purchases used in this analysis also are plagued with zero consumption level problems. As possible reasons for non-purchases, Cheng and Capps (1988) suggest non-preference, price effects, inventory effects, and the duration of the survey period. With respect to the duration of the survey, the authors opined that the shorter the survey, the more likely it is to have zero consumption levels of particular products. On the other hand, the presence of non-purchases in the longer survey might indicate non-preference towards a particular product on the part of households. Given the annual frequency of our data set, we can assume that the presence of zero consumption levels can be attributed to non-preference. The application of ordinary least squares (OLS) method to the selected sample with solely non-zero purchases without accounting for zero purchases introduces sample selection bias (Heckman 1979) and results in inconsistent parameter estimates (Wooldridge 2002). Alternative models such as Tobit, double-hurdle, and Heckman sample selection models are developed to handle zero purchases in a two-stage decision process. In our study, the Heckman sample selection model is used.

First Stage (Selection Stage) of the Heckman Sample Selection Model

In the first stage of the Heckman sample selection model, a probit model is estimated, which models the decision to buy PB or a particular PB brand in both pre- and post-recall periods (*buy-buy*) as a function of a set of socio-economic variables. In addition, in the first stage, accounting for sample selection bias is done by estimating the inverse Mills ratio (*IMR*), also known as non-selection hazard, which is later used in the second stage as an additional explanatory variable.

The following discussion of the probit model is borrowed in large part from Long and Freese (2001) and Heckman (1976, 1979). Assume a latent or unobserved variable y^* ranging from -∞ to ∞ that is related to the observed independent variables by the structural equation,

$$y_i^* = x_i\beta + \varepsilon_i, \tag{6.1}$$

where x_i is a vector of explanatory variables, β is a conformable vector of parameters to be estimated, and ε_i is the disturbance term. The link between the observed binary y and y^* is made with a measurement equation:

$$y_i = \begin{Bmatrix} 1 \; if \; y_i^* > 0 \\ 0 \; if \; y_i^* \le 0 \end{Bmatrix}. \tag{6.2}$$

Cases with positive values of y^* are observed as y=1, while cases with negative or zero values if y^* are observed as y=0. For a given value of x, we write probability P of y=1 as

$$P(y = 1|x) = P(y^* > 0|x). \tag{6.3}$$

Plugging (6.1) into (6.3) and rearranging terms,

$$P(y = 1|x) = P(\varepsilon > -x_i\beta|x). \quad (6.4)$$

The equation (6.4) shows that the probability depends on the distribution of the disturbance term ε. If ε is assumed to be distributed normally with mean 0 and variance 1, then this leads to the binary probit model and equation (6.4) becomes

$$P(y = 1|x) = \Phi(x\beta), \quad (6.5)$$

where $\Phi(x\beta)$ is the normal cumulative distribution function for the probit model that is equal to

$$\Phi(x\beta) = \int_{-\infty}^{x\beta} \phi(t)\, dt, \quad (6.6)$$

where $\phi(x\beta)$ is the standard normal density given by

$$\phi(x\beta) = \frac{1}{\sqrt{2\pi}} exp\left(-\frac{x\beta}{2}\right). \quad (6.7)$$

Having n individual observations on individual choices y_i, maximization of the following log likelihood function yields the maximum likelihood estimates of β

$$L = \sum_{i=1}^{n} y_i \ln[\Phi(x_i'\beta)] + \sum_{i=1}^{n} (1 - y_i) \ln[1 - \Phi(x_i'\beta)]. \quad (6.8)$$

The marginal effect of a continuous kth factor is given by

$$\frac{\partial p(x)}{\partial x_k} = \frac{\partial \Phi(x\beta)}{\partial (x\beta)} \beta_k. \quad (6.9)$$

The marginal effect of a binary kth explanatory factor changing from zero to one is found using the following:

$$\frac{\partial p(x)}{\partial x_k} = \phi(x_i'\beta, x_k = 1) - \phi(x_i'\beta, x_k = 0), \quad (6.10)$$

where $\phi(x_i'\beta)$ is the probability density function of the standard normal distribution. In the first stage estimation of the probit model the *IMR* is computed as

$$IMR_i = \frac{\phi(x_i\hat{\beta}_i)}{\Phi(x_i\hat{\beta}_i)}, \quad (6.11)$$

where ϕ is the normal density. According to Heckman (1976, 1979), the second-stage parameter estimates are obtained by incorporating the IMR_i into the regression equation, which accounts for sample selection bias. As such, in the second stage we get an additional parameter estimate associated with the *IMR*.

Empirical Specification of the First-Stage Probit Model

The empirical specification of the probit model for the PB category and for each of the PB brands is given as

$$Pr(y = 1|x_i'\beta) = \beta_0 + \beta_1 agehh2529 + \beta_2 agehh3034 + \beta_3 agehh3544 + \beta_4 agehh4554 + \beta_5 agehh5564 + \beta_6 agehhgt64 + \beta_7 emphhpt + \beta_8 emphhft + \beta_9 eduhhhs + \beta_{10} eduhhu + \beta_{11} eduhhpc + \beta_{12} reg\_central + \beta_{13} reg\_south + \beta_{14} reg\_west + \beta_{15} race\_black + \beta_{16} race\_oriental + \beta_{17} race\_other + \beta_{18} hisp\_yes + \beta_{19} agepclt6\_only + \beta_{20} agepc6\_12only + \beta_{21} agepc13\_17only + \beta_{22} agepclt6\_6\_12only + \beta_{23} agepclt6\_13\_17only + \beta_{24} agepc6\_12and13\_17only + \beta_{25} agepclt6\_6\_12and13\_17 + \beta_{26} mhonly + \beta_{27} fhonly + \beta_{28} hhsize1 + \beta_{29} hhsize2 + \beta_{30} hhsize3 + \beta_{31} hhsize4 + \beta_{32} hhincome + v_i, \quad (6.12)$$

where *y* corresponds to the decision to buy PB in both the pre- and the post-recall periods. As such, the dependent variable in this case is 1 if households bought PB in both periods, and 0 otherwise. In addition, in (6.12), i=1,...,n denotes the number of observations (households) and v_i is the disturbance term. The names and the description of the variables used in the estimation of the probit model are the same as for the multinomial logit model discussed in Chapter V.

Second Stage (Actual Purchase Stage) of the Heckman Sample Selection Model

In the second stage the actual purchase or demand equation is given as

$$E(\Delta Q_{ih}|y_{ih} = 1) = \rho + \sigma_i \Delta P_{ih} + x'_{ih}\gamma_i + \alpha\widehat{IMR}_{ih} + \tau_{ih}, \tag{6.13}$$

where ΔQ_{ih} is the change in the quantity purchased of ith PB brand (or category) by the hth household, ΔP_{ih} is the change in price of the ith PB brand (or category) for the hth household defined as the difference between the post- and the pre-recall prices, x'_{ih} is a vector of explanatory variables, γ_i is a conformable vector of parameters to be estimated, $\widehat{IMR}_{ih}$ is the computed inverse Mills ratio from the first stage, and τ_{ih} is the error term. The second-stage equation is estimated using a maximum likelihood approach (ML) conditional on y =1. As such, only non-zero observations are used in the second stage. The presence of the sample selection bias is ascertained by carrying out a test of statistical significance on the parameter estimate of *IMR*, α. If α is not statistically significant, then omitting observations for zero consumption levels does not result in a sample selection bias; however, if α is statistically significant, then sample selection bias exists resulting in biased parameter estimates.

The computation of marginal effects of explanatory variables in Heckman sample selection models is provided by Saha, Capps, and Byrne (1997). Following Saha, Capps, and Byrne (1997), let X_{kj} denote the jth regressor that is common to both the first-stage regressors $\mathbf{W}_k$ and the second-stage regressors $\mathbf{X}_k$. The estimated marginal effect (ME) of a change in X_{kj} is calculated as

$$\widehat{ME}_{kj} = \hat{\gamma}_j + \hat{\alpha}\frac{\partial \widehat{IMR}_k}{\partial X_{kj}}. \tag{6.14}$$

The ME consists of two parts: a direct effect on the expected change in the quantity of PB purchased, given by $\hat{\gamma}_j$, and a change in the *IMR* with respect to a unit change in X_{kj} multiplied by the parameter estimate of the *IMR* in the second stage, $\hat{\alpha}$. After some simplification, the ME equation (6.14) can be rewritten as

$$\widehat{ME}_{kj} = \hat{\gamma}_j - \hat{\alpha}\hat{\beta}_j\left[\boldsymbol{W_k}\hat{\beta}\widehat{IMR}_k + \left(\widehat{IMR}_k^2\right)\right], \tag{6.15}$$

where $\hat{\beta}$ is a conformable vector of parameter estimates associated with the regressors in the first stage. Since the estimated ME is observation dependent, we use the sample means to evaluate these effects.

$$\widehat{ME}_{kj}|_{sample\ mean} = \hat{\gamma}_j - \hat{\alpha}\hat{\beta}_j\left(\left(\overline{\boldsymbol{W}}\hat{\beta}\right)\overline{\widehat{IMR}} + \overline{\widehat{IMR}^2}\right) \tag{6.16}$$

where $\overline{\boldsymbol{W}}$ represents the vector of regressor sample means and

$$\overline{\widehat{IMR}} = \frac{\phi\left(\overline{\boldsymbol{W}\hat{\beta}}\right)}{\Phi\left(\boldsymbol{W}\hat{\beta}\right)} \tag{6.17}$$

corresponds to the inverse of the Mills ratio evaluated at those means.

Empirical Specification of the Second-Stage Model

The empirical specification of the Heckman's demand model for the PB category and each of the PB brands is represented as

$$\Delta Q_{ih} = \gamma_0 + \gamma_1 \Delta P + \gamma_2 agehh2529 + \gamma_3 agehh3034 + \gamma_4 agehh3544 + \gamma_5 agehh4554 + \gamma_6 agehh5564 + \gamma_7 agehhgt64 + \gamma_8 emphhpt + \gamma_9 emphhft + \gamma_{10} eduhhhs + \gamma_{11} eduhhu + \gamma_{12} eduhhpc + \gamma_{13} reg_{central} + \gamma_{14} reg_{south} + \gamma_{15} reg_{west} + \gamma_{16} race_{black} + \gamma_{17} race_{oriental} + \gamma_{18} race_{other} + \gamma_{19} hisp_{yes} + \gamma_{20} agepclt6_{only} + \gamma_{21} agepc6_{12only} + \gamma_{22} agepc13_{17only} + \gamma_{23} agepclt6_{6_{12only}} + \gamma_{24} agepclt6_{13_{17only}} + \gamma_{25} agepc6_{12and13_{17only}} + \gamma_{26} agepclt6_{6_{12and13_{17}}} + \gamma_{27} mhonly + \gamma_{28} fhonly + \gamma_{29} hhsize1 + \gamma_{30} hhsize2 + \gamma_{31} hhsize3 + \gamma_{32} hhsize4 + \gamma_{33} hhincome + \gamma_{34} IMR + \tau_{ih}, \tag{6.18}$$

where ΔQ_{ih} is the change in the quantity purchased of the *i*th PB brand (or category) with i=1,...,6 (one for the PB category and 5 for the PB brands) by the *h*th household across the pre- and the post-recall periods computed as a difference between the corresponding post-recall and pre-recall quantities, ΔP is the change in price of the *i*th PB brand (or category) for the *h*th household recorded as the difference between the post- and the pre-recall prices, *IMR* is the inverse Mills ratio from the first stage, and τ_{ih} is the disturbance term. The description of the rest of the socio-economic variables is the same as those used in the first stage probit model.

There are two major estimation approaches for Heckman sample selection models: the two-step estimator (Heckman 1976; 1979) and the full-information maximum likelihood estimator (Amemiya 1985). Puhani (2000) recommends using Heckman's two-step estimator over the full-information maximum likelihood approach when there is a strong collinearity arising from having nearly the same variables in both stages (decision or selection stage and the actual purchase stage). However, Shonkwiler and Yen (1999) present a discussion of the relative inefficiencies of two-step procedure compared to the full-information maximum likelihood approach. In our analysis, the maximum likelihood estimator is used for obtaining parameter estimates in the Heckman sample selection model.

Data

Most of the data used for estimating the Heckman sample selection models for PB category and brands are the same socio-economic variables as the ones used in multinomial logit analysis in Chapter V. However, the present analysis incorporates two additional variables: the change in the quantity purchased and the change in price (unit values) of both PB category and brands across the pre-recall and the post-recall periods.

The change in quantity purchased is constructed based on choice 4 (*buy-buy*) used in the multinomial analysis. The actual change in the quantity purchased is calculated by subtracting the total pre-recall quantity from the total post-recall quantity for the PB category and for the PB brands for the *h*th household. It needs to be pointed out that before the actual subtraction, the pre-recall quantity was divided by 58 (the number of the weeks before the recall) and the post-recall quantity was divided by 71 (the number of the weeks after the recall) to render them to an equal scale across the two recall periods. Unlike the rest of the choice variables (*no buy-no buy*, *buy-no buy*, *no buy-buy*) used in the multinomial analysis, the *buy-buy* choice variable is the only one that allows us to calculate the actual change in the quantity purchased for the *h*th household.

Unit values of PB category and brands were calculated by dividing total expenditure by total quantity for the pre- and the post-recall periods previously adjusting both total expenditure and total quantity by dividing them by corresponding number of weeks for the pre-recall and the post-recall periods (58 weeks for the pre-recall period and 71 weeks for the post-recall period). Then the change in the prices (unit values) was calculated by subtracting the pre-recall price from the corresponding post-recall price. No adjustment for inflation for the change in price variable was done since the average rate of inflation over the studied period (January 1, 2006 to January 1, 2009) was rather small, comprising about 2% per year (U.S. Department of Labor, BLS, accessed 10/30/2010). The change in price variable was included in the second stage of the Heckman sample selection procedure as an explanatory variable. The parameter estimate associated with the change in price variable was hypothesized to be negative according to the law of demand.

To obtain the total expenditure used in calculating unit values, ACNielsen Homescan panel data sets for 2006, 2007, and 2008 were first stacked on top of each other. Next, data on "*Price Paid Deal*" (*PPD*) and "*Price Paid No Deal*" (*PPND*) related to PB bought by the households that were common to the three years and had that purchased PB at least once were isolated. Next, from these PB data, brand specific *PPD* and *PPND* were created. Then, these *PPD* and *PPND* variables were aggregated across households for PB category and brands. Total expenditure for the PB category and the brands was found by adding corresponding *PPD* and *PPND*. Then, the pre-recall total expenditures of PB and brands were divided by 58 (the number of weeks before the recall) and the post-recall total expenditures of PB and brands were divided by 71 (the number of weeks after the recall) to render them to an equal scale across the pre- and the post-recall periods.

Table 6.1 presents the summary statistics. In particular, the average pre-recall quantity of PB, Private Label, Jif, Peter Pan, Skippy, and Other Brands on a per household basis is 2.4, 1.9, 1.8, 1.5, 1.8, and 1.5 ounces, respectively, implying that among PB brands in the pre-recall period, Private Label is the leading brand followed by Jif and Skippy, and Peter Pan and Other Brands. The average post-recall quantity of PB, Private Label, Jif, Peter Pan, Skippy, and Other Brands is 2.7, 1.9, 2.1, 1.3, 1.8, and 1.6 ounces, respectively, suggesting that among PB brands in the post-recall period, Jif is the leading brand followed by Private Label, Skippy, Other Brands, and Peter Pan.

The average pre-recall price of PB, Private Label, Jif, Peter Pan, Skippy, and Other Brands is 10.3, 8.3, 10.6, 9.7, 10.4, and 15.7 cents per ounce, respectively, suggesting that among the PB brands, Other Brands was priced the highest, followed by Jif, Skippy, Peter Pan, and Private Label. The average post-recall price of PB, Private Label, Jif, Peter Pan, Skippy, and Other Brands is 11.4, 9.4, 11.9, 10.1, 11.9, and 16.6 cents per ounce, respectively, revealing that of all the PB brands Other Brands has the highest price, followed by Jif and Skippy, Peter Pan, and Private Label.

Table 6.1. Descriptive Statistics of the Quantity, Price, and Income Variables for Peanut Butter Category and Brands By the Pre-Recall and the Post-Recall Periods

		PEANUT BUTTER CATEGORY					PRIVATE LABEL					JIF				
Variable	Units	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
Quantity Pre-recall	Oz	21,108	2.414	2.997	0.155	57.759	6,276	1.908	2.718	0.207	55.483	7,439	1.832	2.376	0.207	40.069
Quantity Post-recall	Oz	21,108	2.666	3.137	0.127	91.266	6,276	1.867	2.706	0.169	73.000	7,439	2.124	2.760	0.169	32.563
delta_ quantity	Oz	21,108	0.251	2.650	-40.921	37.789	6,276	-0.041	2.322	-23.403	31.856	7,439	0.291	2.328	-19.038	29.218
Price Pre-recall	cents/oz	21,108	10.275	3.035	0.000	54.900	6,276	8.268	2.266	0.000	33.250	7,439	10.638	2.321	3.550	55.926
Price Post-recall	cents/oz	21,108	11.389	3.267	0.000	66.400	6,276	9.353	2.407	0.000	28.688	7,439	11.901	2.451	2.500	27.185
delta_price	cents/oz	21,108	1.114	3.045	-42.629	47.713	6,276	1.086	2.303	-25.775	18.569	7,439	1.263	2.531	-40.955	16.130
HH Income	dollars	21,108	56,753	36,445	2,500	200,000	6,276	50,335	33,500	2,500	200,000	7,439	59,041	36,469	2,500	200,000

		PETER PAN					SKIPPY					OTHER BRANDS				
Variable		Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
Quantity Pre-recall	Oz	3,572	1.547	2.003	0.207	29.407	4,542	1.768	2.180	0.155	40.828	2,063	1.516	2.341	0.172	31.862
Quantity Post-recall	Oz	3,572	1.346	1.615	0.197	19.493	4,542	1.784	2.266	0.127	42.344	2,063	1.579	2.329	0.092	33.803
delta_ quantity	Oz	3,572	-0.201	1.978	-27.886	16.861	4,542	0.016	2.073	-30.360	30.331	2,063	0.063	1.954	-18.976	22.273
Price Pre-recall	cents/oz	3,572	9.665	1.928	3.111	22.222	4,542	10.368	2.785	3.375	37.963	2,063	15.731	4.947	0.000	54.900
Price Post-recall	cents/oz	3,572	10.064	2.624	3.225	28.778	4,542	11.915	3.044	4.038	24.917	2,063	16.634	7.791	0.000	255.056
delta_price	cents/oz	3,572	0.399	2.840	-14.167	18.333	4,542	1.548	3.310	-25.574	16.013	2,063	0.904	7.262	-40.400	223.174
HH Income	dollars	3,572	55,118	34,708	2,500	200,000	4,542	62,256	38,217	2,500	200,000	2,063	56,620	37,582	2,500	200,000

*delta_quantity = Quantity Post-recall - Quantity Pre-recall and delta_price = Price Post-recall - Price Pre-recall.

*Statistics associated with income variable is the same for the pre- and the post-recall periods.

*Zeros for the minimum of the pre-recall and the post-recall prices for PB category, Private Label, and Other Brands indicate that no values for “Price Paid Deal” (PPD) and “Price Paid No Deal” (PPND) variables were recorded in the ACNielsen data set for the corresponding households even though the total ounces purchased were given. In particular, the number of households with no record for PPD and PPND was 18 for PB category, was 5 for Private Label, and was 50 for Other Brands. Despite this data issue, our analysis included these households.

The data in Table 6.1 reveal that the average change in the quantity purchased of Private Label and Peter Pan is negative implying that, on average, households decreased their consumption of these PB brands going from the pre-recall period to the post-recall period. On the other hand, the average change in the quantity purchased of PB, Jif, Skippy and Other Brands is positive indicating that, on average, households increased their consumption of PB and these PB brands across the pre- and the post-recall periods. The largest average decrease in the quantity purchased is observed for Peter Pan (by 0.2 ounces), which is expected given that this brand was implicated in the recall.

On the other hand, the largest average increase in the quantity purchased is observed for Jif (by 0.3 ounces) followed by Other Brands (by 0.06 ounces) and Skippy (by 0.02 ounces). The average change in the quantity purchased of PB is a positive 0.3 ounces meaning that, on average, households increased their consumption of PB across the two recall periods by 0.3 ounces. The average change in price for the PB, Private Label, Jif, Peter Pan, Skippy, and Other Brand is 1.1, 1.1, 1.3, 0.4, 1.5, and 0.9 cents/oz, respectively. They are all positive suggesting that, on average, the prices for PB and PB brands increased across the two recall periods with the lowest average price increase observed for Peter Pan and the highest average price increase observed for Skippy.

Estimation Results

The parameter estimates and the associated p-values for the first and second stages of the Heckman sample selection procedure obtained from the maximum likelihood estimation approach are provided in Table 6.2, which first presents the probit parameter estimates followed by the ML parameter estimates. The results shown in Table 6.2. pertain to the PB category as well as PB brands. With the first-stage probit analysis the economic and demographic variables driving the household choice to purchase PB in both pre-recall and post-recall periods are determined. Through the second-stage ML analysis, factors affecting the change in the purchase level of PB across the two recall periods are identified. To evaluate the statistical significance of the parameter estimates 0.05 significance level was used. McFadden's R^2 estimates computed for the first stage range from 0.002 to 0.015 and the conventional R^2 estimates computed for the second stage range from 0.001 to 0.025. The Wald χ^2 test statistics are statistically significant for all the models suggesting that the parameter estimates from the Heckman sample selection procedure are jointly statistically significant.

First-Stage Probit Analysis

As the household heads become 55 and older, the probability of buying PB in the pre- and the post-recall periods increases relative to households with heads aged less than 25. Similarly, in comparison to households with heads aged less than 25, the probability of purchasing Private Label in the pre- and the post-recall periods goes up for the households with heads aged 55 and older.

Table 6.2. Parameter Estimates and Associated p-values Obtained in the First and Second Stages of the Heckman Sample Selection Procedure

Variables	Peanut Butter Category	Private Label	Jif	Peter Pan	Skippy	Other Brands
First-stage probit results						
Age of the household head						
agehh2529	0.059[a]	0.315	-0.344	0.069	0.128	0.322
	(0.781)[b]	(0.269)	(0.129)	(0.831)	(0.680)	(0.449)
agehh3034	0.185	0.360	-0.164	0.025	0.288	0.372
	(0.366)	(0.196)	(0.452)	(0.938)	(0.340)	(0.371)
agehh3544	0.326	0.478	-0.108	0.230	0.324	0.350
	(0.106)	(0.083)	(0.617)	(0.461)	(0.278)	(0.397)
agehh4554	0.357	0.495	-0.171	0.276	0.340	0.418
	(0.076)	(0.072)	(0.426)	(0.376)	(0.254)	(0.311)
agehh5564	0.430*	0.561*	-0.165	0.280	0.418	0.441
	(0.032)	(0.041)	(0.443)	(0.369)	(0.161)	(0.285)
agehhgt64	0.577*	0.628*	-0.126	0.318	0.492	0.510
	(0.004)	(0.023)	(0.558)	(0.308)	(0.099)	(0.217)
Employment status of the household head						
emphhpt	0.040	0.023	-0.005	0.002	0.021	-0.019
	(0.100)	(0.349)	(0.849)	(0.937)	(0.452)	(0.579)
emphhft	-0.006	-0.022	-0.003	0.022	-0.019	-0.146*
	(0.783)	(0.308)	(0.896)	(0.395)	(0.437)	(0.000)

Table 6.2 continued

Variables	Peanut Butter Category	Private Label	Jif	Peter Pan	Skippy	Other Brands
First-stage probit results						
Education level of the household head						
eduhhhs	-0.015	-0.151*	0.073	0.016	0.042	-0.019
	(0.749)	(0.001)	(0.125)	(0.777)	(0.453)	(0.770)
eduhhu	-0.024	-0.123*	-0.002	-0.064	0.050	0.075
	(0.600)	(0.007)	(0.970)	(0.241)	(0.361)	(0.248)
eduhhpc	-0.020	-0.032	-0.032	-0.070	-0.003	0.241*
	(0.696)	(0.538)	(0.543)	(0.268)	(0.966)	(0.001)
Region						
reg_central	0.041	-0.008	0.368*	-0.155*	-0.263*	-0.103*
	(0.096)	(0.744)	(0.000)	(0.000)	(0.000)	(0.003)
reg_south	0.020	-0.038	0.267*	0.318*	-0.768*	-0.088*
	(0.393)	(0.115)	(0.000)	(0.000)	(0.000)	(0.007)
reg_west	-0.058*	-0.113*	0.038	-0.747*	0.020	0.017
	(0.024)	(0.000)	(0.181)	(0.000)	(0.464)	(0.641)
Race						
race_black	-0.328*	-0.294*	-0.213*	-0.212*	-0.148*	-0.183*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
race_oriental	-0.247*	-0.242*	-0.456*	-0.302*	0.0004	-0.060
	(0.000)	(0.000)	(0.000)	(0.001)	(0.994)	(0.441)
race_other	-0.133*	-0.056	-0.124*	-0.055	-0.124*	0.073
	(0.002)	(0.248)	(0.011)	(0.361)	(0.019)	(0.238)

Table 6.2 continued

Variables	Peanut Butter Category	Private Label	Jif	Peter Pan	Skippy	Other Brands
First-stage probit results						
Ethnicity						
hisp_yes	-0.099*	-0.058	-0.241*	-0.163*	0.070	0.066
	(0.014)	(0.196)	(0.000)	(0.004)	(0.141)	(0.250)
Age and presence of children						
agepclt6_only	-0.093	-0.110	-0.043	-0.043	-0.016	0.041
	(0.083)	(0.074)	(0.455)	(0.550)	(0.801)	(0.626)
agepc6_12only	0.142*	0.132*	0.118*	0.047	0.007	0.115
	(0.001)	(0.003)	(0.006)	(0.369)	(0.890)	(0.067)
agepc13_17only	0.119*	0.060	0.054	0.025	0.037	0.019
	(0.001)	(0.125)	(0.148)	(0.580)	(0.381)	(0.740)
agepclt6_6_12only	0.186*	0.108	0.145*	-0.006	0.087	0.160
	(0.005)	(0.104)	(0.024)	(0.944)	(0.232)	(0.095)
agepclt6_13_17only	0.039	-0.081	0.084	0.106	-0.056	-0.188
	(0.755)	(0.543)	(0.499)	(0.478)	(0.704)	(0.415)
agepc6_12and13_17only	0.165*	0.150*	0.005	0.054	0.026	0.201*
	(0.003)	(0.006)	(0.920)	(0.409)	(0.663)	(0.010)
agepclt6_6_12and13_17	0.045	0.018	-0.001	0.233	0.017	0.110
	(0.689)	(0.879)	(0.996)	(0.077)	(0.896)	(0.519)
Presence of male and/or female household head						
fhonly	-0.142*	-0.140*	-0.104*	-0.111*	-0.056	-0.066
	(0.000)	(0.000)	(0.001)	(0.003)	(0.100)	(0.122)
mhonly	-0.181*	0.044	-0.245*	-0.096	-0.010	-0.003
	(0.000)	(0.265)	(0.000)	(0.051)	(0.812)	(0.953)

Table 6.2 continued

Variables	Peanut Butter Category	Private Label	Jif	Peter Pan	Skippy	Other Brands
First-stage probit results						
Household size						
hhsize1	-0.176*	-0.296*	-0.127*	-0.223*	-0.252*	0.176*
	(0.002)	(0.000)	(0.027)	(0.001)	(0.000)	(0.035)
hhsize2	-0.057	-0.252*	0.015	-0.129*	-0.162*	0.147*
	(0.218)	(0.000)	(0.747)	(0.021)	(0.002)	(0.033)
hhsize3	-0.033	-0.163*	0.017	-0.103	-0.088	0.058
	(0.460)	(0.000)	(0.701)	(0.054)	(0.076)	(0.380)
hhsize4	0.045	-0.064	0.052	-0.053	-0.015	-0.014
	(0.279)	(0.120)	(0.199)	(0.280)	(0.740)	(0.815)
Household income						
hhincome	-0.0000006*	-0.000005*	0.0000009*	-0.000001*	0.000002*	0.0000001
	(0.012)	(0.000)	(0.000)	(0.001)	(0.000)	(0.675)
constant	0.327	-0.677*	-0.722*	-1.192*	-1.123*	-1.992*
	(0.119)	(0.016)	(0.001)	(0.000)	(0.000)	(0.000)

Table 6.2 continued

Variables	Peanut Butter Category	Private Label	Jif	Peter Pan	Skippy	Other Brands
Second-stage ML results						
Price						
delta_price	-0.066*	-0.038*	-0.112*	-0.039*	-0.051*	-0.012*
	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.029)
Age of the household head						
agehh2529	-0.060	-1.582	0.879	0.385	0.762	-1.451
	(0.918)	(0.213)	(0.241)	(0.765)	(0.563)	(0.489)
agehh3034	-0.172	-2.286	0.699	0.588	0.657	-1.318
	(0.764)	(0.066)	(0.326)	(0.640)	(0.608)	(0.523)
agehh3544	-0.387	-2.283	0.748	-0.192	0.622	-1.646
	(0.494)	(0.063)	(0.285)	0.877)	(0.624)	(0.423)
agehh4554	-0.456	-2.329	0.701	-0.236	0.593	-1.654
	(0.420)	(0.058)	(0.316)	(0.849)	(0.640)	(0.421)
agehh5564	-0.545	-2.576*	0.737	-0.360	0.840	-1.494
	(0.336)	(0.036)	(0.293)	(0.771)	(0.508)	(0.468)
agehhgt64	-0.690	-2.785*	0.660	-0.451	0.796	-1.265
	(0.224)	(0.024)	(0.347)	(0.716)	(0.531)	(0.539)
Employment status of the household head						
emphhpt	-0.078	0.009	0.028	-0.048	-0.175	-0.204
	(0.159)	(0.923)	(0.730)	(0.673)	(0.094)	(0.159)
emphhft	-0.123*	0.029	-0.039	-0.072	-0.160	-0.407*
	(0.010)	(0.732)	(0.572)	(0.462)	(0.081)	(0.002)

Table 6.2 continued

Variables	Peanut Butter Category	Private Label	Jif	Peter Pan	Skippy	Other Brands
Second-stage ML results						
Education level of the household head						
eduhhhs	0.068	0.187	-0.166	0.088	0.246	-0.087
	(0.524)	(0.271)	(0.301)	(0.674)	(0.252)	(0.765)
eduhhu	0.066	0.119	-0.157	0.120	0.218	0.111
	(0.525)	(0.478)	(0.323)	(0.562)	(0.303)	(0.695)
eduhhpc	-0.033	-0.183	-0.285	0.089	0.026	0.408
	(0.784)	(0.351)	(0.115)	(0.710)	(0.913)	(0.192)
Region						
reg_central	0.170*	-0.045	0.073	0.693*	-0.513*	-0.086
	(0.003)	(0.650)	(0.568)	(0.000)	(0.000)	(0.572)
reg_south	0.001	-0.083	0.015	-0.563*	-1.406*	-0.097
	(0.980)	(0.375)	(0.893)	(0.000)	(0.000)	(0.494)
reg_west	0.052	0.167	0.081	2.312*	0.072	-0.049
	(0.395)	(0.126)	(0.432)	(0.000)	(0.461)	(0.751)
Race						
race_black	-0.069	0.340*	-0.078	0.452*	-0.302*	-0.430*
	(0.391)	(0.017)	(0.529)	(0.002)	(0.048)	(0.046)
race_oriental	-0.303*	-0.050	-0.247	0.803*	-0.094	-0.099
	(0.025)	(0.855)	(0.369)	(0.029)	(0.653)	(0.771)
race_other	-0.040	-0.239	-0.066	0.173	-0.295	0.110
	(0.721)	(0.222)	(0.717)	(0.477)	(0.144)	(0.684)

Table 6.2 continued

Variables	Peanut Butter Category	Private Label	Jif	Peter Pan	Skippy	Other Brands
Second-stage ML results						
Ethnicity						
hisp_yes	-0.146	0.085	0.011	0.037	0.348	0.417
	(0.152)	(0.642)	(0.952)	(0.870)	(0.051)	(0.100)
Age and presence of children						
agepclt6_only	0.307*	0.349	0.069	0.361	0.135	0.495
	(0.023)	(0.166)	(0.727)	(0.203)	(0.577)	(0.193)
agepc6_12only	-0.009	-0.388*	-0.072	0.098	-0.007	0.494
	(0.924)	(0.022)	(0.613)	(0.626)	(0.969)	(0.080)
agepc13_17only	0.113	-0.137	-0.141	0.132	0.361*	0.217
	(0.191)	(0.363)	(0.255)	(0.445)	(0.023)	(0.391)
agepclt6_6_12only	0.233	-0.275	0.564*	0.650*	0.180	-0.156
	(0.118)	(0.277)	(0.006)	(0.038)	(0.508)	(0.723)
agepclt6_13_17only	0.288	-0.027	0.365	0.787	-0.474	-1.577
	(0.321)	(0.958)	(0.359)	(0.165)	(0.394)	(0.144)
agepc6_12and13_17only	0.439*	-0.238	0.283	0.127	0.614*	1.147*
	(0.000)	(0.250)	(0.113)	(0.609)	(0.007)	(0.001)
agepclt6_6_12and13_17	1.181*	1.461*	0.061	-0.110	0.600	1.812*
	(0.000)	(0.001)	(0.873)	(0.823)	(0.216)	(0.018)
Presence of male and/or female household head						
fhonly	-0.165*	0.191	-0.105	0.308*	-0.143	-0.318
	(0.018)	(0.121)	(0.325)	(0.032)	(0.276)	(0.092)
mhonly	-0.060	-0.049	-0.037	0.311	-0.010	-0.311
	(0.512)	(0.754)	(0.817)	(0.111)	(0.953)	(0.185)

Table 6.2 continued

Variables	Peanut Butter Category	Private Label	Jif	Peter Pan	Skippy	Other Brands
Second-stage ML results						
Household size						
hhsize1	0.098	0.280	-0.278	0.603*	0.074	0.986*
	(0.455)	(0.213)	(0.157)	(0.026)	(0.764)	(0.009)
hhsize2	0.064	0.171	-0.155	0.534*	0.108	0.800*
	(0.545)	(0.341)	(0.308)	(0.013)	(0.582)	(0.010)
hhsize3	-0.005	-0.039	-0.041	0.244	0.257	0.337
	(0.961)	(0.820)	(0.778)	(0.235)	(0.174)	(0.258)
hhsize4	-0.109	-0.274	-0.123	0.172	0.235	0.154
	(0.234)	(0.074)	(0.347)	(0.362)	(0.167)	(0.568)
Household Income						
hhincome	0.000001*	0.000009*	0.000001	0.000001	0.000005*	0.0000005
	(0.041)	(0.000)	(0.195)	(0.338)	(0.000)	(0.726)
constant	0.863	4.791*	0.117	3.684*	-4.548*	-4.068
	(0.144)	(0.000)	(0.889)	(0.004)	(0.000)	(0.052)
lambda (inverse Mills ratio) (z statistic is below)	-0.345	-2.205*	-0.134	-2.724*	2.546*	2.675*
	(-1.951)	(-24.598)	(-0.406)	(-36.669)	(33.217)	(21.338)
rho (z statistic is below)	-0.130*	-0.735*	-0.058	-0.887*	0.843*	0.863*
	(-1.968)	(-44.280)	(-0.407)	(-128.154)	(87.461)	(66.025)
sigma (z statistic is below)	2.642*	2.999*	2.301*	3.072*	3.019*	3.101*
	(153.591)	(51.822)	(96.891)	(48.592)	(50.394)	(30.273)

Table 6.2 continued

Variables	Peanut Butter Category	Private Label	Jif	Peter Pan	Skippy	Other Brands
Second-stage ML results						
Number of obs	29,841	29,841	29,841	29,841	29,841	29,841
Censored obs	8,733	23,565	22,402	26,269	25,299	27,778
Uncensored obs	21,108	6,276	7,439	3,572	4,542	2,063
McFadden's R^2 (first stage)[d]	0.002	0.003	0.003	0.015	0.008	0.007
R^2 (second stage)[e]	0.014	0.004	0.025	0.007	0.001	0.007
Wald chi2(33)	291.09	174.98	170.16	536.37	364.17	155.53
Prob > chi2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Log likelihood	-68048.58	-29110.96	-33052.09	-17442.64	-21520.27	-11634.51

[a]Coefficient.
[b]p-value.
[c]Asterisk indicates significant at 0.05 level.
[d]McFadden's R^2 is the difference between one and the ratio of the log likelihood of the intercept model and the log likelihood of the full model.
[e]R^2 for the second stage is computed by squaring the correlation coefficient between the actual and the predicted values of the dependent variable.
*See Table 5.1 for the categories, variable names, and description of all the variables.

Households with heads employed full-time have a lower probability of buying the Other Brands PB in the pre- and the post-recall periods relative to those households with heads not employed for full pay. Both households with heads who have high school education only and households with heads who have undergraduate education only have lower probability of purchasing Private Label in the pre- and the post-recall periods in comparison with households with heads who have less than high school education. In addition, households with heads who have some post-college education have a higher probability to buy Other Brands in the pre- and the post-recall periods relative to the household heads who have less than high school education.

The probability to purchase PB in the pre- and the post-recall periods is lower for the households from the West relative to households from the East. Similarly, the probability to buy Private Label in the pre- and the post-recall periods is lower for the households from the West compared to the households from the East. Households from the Midwest and the South have a higher probability to buy Jif in the pre- and the post-recall periods compared to the households from the East. Households from the Midwest and the West have a lower probability to buy Peter Pan in the pre- and the post-recall periods in comparison to the households from the East. Households from the South have a higher probability to buy Peter Pan in the pre- and the post-recall periods relative to the households from the East. The probability to buy Skippy and Other Brands in the pre- and the post-recall periods is lower for the households from the Midwest and the South compared to the households from the East.

Black households have a lower probability to buy PB or any of the PB brands in the pre- and the post-recall periods compared to white households. The probability to buy PB, Private Label, Jif, and Peter Pan in the pre- and the post-recall periods is lower for oriental households compared to white households. In addition, relative to white households, other households have a lower probability to buy PB, Jif, and Skippy in the pre- and the post-recall periods. Hispanic households are less likely to purchase PB, Jif , and Peter Pan in the pre- and the post-recall periods compared to non-Hispanic households.

The age and presence of children in the household is a statistically significant factor for purchasing PB, Private Label, Jif and Other Brands in the pre- and the post-recall periods. In particular, households with pre-adolescent children only, households with adolescent children only, households with pre-school and pre-adolescent children only, and households with pre-adolescent and adolescent children only have a higher probability to buy PB in the pre- and the post-recall periods as opposed to the households with no children less than 18 years of age. In addition, households with pre-adolescent children only and households with pre-adolescent and adolescent children only have a higher probability to buy Private Label in the pre- and the post-recall periods compared to households with no children less than 18 years of age. Households with pre-adolescent children only and households with pre-school and pre-adolescent children only have a higher probability to purchase Jif in the pre- and the post-recall periods relative to the households with no children less than 18 years of age. Finally, compared to the households with no children less than 18 years of age, households with pre-adolescent and adolescent children only have a higher probability to buy Other Brands in the pre- and the post-recall periods.

Households with female head only have a lower probability to buy PB, Private Label, Jif, and Peter Pan in the pre- and the post-recall periods relative to the households with male and female heads. In addition, the probability of buying PB and Jif in the pre- and the post-recall periods is lower for the households with male head only compared to households with male and female heads.

One-member households are less likely to purchase PB, Private Label, Jif, Peter Pan and Skippy and are more likely to purchase Other Brands in both recall periods relative to households with five and more members. Compared to households with five and more members, two-member households are less likely to purchase Private Label, Peter Pan, and Skippy and are more likely to purchase Other Brands in the pre- and the post-recall periods. Households with three members are less likely to buy Private Label in both recall periods compared to the households with five and more members. Income negatively impacts the probability of buying PB, Private Label, and Peter Pan in the pre- and the post-recall periods and positively impacts the probability of purchasing Jif and Skippy in the pre- and the post-recall periods.

Second-Stage Maximum Likelihood Analysis

This part of the study presents the discussion of the key factors driving the change in the purchase level of PB across the two recall periods. Before the actual interpretation of the estimation results, it needs to be pointed out that the coefficient associated with the inverse Mills ratio (*IMR*), lambda, was statistically significant for Private Label, Peter Pan, Skippy, and Other Brands models suggesting that sample selection bias was an issue for these models. At the same time, sample selection bias was not an issue for the PB category and Jif demand models. As such, the coefficients estimated in the second stage of the Heckman sample selection procedure for the PB category and Jif models are the appropriate marginal effects, whereas, the marginal effects for the Private Label, Peter Pan, Skippy, and Other Brands models had to be adjusted using the procedure by Saha, Capps, and Byrne (1997).

The discussion of the second-stage parameter estimates focuses on the marginal effects evaluated at the sample means. Table 6.3 reports these marginal effects. Due to the unavailability of p-values associated with the marginal effects, it is not possible to discern their statistical significance. Hence, we focus only on those marginal effects whose corresponding second-stage parameter estimates were statistically significant.

Table 6.3 shows that, as anticipated, a one unit increase in the change in price of PB, Private Label, Jif, Peter Pan, Skippy, and Other Brands decreases the change in quantity purchased by 0.07, 0.04, 0.11, 0.04, 0.05, and 0.01 ounces, respectively, holding everything else constant. Relative to the households where the head is less than 25 years of age, the change in the quantity purchased of the Private Label PB across the two recall periods is lower by 1.7 and 1.8 ounces for the households with heads between 55 and 64 years of age and households with heads aged 64 and older, respectively.

Table 6.3. Marginal Effects Obtained From the Heckman Sample Selection Procedure with Adjustment by Saha, Capps, and Byrne (1997)

Variables	Peanut Butter Category	Private Label	Jif	Peter Pan	Skippy	Other Brands
Price						
delta_price	-0.0664*	-0.0385*	-0.1124*	-0.0392*	-0.0511*	-0.0124*
Age of the household head						
agehh2529	-0.0605	-1.0995	0.8787	0.4349	0.6126	-2.0312
agehh3034	-0.1716	-1.7357	0.6987	0.6059	0.3210	-1.9901
agehh3544	-0.3873	-1.5522	0.7478	-0.0243	0.2436	-2.2768
agehh4554	-0.4559	-1.5719	0.7013	-0.0353	0.1952	-2.4086
agehh5564	-0.5446	-1.7179*	0.7367	-0.1559	0.3516	-2.2909
agehhgt64	-0.6899	-1.8254*	0.6599	-0.2196	0.2212	-2.1850
Employment status of the household head						
emphhpt	-0.0781	0.0450	0.0284	-0.0467	-0.1990	-0.1702
emphhft	-0.1233*	-0.0046	-0.0395	-0.0562	-0.1379	-0.1422*
Education level of the household head						
eduhhhs	0.0675	-0.0448	-0.1664	0.0993	0.1971	-0.0516
eduhhu	0.0664	-0.0700	-0.1571	0.0736	0.1596	-0.0246
eduhhpc	-0.0325	-0.2321	-0.2853	0.0385	0.0289	-0.0266
Region						
reg_central	0.1702*	-0.0573	0.0725	0.5807*	-0.2066*	0.1003
reg_south	0.0013	-0.1418	0.0147	-0.3309*	-0.5096*	0.0610
reg_west	0.0525	-0.0051	0.0808	1.7680*	0.0489	-0.0789

Table 6.3 continued

Variables	Peanut Butter Category	Private Label	Jif	Peter Pan	Skippy	Other Brands
Race						
race_black	-0.0686	-0.1090*	-0.0783	0.2972*	-0.1287*	-0.1003*
race_oriental	-0.3029*	-0.4205	-0.2472	0.5833*	-0.0946	0.0092
race_other	-0.0398	-0.3247	-0.0660	0.1321	-0.1505	-0.0216
Ethnicity						
hisp_yes	-0.1465	-0.0036	0.0110	-0.0818	0.2658	0.2972
Age and presence of children						
agepclt6_only	0.3070*	0.1805	0.0686	0.3298	0.1541	0.4213
agepc6_12only	-0.0095	-0.1867*	-0.0717	0.1319	-0.0151	0.2857
agepc13_17only	0.1127	-0.0458	-0.1412	0.1499	0.3180*	0.1831
agepclt6_6_12only	0.2329	-0.1098	0.5644*	0.6463*	0.0787	-0.4440
agepclt6_13_17only	0.2882	-0.1501	0.3650	0.8646	-0.4092	-1.2383
agepc6_12and13_17only	0.4387*	-0.0077	0.2834	0.1659	0.5833*	0.7848*
agepclt6_6_12and13_17	1.1811*	1.4885*	0.0608	0.0592	0.5807	1.6133*
Presence of male and/or female household head						
fhonly	-0.1647*	-0.0242	-0.1050	0.2278*	-0.0773	-0.1986
mhonly	-0.0604	0.0185	-0.0368	0.2414	0.0020	-0.3053
Household size						
hhsize1	0.0980	-0.1724	-0.2776	0.4403*	0.3682	0.6679*
hhsize2	0.0638	-0.2151	-0.1546	0.4394*	0.2968	0.5342*
hhsize3	-0.0049	-0.2887	-0.0408	0.1686	0.3592	0.2323
hhsize4	-0.1095	-0.3716	-0.1227	0.1333	0.2528	0.1797
Household income						
hhincome	0.000001*	0.000002*	0.000001	0.0000004	0.000003*	0.0000003

*Asterisk indicates significant at 0.05 level.
*The significant coefficients correspond to those of the second-stage parameter estimates in the Heckman sample selection procedure.
*See Table 5.1 for the categories, variable names, and description of all the variables.

The change in the quantity purchased of PB across the two recall periods is lower by 0.1 ounces for the households with heads employed full-time relative to households with heads not employed for full pay. The change in the quantity purchased of the Other Brands PB across the two recall periods is lower by 0.1 ounces for the households with heads employed full-time relative to the households with heads not employed for full pay.

Compared to the households from the East, moving from the pre-recall period to the post-recall period, the change in the quantity purchased of PB and the Peter Pan PB is more by 0.2 and 0.6 ounces, respectively, and is less by 0.2 ounces for the Skippy PB for households from the Midwest. Going from the pre-recall period to the post-recall period, the change in the quantity purchased of the Peter Pan PB and the Skippy PB is less by 0.3 and 0.5 ounces, respectively, for the households from the South relative to the households from the East. Relative to the households from the East, going from the pre-recall period to the post-recall period, the change in the quantity purchased of the Peter Pan PB increases by 1.8 ounces for the households from the West.

Reading from the pre-recall period to the post-recall period, relative to white households, the change in the quantity purchased of the Private Label PB, the Skippy PB, and the Other Brands PB for black households goes down by 0.1 ounces and the change in the quantity purchased of the Peter Pan PB goes up by 0.3 ounces. In addition, across the two recall periods, the change in the quantity purchased of PB decreased by 0.3 ounces for oriental households compared to white households. Across the two recall periods, the change in the quantity purchased of the Peter Pan PB increased by 0.6 ounces for oriental households relative to white households.

Across the two recall periods, for the households with pre-school children only, the change in the quantity purchased of PB increased by 0.3 ounces relative to the households with no children less than 18 years of age. Moving from the pre-recall period to the post-recall period, for the households with pre-adolescent children only, the change in the quantity purchased of the Private Label PB decreased by 0.2 ounces compared to the households with no children less than 18 years of age. The change in the quantity purchased of the Skippy PB increased by 0.3 ounces for the households with adolescent children only relative to the households with no children less than 18 years of age, as we read from the pre-recall period to the post-recall period. Across the two recall periods, the change in the quantity purchased of the Jif PB and the Peter Pan PB increased by 0.6 ounces for the households with pre-school and pre-adolescent children only relative to the households with no children less than 18 years of age. Across the two recall periods, the change in the quantity purchased of PB, Skippy, and Other Brands increased by 0.4, 0.6, and 0.8 ounces, respectively, for the households with pre-adolescent and adolescent children only compared to the households with no children less than 18 years of age. Finally, moving from the pre-recall period to the post-recall period, relative to the households with no children less than 18 years of age, the change in the quantity purchased of PB, Private Label, and Other Brands increases by 1.2, 1.5, and 1.6 ounces, respectively, for the households with pre-school, pre-adolescent, and adolescent children only.

Across the two recall periods, the change in the quantity purchased of PB decreased by 0.2 ounces for the households with female head only compared to the households that have both male and female heads. Going from the pre-recall period to the post-recall period, the change in the quantity purchased of the Peter Pan PB increased by 0.2 ounces for the households with female head only relative to the households with male and female heads. Compared to the households with five and more members, across the two recall periods, the change in the quantity purchased of the Peter Pan PB and Other Brands PB increased by 0.4 and 0.7 ounces, respectively, for one-person households. Relative to the households with five and more members, across the two recall periods, the change in the quantity purchased of the Peter Pan PB and the Other Brands PB increased by 0.4 and 0.5 ounces, respectively, for two-person households.

Across the two recall periods, an additional unit in the household income translated to an increase of 0.000001 ounces in the change in quantity purchased of PB, to an increase of 0.000002 ounces in the change in quantity purchased of the Private Label PB, and to an increase of 0.000003 ounces in the change in quantity purchased of the Skippy PB.

Elasticity Estimates

Uncompensated own-price elasticities and income elasticities computed at the sample means for the pre- and the post-recall periods are provided in Table 6.4. The pre-recall (post-recall) own-price elasticity was calculated by multiplying the marginal effect associated with the change in the price (*delta_price*) variable by the ratio of the average pre-recall (post-recall) price to the average pre-recall (post-recall) quantity. The pre-recall (post-recall) income elasticity was computed by multiplying the marginal effect associated with the *Household income* variable (hhincome) by the ratio of the average income to the average pre-recall (post-recall) quantity.

Table 6.4. The Pre-Recall and the Post-Recall Own-Price and Income Elasticities for Peanut Butter Category and Brands

	Peanut Butter Category	Private Label	Jif	Peter Pan	Skippy	Other Brands
Own-Price Elasticity Pre-Recall	-0.283	-0.167	-0.652	-0.245	-0.300	-0.129
Own-Price Elasticity Post-Recall	-0.284	-0.193	-0.630	-0.293	-0.341	-0.130
Income elasticity Pre-Recall	0.026	0.044	0.040	0.015	0.105	0.010
Income elasticity Post-recall	0.023	0.045	0.035	0.018	0.104	0.010

*Elasticities were computed at the sample means.

The results in Table 6.4 show that a 1% increase in the PB price results in a 0.283% and 0.284% decrease in the quantity purchased of PB in the pre-recall and the post-recall periods, respectively, *ceteris paribus*. A 1% increase in the price of the Private Label PB decreases the quantity purchased of the Private Label PB in the pre-recall and the post-recall periods by 0.167% and 0.193%, respectively, *ceteris paribus*. A 1% increase in the price of the Jif PB decreases the quantity purchased of the Jif PB in the pre and the post-recall periods by 0.652% and 0.63%, respectively, *ceteris paribus*.

A 1% increase in the price of the Peter Pan PB results in a decrease of 0.245% and 0.293% in the quantity purchased of the Peter Pan PB in the pre-recall and the post-recall periods, respectively, *ceteris paribus*. In addition, a 1% increase in the price of the Skippy PB leads to a decrease of 0.3% and 0.341% in the quantity purchased of the Skippy PB in the pre- and the post-recall periods, respectively, *ceteris paribus*. Finally, for every 1% increase in the price of the Other Brands PB, the quantity purchased of the Other Brands PB decreases by 0.129% and 0.13% in the pre- and the post-recall periods, respectively, *ceteris paribus*.

As indicated by Table 6.4, the pre-recall own-price elasticities are less than 1 in absolute values, suggesting that the demand for the PB and PB brands is inelastic in both recall periods. This finding compares favorably with the one suggested in Table 4.6, where the demand for Private Label, Jif, Skippy, and Other Brands was found to be inelastic.

All the post-recall own-price elasticities are less than unity in absolute values suggesting that the demand for the PB and the PB brands is inelastic in the post-recall period. As evidenced by Table 4.10, the demand for Private Label, Skippy, and Other Brands was also found to be inelastic in the post-recall period. Comparing the own-price elasticities across the PB category and the brands, it becomes evident that the Other Brands PB is the most inelastic price in both the pre- and the post-recall periods.

Income elasticities presented in Table 6.4 indicate that PB, Private Label, Jif, Peter Pan, Skippy, and Other Brands are normal goods in both the pre-recall and the post-recall periods. According to the results in Table 6.4, a 1% increase in income results in a 0.026% and 0.023% increase in the quantity purchased of PB in the pre-recall and the post-recall periods, respectively, *ceteris paribus*. A 1% increase in income increases the quantity purchased of the Private Label PB in the pre-recall and the post-recall periods by 0.044% and 0.045%, respectively, *ceteris paribus*. A 1% increase in income increases the quantity purchased of the Jif PB in the pre and the post-recall periods by 0.04% and 0.035%, respectively, *ceteris paribus*. A 1% increase in income results in an increase of 0.015% and 0.018% in the quantity purchased of the Peter Pan PB in the pre-recall and the post-recall periods, respectively, *ceteris paribus*. In addition, a 1% increase in income leads to an increase of 0.105% and 0.104% in the quantity purchased of the Skippy PB in the pre- and the post-recall periods, respectively, *ceteris paribus*. Finally, for every 1% increase in income, the quantity purchased of the Other Brands PB increases by 0.01% both in the pre- and the post-recall periods, *ceteris paribus*.

Conclusions and Recommendations for Future Research

Using ACNielsen panel data, a Heckman sample selection model was estimated to evaluate the effect of different socio-economic variables on the likelihood of buying PB in the pre-recall and the post-recall periods. In addition, the study analyzed the impact of various socio-economic variables on the change in the quantity purchased of PB based on the decision by households to purchase PB in both recall periods. The results of the study showed that a set of socio-economic variables are important determinants of both the probability of purchasing PB and the change in the quantity purchased of PB across the pre- and the post-recall periods.

In particular, relative to the households from the East, households from the Midwest and the South have a higher probability to purchase Jif in the pre- and the post-recall periods. Relative to the households from the East, households from the Midwest and the West have a lower probability to purchase Peter Pan in the pre- and the post-recall periods, and households from the South have a higher probability to purchase Peter Pan in the pre- and the post-recall periods. Relative to the households from the East, the probability to purchase Skippy in the pre- and the post-recall periods is lower for the households from the Midwest and the South.

Relative to white households, black households have a lower probability to purchase Jif, Peter Pan, and Skippy in the pre- and the post-recall periods. Relative to white households, the probability to purchase Jif and Peter Pan in the pre- and the post-recall periods is lower for oriental households. In addition, other households have a lower probability to purchase Jif and Skippy in the pre- and the post-recall periods compared to white households. Relative to non-Hispanic households, Hispanic households are less likely to buy Jif and Peter Pan in the pre- and the post-recall periods.

Compared to the households with no children less than 18 years of age, households with pre-adolescent children only and households with pre-school and pre-adolescent children only have a higher probability to buy Jif in the pre- and the post-recall periods. Compared to the households with male and female heads, households with female head only have a lower probability to purchase Jif and Peter Pan in the pre- and the post-recall periods. In addition, relative to households with male and female heads, the probability of purchasing Jif in the pre- and the post-recall periods is lower for the households with male head only.

Compared to households with five and more members, one-member households are less likely to buy Jif, Peter Pan, and Skippy in both recall periods. Two-member households are less likely to buy Peter Pan and Skippy in the pre- and the post-recall periods relative to households with five and more members. Income negatively affects the probability of purchasing Peter Pan in the pre- and the post-recall periods and positively affects the probability of buying Jif and Skippy in the pre- and the post-recall periods.

The ML parameter estimates obtained in the second stage of the Heckman sample selection procedure were converted into marginal effects for further interpretation. These marginal effects indicate that the change in the own price and the age and presence of children in household are important factors affecting the change in the quantity purchased of Jif, Peter Pan, and Skippy across the pre- and the post-recall periods. Region and race are key characteristics influencing the change in the quantity purchased of Peter Pan and Skippy across the pre- and the post-recall periods. The type of the household head and household size are key factors affecting the change in the quantity purchased of Peter Pan across the pre- and the post-recall periods. Income is found to be a key factor affecting the change in the quantity purchased of Skippy.

The own-price elasticity estimates suggest that in both the pre-recall and the post-recall periods the demand for PB and all PB brands is inelastic. These own-price elasticity estimates imply that PB producing firms can increase their sales revenues in the short-run by increasing the price, controlling for other factors. Income elasticity estimate for both recall periods indicate that PB and all PB brands are normal goods.

These results can be used by PB manufacturers to understand the market for PB better, which is of utmost importance when designing marketing strategies targeting specific demographic groups. As well, these findings can assist in developing education programs for specific demographic groups to expand their knowledge about recalls and to aid them in adjusting their diet to reduce the hazardous effects of product contamination.

The analysis done in this study did not investigate the interrelationships among the PB brands. As such, to circumvent this limitation future research evaluating the interrelationships among PB brands would be worthwhile.

CHAPTER VII

SUMMARY, CONCLUSIONS, LIMITATIONS, AND RECOMMENDATIONS FOR FUTURE RESEARCH

Based on the increase in the number of reports at the Centers for Disease Control and Prevention (CDC) and state health departments in November of 2006 linking peanut butter (PB) to salmonella contamination, the Food and Drug Administration (FDA) launched a multistate investigation during February 5-13, 2007 (CDC 2007). The investigation confirmed that the foodborne illness was caused by the consumption of two PB brands, Peter Pan and Great Value, manufactured by ConAgra Foods Inc. at its Sylvester, Georgia, processing plant. As a result, on February 14, 2007, ConAgra voluntarily issued a nationwide recall of its Peter Pan and Great Value PB products through a news release (CDC 2007).

The general objectives in this study were to discern whether the announcement of the recall had a statistically significant effect on PB demand; to determine how the changes in the demand for PB were distributed over time; to identify whether consumers returned to the pre-recall consumption patterns of PB and, if they did, how long it took them to do so; to determine any potential spillover effects among three major PB brands, private label PB, and other small PB brands in the light of the recall; and to obtain the socio-economic profile of the households that changed their purchase pattern of PB as a result of the recall.

In most cases, studies analyzing the impact of a food safety issue on the demand for various products have centered attention on the category level. In this study, the influence of the 2007 Peter Pan PB recall on the demand for PB was analyzed both at the category level and at the brand level. In addition, both household- and market-level perspectives of the impact of the 2007 Peter Pan recall on the demand for PB were investigated in this study. In contrast to previous studies that attempted to quantify recall events, this study considered the number of confirmed cases of infections resulting from the consumption of PB in constructing the outbreak variable.

To accomplish the objectives outlined above, four alternative econometric models were estimated using the Nielsen Homescan Panel for household purchases covering calendar years 2006, 2007 and 2008. First, the results from the polynomial distributed lag (PDL) and Barten synthetic models (BSM) dealing with the market-level perspective of the Peter Pan recall are presented followed by the discussion of the results from the multinomial logit and the Heckman sample selection models that deal with the household-level perspective.

The results from the PDL model provided statistically significant evidence that the recall positively affected the demand for PB at the category level. An overall increase in the demand for PB at the category level can likely be explained by the re-stocking activities on the part of the consumers, wherein they removed the affected PB brands and replaced them with untainted brands. In addition, the findings suggested a statistically significant increase in demand for the main competitor, the Jif brand, yet a statistically significant decrease in demand for the Skippy brand. From a managerial perspective, this finding suggests spillover effects among brands within the PB category, where the recall of one brand resulted in consumers switching away from the affected brand toward the category leader (Jif). Indeed, over the entire study period from January 2006 to December 2008, Jif enjoyed the largest market share (35.5%) followed by Private Label (23%), Skippy (19.7%), Other Brands (12%), and Peter Pan (9.8%).

For the market-level perspective, three information variables were considered to account for the recall. First, a dummy variable was included in the model to identify the possible structural change in the demand for PB. Second, a variable which counted the weeks from the recall, was considered to determine whether consumers gradually increased their consumption of PB as time passed after the initial release of the recall announcement. Third, a polynomial distributed lag structure was imposed on the outbreak variable that was constructed based on the weekly number of confirmed cases of Salmonella Tennessee infection associated with consumption of PB.

The coefficient estimate associated with the dummy variable was positive and significantly different from zero for Jif suggesting a structural increase in the demand for the Jif PB, and it was negative and statistically significant for Skippy implying a structural decrease in the demand for the Skippy PB. The parameter estimate associated with the variable that counted the weeks from the recall was positive and statistically significant for both Jif and Skippy, implying that with passage of time from the release of the recall, the quantity purchased of Jif and Skippy went up. Not only did the coefficient estimates associated with the outbreak variable helped to determine that the recall was a statistically significant driver of the demand for PB at the category level and for Jif and Skippy, but it also helped to ascertain that the maximum impact of the recall in all the cases happened one to two weeks after the recall announcement. This result indicates that while consumers were paying close attention to the issued negative information, they did not turn their back on PB as evidenced by the increase in the demand for PB at the category level.

Calculated short-run and long-run elasticities associated with the outbreak variable were small in magnitude both at the PB category level and at the brand level. In particular, the short-run elasticity associated with the outbreak variable for PB at the category level indicated that as the outbreak variable increased by 10%, the short-run quantity purchased of PB increased by 0.01%, everything else held fixed. The long-run elasticity associated with the outbreak variable for the PB at the category level showed that, in the long-run, a 10% increase in the outbreak variable resulted in a 0.05% increase in the quantity purchased of PB, *ceteris paribus*.

The short-run elasticity associated with the outbreak variable for Jif indicated that for every 10% increase in the outbreak variable, the short-run quantity purchased of Jif increased by 0.02%, everything else held fixed. The long-run elasticity associated with the outbreak variable for Jif suggested that, in the long-run, a 10% increase in outbreak variable resulted in 0.1% increase in the quantity purchased of the Jif PB, *ceteris paribus*.

The short-run elasticity associated with the outbreak variable for Skippy indicated that for every 10% increase in the outbreak variable, there was a 0.02% decrease in the quantity purchased of Skippy, *ceteris paribus*. The long-run elasticity associated with the outbreak variable for the Skippy PB suggested that, in the long-run, a 10% increase in the outbreak variable resulted in 0.08% decrease in the quantity purchased of the Skippy PB, *ceteris paribus*. These rather small magnitudes of elasticities associated with the outbreak variable, in some way, show the consumer loyalty to brands, since the recall does not induce significant responsiveness on the part of consumers.

To investigate structural change in the demand for PB caused by the recall of Peter Pan, demand system models were estimated for the pre- and the post-recall periods resulting in matrices of price and expenditure elasticities. Then, statistical tests of the equality between the corresponding entries in the compensated price elasticity matrices for the two recall periods were carried out. The results showed that by virtue of changes in the own- and cross-price relationships among PB brands, the recall contributed to a structural change in the demand for PB.

Most of the elements in the respective matrices were statistically significant and larger in absolute value in the post-recall period as compared to the pre-recall period. For example, going from the pre-recall period to the post-recall period, the demand for Jif changed from inelastic to elastic. This result was expected, since Jif was a major player in the market enjoying the largest market share (22% in the pre-recall period and 24% in the post recall period), hence, it adjusted its production plan so as to operate at the elastic portion of the demand curve consistent with profit-maximizing behavior of a company with market power. The cross-price elasticity estimate of Jif with respect to Skippy increased across the two recall periods. This finding indicates strengthening in the competition between the two brands striving to capture larger market share made available by the weakening of Peter Pan's position in the market due to the recall. Furthermore, after the recall, Skippy strengthened its position as a major competitor to Peter Pan, which is why Skippy increased its price across the recall periods anticipating that consumers would switch away from Peter Pan to purchasing its brand when looking to meet their PB needs. Finally, the general Barten synthetic model was found to be superior to other forms of differential demand systems for evaluating the influence of the recall on the demand for PB.

The first household-level analysis estimated multinomial logit model to evaluate the influence of household socio-economic characteristics (age, employment, education, race, ethnicity, presence of male and/or female household head, as well as region, age and presence of children in household, household size, and income) associated with choices to buy PB across the pre-recall period and the post-recall period. Those choices included *no buy-no buy*, *buy-no buy*, *no buy-buy*, and *buy-buy*. Principal interest lies in *no buy-buy* choice as far as Jif and Skippy were concerned and *buy-no buy* choice as far as Peter Pan was concerned. In particular, the findings showed that compared to households from the East, households from the Midwest and the South are more likely to start buying Jif and are less likely to start buying Skippy in the post-recall period after buying none in the pre-recall period. Relative to households from the East, households from the Midwest and the West are less likely and the households from the South are more likely to quit buying the Peter Pan brand in the post-recall period. Oriental households are less likely to begin purchasing Jif and are more likely to begin purchasing Skippy in the post-recall period relative to white households. In addition, oriental households are less likely to discontinue purchasing the Peter Pan brand in the post-recall period compared to white households. Income was statistically significant and positively associated with the choice of *no buy-buy* for Jif and Skippy indicating an increasing likelihood of selecting this particular choice for Jif and Skippy. At the same time, *Household income* was statistically significant and negatively associated with the choice of *buy-no buy* for Peter Pan indicating a decreasing likelihood of selecting this particular choice for Peter Pan.

Conditional on households buying PB in the pre-recall period and the post-recall period (*buy-buy,* which is indicative of the loyalty of households), the Heckman sample selection model was estimated to account for a potential sample selection bias arising from omitting the rest of the choices (*no buy-no buy*, *buy-no buy*, and *no buy-buy*). In particular, this study analyzed the influence of the same aforementioned socio-economic variables and the change in the own price on the change in the quantity bought of PB. The actual change in the quantity purchased was calculated by subtracting the total pre-recall quantity from the total post-recall quantity for the PB category and for the PB brands for each household. Before the actual subtraction, the pre-recall quantity was divided by 58 (the number of the weeks before the recall) and the post-recall quantity was divided by 71 (the number of the weeks after the recall) to render them to an equal scale across the two recall periods. The change in price was computed by subtracting the pre-recall price from the corresponding post-recall price previously rendering them to an equal scale across the two recall periods as in the case of quantity.

As the data in Table 6.1 showed, the households decreased their consumption of Peter Pan going from the pre-recall period to the post-recall period by 0.2 ounces. On the other hand, on average, households increased their consumption of Jif and Skippy by 0.3 ounces and by 0.02 ounces, respectively, across the pre-recall period and the post-recall period. The average change in price for Jif, Peter Pan, and Skippy was 1.3, 0.4, and 1.5 cents/oz, respectively.

According to the results, sample selection bias was an issue for Private Label, Peter Pan, Skippy, and Other Brands, while there was no sample selection bias detected for Jif and PB category. In addition, the results indicated that the probability to buy Jif in the pre- and the post-recall periods is higher for the households from the Midwest and the South relative to the households from the East. Compared to the households from the East, the probability to purchase Peter Pan is lower for the households from the Midwest and the West and it is higher for the households from the South. The probability to purchase Skippy in the pre-recall and the post-recall periods is lower for the households from the Midwest and the South relative to the households from the East.

Black households have a lower probability to purchase Jif, Peter Pan, and Skippy and oriental households have a lower probability to buy Jif and Peter Pan in both recall periods compared to white households. The probability to purchase Jif and Skippy in the pre-recall and the post-recall periods is lower for other households compared to white households. Hispanic households are less likely to buy Jif and Peter Pan across the pre-recall and the post-recall periods relative to non-Hispanic households. One-member households are less likely to buy Jif, Peter Pan and Skippy and two-member households are less likely to buy Peter Pan and Skippy in both recall periods compared to households with five and more members. Income positively influenced the probability of buying Jif and Skippy in both recall periods, while it negatively influenced the probability of buying Peter Pan in both recall periods.

The number and the type of statistically significant demographic characteristics influencing the change in the quantity purchased of PB brands across the pre-recall and the post-recall periods varied by PB brands. However, the change in own-price, and the *age and the presence of children* in household were the only statistically significant drivers of the change in the quantity purchased of all the PB brands across the pre- and the post-recall periods. In particular, change in the own-price negatively affected the change in the quantity purchased of all PB brands across the two recall periods, while the age and presence of children in household positively affected the change in the quantity purchased of all PB brands across the two recall periods. From a managerial perspective, these socio-economic characteristics of households should be carefully considered when designing product positioning strategies targeting specific demographic groups.

The own-price elasticity estimates calculated for both the pre- and the post-recall periods indicated that the demand for PB and PB brands was inelastic. In particular, a 1% increase in the price of the Jif PB decreased the quantity purchased of the Jif PB in the pre and the post-recall periods by 0.652% and 0.63%, respectively, *ceteris paribus*. A 1% increase in the price of the Peter Pan PB resulted in a decrease of 0.245% and 0.293% in the quantity purchased of the Peter Pan PB in the pre-recall and the post-recall periods, respectively, *ceteris paribus*. In addition, a 1% increase in the price of the Skippy PB led to a decrease of 0.3% and 0.341% in the quantity purchased of the Skippy PB in the pre- and the post-recall periods, respectively, *ceteris paribus*. Other things held constant, these elasticity estimates suggest that in order to increase total revenue, the price should be raised.

A few limitations present in this study are worth pointing out. First, the information on the likelihood of the recall announcement reaching the households was not incorporated in the study in any way. As such, future research perhaps should focus on appropriate adjustments to account for this situation. With this additional information, we have a better understanding of household behavior across the two recall periods. In other words, the dominance of the choice 1 (*no buy-no buy*) across all PB brands may be explained by the fact that the households were associated with this choice since they did not get the information on the recall, and they may have displayed other purchase behavior should they had the recall information. Second, the entire study used only observational data, which is why there may be causal connections among the explanatory variables. However, these causal structures were not studied. As such, future research may focus on addressing such causal connections among variables using the method of directed acyclic graphs (DAGs).

Third, no separate household purchase data on the Great Value PB, which was also involved in the recall, were available. Rather, it was included in the Private Label category. As such, obtaining data on the Great Value PB and incorporating Great Value into the analysis as a separate brand may be worth considering for future research.

However, we do not expect the inclusion of Great Value to result in notable changes in the overall findings owing to its rather small market share. Finally, future research should extend the current data set and include calendar year 2009 to provide more insights into the households' post-recall purchase behavior associated with PB.

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APPENDIX A

Table A.1 Parameter Estimates Associated with Various Lags of the Dummy Variable and the Schwarz Information Criterion (SIC) from Single-Equation Model for Peanut Butter Category for Testing for Structural Breakpoints

Variable	Estimate	p-value	SIC
Dummy_lag0	-0.010	0.224	-671.810
Dummy_lag1	-0.010	0.246	-671.662
Dummy_lag2	-0.005	0.563	-670.567
Dummy_lag3	-0.005	0.560	-670.573
Dummy_lag4	-0.009	0.336	-665.913
Dummy_lag5	-0.009	0.355	-660.424
Dummy_lag6	-0.011	0.259	-655.458
Dummy_lag7	-0.013	0.197	-650.260
Dummy_lag8	-0.020	0.062	-646.751
Dummy_lag9	-0.014	0.208	-639.463
Dummy_lag10	-0.008	0.473	-632.913
Dummy_lag11	-0.010	0.397	-627.537
Dummy_lag12	-0.011	0.349	-622.092
Dummy_lag13	-0.007	0.550	-621.079

*Significance level chosen is 0.05.

Table A.2 Actual Unit Values for Private Label, Jif, Skippy, and Other Brands and Imputed Unit Values for Peter Pan

Week	Private Label	Jif	Skippy	Other Brands	Peter Pan
65	8.163	10.391	10.445	15.379	9.884
68	7.849	10.692	10.576	14.681	9.873
69	8.001	10.705	10.777	13.827	9.867
70	7.865	10.629	10.602	14.854	9.876
73	8.429	10.677	10.520	16.166	10.062
76	8.442	10.493	9.933	15.037	9.860
78	8.302	10.498	10.692	15.121	9.947
83	7.914	10.598	9.946	14.944	9.795

Table A.3 Description of Variable Labels

Variables	Units	Description
QPB	oz	weekly total amount of peanut butter purchased per household
PPB	cents/oz	weekly real unit value of peanut butter
PJ	cents/oz	weekly real unit value of jelly
COUPPB	cents	weekly real coupon values per household
INC	dollars	weekly real per household income
CDCCASE	number of confirmed cases	weekly number of CDC confirmed cases of Salmonella Tennessee
QPL	oz	weekly total amounts of Private Label PB purchased per household
QJIF	oz	weekly total amounts of Jif PB purchased per household
QPPAN	oz	weekly total amounts of Peter Pan PB purchased per household
QSKIPPY	oz	weekly total amounts of Skippy PB purchased per household
QOBRAND	oz	weekly total amounts of Other Brands PB purchased per household
PPL	cents/oz	weekly real unit values of Private Label
PJIF	cents/oz	weekly real unit values of Jif
PPPAN	cents/oz	weekly real unit values of Peter Pan
PSKIPPY	cents/oz	weekly real unit values of Skippy
POBRAND	cents/oz	weekly real unit values of Other Brands
PJ	cents/oz	weekly real unit values of jelly
COUPPL	cents	weekly real coupon values of Private Label per household
COUPJIF	cents	weekly real coupon values of Jif per household
COUPSKIPPY	cents	weekly real coupon values of Skippy per household
COUPOBRAND	cents	weekly real coupon values of Other Brands per household

Table A.4 Schwarz Information Criterion for Alternative Number of Lags and Degrees for Peanut Butter Category, N=156

Number of lags and degree	SIC
3 lag and 2nd degree	-671.81038
4 lag and 2nd degree	-666.75334
5 lag and 2nd degree	-661.57798
6 lag and 2nd degree	-656.50303
7 lag and 2nd degree	-651.17487
8 lag and 2nd degree	-645.90238
9 lag and 2nd degree	-640.95414
10 lag and 2nd degree	-635.79147
11 lag and 2nd degree	-630.56607
12 lag and 2nd degree	-625.37891
13 lag and 2nd degree	-624.87558
3 lag and 3rd degree	-669.34430

Table A.5 Multicollinearity Analysis for the Peanut Butter Category

Variables	Variance Inflation Factor
Intercept	0.00000
lnPPB	3.44961
lnPJ	1.95466
lnCOUPPB	1.64897
lnINC	17.47676
WKSFRRECALL	15.18755
Q1	2.77466
Q2	2.91682
Q3	2.58811
DUMMY	7.09570
SQRTCDCCASE	4.76555

*See Table A.3 in Appendix A for the description of the variable labels.

Table A.6 Multicollinearity Analysis for the Peanut Butter Category

			Collinearity Diagnostics										
			Proportion of Variation										
Num	Eigenvalue	Condition Index	Intercept	lnPPb	lnPJ	lnCOUPPB	lnINC	WKSFRRECALL	Q1	Q2	Q3	dummy	SQRTCDCCASE
1	7.062	1.000	0.000	0.000	0.000	0.001	0.000	0.000	0.001	0.001	0.002	0.001	0.001
2	1.357	2.282	0.000	0.000	0.000	0.000	0.000	0.004	0.053	0.016	0.007	0.003	0.047
3	1.019	2.632	0.000	0.000	0.000	0.000	0.000	0.000	0.002	0.126	0.133	0.000	0.000
4	0.805	2.962	0.000	0.000	0.000	0.000	0.000	0.005	0.114	0.040	0.051	0.004	0.041
5	0.427	4.066	0.000	0.000	0.000	0.000	0.000	0.018	0.114	0.038	0.114	0.008	0.110
6	0.177	6.308	0.000	0.000	0.001	0.063	0.000	0.000	0.182	0.114	0.177	0.092	0.085
7	0.096	8.559	0.000	0.000	0.000	0.001	0.000	0.153	0.152	0.196	0.112	0.194	0.033
8	0.055	11.369	0.000	0.000	0.003	0.831	0.000	0.004	0.002	0.198	0.017	0.017	0.012
9	0.001	70.853	0.000	0.010	0.947	0.020	0.000	0.001	0.126	0.248	0.366	0.020	0.000
10	0.000	193.077	0.000	0.840	0.049	0.080	0.000	0.194	0.002	0.007	0.004	0.050	0.001
11	0.000	21846.000	1.000	0.150	0.001	0.003	1.000	0.621	0.253	0.016	0.018	0.611	0.671

*See Table A.3 in Appendix A for the description of the variable labels.

Table A.7 Multicollinearity Analysis for Peanut Butter Brands

Variables	Variance Inflation Factor
Intercept	0.00000
lnPPL	5.66900
lnPJIF	4.43801
lnPPPAN	1.59463
lnPSKIPPY	3.84905
lnPOBRAND	1.23264
lnPJ	2.16354
COUPPL	1.16484
COUPJIF	1.68962
COUPPPAN	1.58427
COUPSKIPPY	1.69098
COUPOBRAND	1.57537
lnINC	11.24855
WKSFRRECALL	28.21241
Q1	2.58177
Q2	3.12045
Q3	2.77041
SQRTCDCCASE	3.78056

*See Table A.3 in Appendix A for the description of the variable labels.

Table A.8 Multicollinearity Analysis for Peanut Butter Brands

Collinearity Diagnostics											
			Proportion of Variation								
Number	Eigenvalue	Condition Number	lnPPL	lnPPAN	lnINC	WKSFRRECALL	Q1	Q2	Q3	SQRTCDCCASE	DUMMY
1	5.3569	1.0000	0.0000	0.0001	0.0000	0.0012	0.0031	0.0031	0.0038	0.0029	0.0030
2	4.6702	1.0710	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0000
3	3.9019	1.1717	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	2.8277	1.3764	0.0000	0.0000	0.0000	0.0002	0.0001	0.0004	0.0005	0.0000	0.0005
5	1.5176	1.8788	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0005	0.0000
6	1.4549	1.9189	0.0000	0.0000	0.0000	0.0028	0.0715	0.0150	0.0105	0.0951	0.0024
7	1.2617	2.0606	0.0000	0.0000	0.0000	0.0002	0.0015	0.0000	0.0006	0.0032	0.0001
8	1.1990	2.1137	0.0000	0.0000	0.0000	0.0001	0.0003	0.0213	0.0252	0.0004	0.0000
9	1.1273	2.1799	0.0000	0.0000	0.0000	0.0005	0.0002	0.0808	0.0810	0.0016	0.0001
10	1.0606	2.2474	0.0000	0.0000	0.0000	0.0018	0.0105	0.0091	0.0011	0.0423	0.0016
11	1.0163	2.2959	0.0000	0.0000	0.0000	0.0000	0.0047	0.0000	0.0037	0.0000	0.0000
12	1.0100	2.3030	0.0000	0.0000	0.0000	0.0001	0.0003	0.0004	0.0010	0.0007	0.0000
13	0.9938	2.3217	0.0000	0.0000	0.0000	0.0002	0.0006	0.0004	0.0002	0.0041	0.0002
14	0.9630	2.3585	0.0000	0.0000	0.0000	0.0011	0.0001	0.0009	0.0003	0.0158	0.0011
15	0.9445	2.3816	0.0000	0.0000	0.0000	0.0000	0.0000	0.0100	0.0122	0.0007	0.0000
16	0.8369	2.5300	0.0000	0.0000	0.0000	0.0011	0.0116	0.0000	0.0285	0.0117	0.0013
17	0.8185	2.5583	0.0000	0.0000	0.0000	0.0014	0.0101	0.1097	0.0371	0.0046	0.0006
18	0.7702	2.6374	0.0000	0.0000	0.0000	0.0052	0.1304	0.0197	0.0916	0.0602	0.0057
19	0.6962	2.7739	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0001	0.0001	0.0000
20	0.5488	3.1243	0.0000	0.0000	0.0000	0.0056	0.0033	0.0197	0.0330	0.0016	0.0048
21	0.4397	3.4906	0.0000	0.0000	0.0000	0.0056	0.0478	0.0166	0.0314	0.0587	0.0033
22	0.3861	3.7247	0.0000	0.0000	0.0000	0.0148	0.1858	0.0464	0.0895	0.2278	0.0078

Table A.8 continued

Collinearity Diagnostics											
			Proportion of Variation								
Number	Eigenvalue	Condition Number	lnPPL	lnPPAN	lnINC	WKSFRRECALL	Q1	Q2	Q3	SQRTCDCCASE	DUMMY
23	0.3601	3.8568	0.0000	0.0000	0.0000	0.0027	0.0386	0.0091	0.0174	0.0469	0.0014
24	0.1746	5.5397	0.0000	0.0006	0.0000	0.0009	0.0073	0.0252	0.0205	0.0615	0.0402
25	0.1485	6.0067	0.0001	0.0015	0.0001	0.0050	0.0537	0.1093	0.1215	0.0927	0.1630
26	0.1310	6.3936	0.0001	0.0010	0.0001	0.0046	0.0404	0.0797	0.0903	0.0607	0.1143
27	0.1167	6.7754	0.0000	0.0001	0.0000	0.0004	0.0035	0.0069	0.0079	0.0051	0.0099
28	0.0970	7.4304	0.0000	0.0006	0.0000	0.1007	0.0708	0.1287	0.0757	0.0593	0.1409
29	0.0878	7.8118	0.0000	0.0013	0.0001	0.1593	0.1445	0.2624	0.1658	0.1214	0.1943
30	0.0787	8.2527	0.0000	0.0001	0.0000	0.0062	0.0064	0.0117	0.0076	0.0054	0.0070
31	0.0031	41.5037	0.0215	0.9548	0.0153	0.0077	0.1322	0.0090	0.0025	0.0142	0.0235
32	0.0005	106.2025	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
33	0.0002	167.2693	0.0071	0.0007	0.0077	0.0057	0.0001	0.0001	0.0002	0.0001	0.0050
34	0.0002	177.3657	0.9708	0.0389	0.9761	0.6646	0.0195	0.0044	0.0390	0.0005	0.2678
35	0.0001	206.2640	0.0003	0.0003	0.0005	0.0002	0.0000	0.0000	0.0000	0.0000	0.0001

Table A.8 continued

Collinearity Diagnostics										
			Proportion of Variation							
Number	Eigenvalue	Condition Number	lnPJIF	lnINC	WEEKSFRRECALL	Q1	Q2	Q3	SQRTCDCCASE	DUMMY
1	5.3569	1.0000	0.0000	0.0000	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
2	4.6702	1.0710	0.0000	0.0000	0.0017	0.0026	0.0021	0.0028	0.0020	0.0027
3	3.9019	1.1717	0.0000	0.0000	0.0019	0.0028	0.0023	0.0030	0.0022	0.0029
4	2.8277	1.3764	0.0000	0.0000	0.0006	0.0004	0.0005	0.0007	0.0001	0.0008
5	1.5176	1.8788	0.0000	0.0000	0.0034	0.0527	0.0087	0.0059	0.0630	0.0017
6	1.4549	1.9189	0.0000	0.0000	0.0001	0.0003	0.0000	0.0001	0.0010	0.0001
7	1.2617	2.0606	0.0000	0.0000	0.0026	0.0420	0.0112	0.0020	0.0496	0.0015
8	1.1990	2.1137	0.0000	0.0000	0.0006	0.0015	0.0391	0.0533	0.0024	0.0001
9	1.1273	2.1799	0.0000	0.0000	0.0002	0.0002	0.0466	0.0435	0.0000	0.0000
10	1.0606	2.2474	0.0000	0.0000	0.0020	0.0090	0.0001	0.0008	0.0202	0.0009
11	1.0163	2.2959	0.0000	0.0000	0.0004	0.0005	0.0005	0.0010	0.0037	0.0003
12	1.0100	2.3030	0.0000	0.0000	0.0002	0.0011	0.0008	0.0018	0.0062	0.0002
13	0.9938	2.3217	0.0000	0.0000	0.0006	0.0019	0.0001	0.0074	0.0135	0.0002
14	0.9630	2.3585	0.0000	0.0000	0.0001	0.0011	0.0027	0.0021	0.0017	0.0002
15	0.9445	2.3816	0.0000	0.0000	0.0002	0.0000	0.0543	0.0450	0.0001	0.0000
16	0.8369	2.5300	0.0000	0.0000	0.0093	0.0793	0.0481	0.0270	0.0517	0.0050
17	0.8185	2.5583	0.0000	0.0000	0.0000	0.0022	0.0368	0.0678	0.0021	0.0002
18	0.7702	2.6374	0.0000	0.0000	0.0001	0.0114	0.0000	0.0107	0.0024	0.0001
19	0.6962	2.7739	0.0000	0.0000	0.0073	0.0740	0.0198	0.0458	0.0507	0.0043
20	0.5488	3.1243	0.0000	0.0000	0.0062	0.0023	0.0127	0.0222	0.0018	0.0031
21	0.4397	3.4906	0.0000	0.0000	0.0194	0.1190	0.0328	0.0604	0.1259	0.0067
22	0.3861	3.7247	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0010	0.0000

Table A.8 continued

			Collinearity Diagnostics							
			Proportion of Variation							
Number	Eigenvalue	Condition Number	lnPJIF	lnINC	WEEKSFRRECALL	Q1	Q2	Q3	SQRTCDCCASE	DUMMY
23	0.3601	3.8568	0.0000	0.0000	0.0283	0.1847	0.0485	0.0916	0.1964	0.0095
24	0.1746	5.5397	0.0000	0.0000	0.0011	0.0000	0.0008	0.0003	0.0100	0.0059
25	0.1485	6.0067	0.0001	0.0001	0.0098	0.0203	0.0336	0.0417	0.0414	0.1324
26	0.1310	6.3936	0.0000	0.0000	0.0207	0.0085	0.0127	0.0206	0.0110	0.0959
27	0.1167	6.7754	0.0002	0.0002	0.0393	0.0405	0.0651	0.0888	0.0695	0.3166
28	0.0970	7.4304	0.0001	0.0001	0.1622	0.1214	0.1800	0.1269	0.0918	0.0906
29	0.0878	7.8118	0.0000	0.0000	0.0627	0.0489	0.0721	0.0513	0.0341	0.0386
30	0.0787	8.2527	0.0001	0.0002	0.2279	0.1652	0.2460	0.1723	0.1240	0.1335
31	0.0031	41.5037	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
32	0.0005	106.2025	0.0002	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
33	0.0002	167.2693	0.0003	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003
34	0.0002	177.3657	0.0002	0.0002	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
35	0.0001	206.2640	0.9988	0.9988	0.3910	0.0053	0.0218	0.0030	0.0203	0.1455

Table A.8 continued

			Collinearity Diagnostics							
			Proportion of Variation							
Number	Eigenvalue	Condition Number	lnPSKIPPY	lnINC	WKSFRRECALL	Q1	Q2	Q3	SQRTCDCCASE	DUMMY
1	5.3569	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	4.6702	1.0710	0.0000	0.0000	0.0015	0.0024	0.0020	0.0027	0.0018	0.0027
3	3.9019	1.1717	0.0000	0.0000	0.0022	0.0035	0.0030	0.0040	0.0026	0.0039
4	2.8277	1.3764	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	1.5176	1.8788	0.0000	0.0000	0.0025	0.0407	0.0061	0.0052	0.0497	0.0015
6	1.4549	1.9189	0.0000	0.0000	0.0001	0.0006	0.0000	0.0001	0.0010	0.0000
7	1.2617	2.0606	0.0000	0.0000	0.0048	0.0714	0.0069	0.0130	0.0879	0.0028
8	1.1990	2.1137	0.0000	0.0000	0.0000	0.0006	0.0250	0.0199	0.0007	0.0000
9	1.1273	2.1799	0.0000	0.0000	0.0001	0.0000	0.0331	0.0315	0.0000	0.0000
10	1.0606	2.2474	0.0000	0.0000	0.0001	0.0001	0.0017	0.0004	0.0003	0.0000
11	1.0163	2.2959	0.0000	0.0000	0.0000	0.0001	0.0011	0.0026	0.0004	0.0000
12	1.0100	2.3030	0.0000	0.0000	0.0011	0.0014	0.0000	0.0029	0.0184	0.0007
13	0.9938	2.3217	0.0000	0.0000	0.0007	0.0000	0.0148	0.0124	0.0057	0.0002
14	0.9630	2.3585	0.0000	0.0000	0.0001	0.0000	0.0153	0.0141	0.0000	0.0000
15	0.9445	2.3816	0.0000	0.0000	0.0002	0.0000	0.1115	0.1183	0.0008	0.0000
16	0.8369	2.5300	0.0000	0.0000	0.0046	0.0453	0.0167	0.0285	0.0262	0.0031
17	0.8185	2.5583	0.0000	0.0000	0.0003	0.0020	0.0016	0.0007	0.0013	0.0002
18	0.7702	2.6374	0.0000	0.0000	0.0009	0.0128	0.0037	0.0067	0.0071	0.0006
19	0.6962	2.7739	0.0000	0.0000	0.0128	0.1043	0.0394	0.0718	0.0732	0.0085
20	0.5488	3.1243	0.0000	0.0000	0.0004	0.0011	0.0007	0.0014	0.0010	0.0002
21	0.4397	3.4906	0.0000	0.0000	0.0143	0.0998	0.0248	0.0528	0.0999	0.0055

Table A.8 continued

			Collinearity Diagnostics							
			Proportion of Variation							
Number	Eigenvalue	Condition Number	lnPSKIPPY	lnINC	WKSFRRECALL	Q1	Q2	Q3	SQRTCDCCASE	DUMMY
22	0.3861	3.7247	0.0000	0.0000	0.0146	0.1057	0.0261	0.0546	0.1061	0.0055
23	0.3601	3.8568	0.0000	0.0000	0.0168	0.1093	0.0296	0.0605	0.1093	0.0066
24	0.1746	5.5397	0.0000	0.0000	0.0000	0.0002	0.0005	0.0004	0.0015	0.0016
25	0.1485	6.0067	0.0002	0.0002	0.0058	0.0089	0.0155	0.0207	0.0199	0.0760
26	0.1310	6.3936	0.0004	0.0004	0.0279	0.0206	0.0354	0.0520	0.0443	0.2409
27	0.1167	6.7754	0.0006	0.0005	0.0249	0.0297	0.0508	0.0695	0.0642	0.2770
28	0.0970	7.4304	0.0002	0.0003	0.0787	0.0626	0.0938	0.0678	0.0519	0.0458
29	0.0878	7.8118	0.0002	0.0004	0.1069	0.0833	0.1244	0.0893	0.0672	0.0663
30	0.0787	8.2527	0.0005	0.0008	0.2495	0.1848	0.2760	0.1956	0.1506	0.1586
31	0.0031	41.5037	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
32	0.0005	106.2025	0.9950	0.9945	0.4269	0.0088	0.0402	0.0003	0.0067	0.0914
33	0.0002	167.2693	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
34	0.0002	177.3657	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
35	0.0001	206.2640	0.0028	0.0028	0.0012	0.0000	0.0001	0.0000	0.0000	0.0002

Table A.8 continued

Collinearity Diagnostics								
			Proportion of Variation					
Number	Eigenvalue	Condition Number	lnPOBRAND	lnINC	Q1	Q2	Q3	SQERCDCCASE
1	5.3569	1.0000	0.0000	0.0000	0.0003	0.0003	0.0003	0.0004
2	4.6702	1.0710	0.0000	0.0000	0.0006	0.0005	0.0005	0.0008
3	3.9019	1.1717	0.0000	0.0000	0.0003	0.0002	0.0003	0.0004
4	2.8277	1.3764	0.0000	0.0000	0.0176	0.0093	0.0108	0.0250
5	1.5176	1.8788	0.0000	0.0000	0.0097	0.0069	0.0044	0.0097
6	1.4549	1.9189	0.0000	0.0000	0.0243	0.0162	0.0102	0.0237
7	1.2617	2.0606	0.0000	0.0000	0.0052	0.0063	0.0003	0.0044
8	1.1990	2.1137	0.0000	0.0000	0.0001	0.0742	0.0859	0.0000
9	1.1273	2.1799	0.0000	0.0000	0.0005	0.0140	0.0086	0.0005
10	1.0606	2.2474	0.0000	0.0000	0.0766	0.0180	0.0378	0.0338
11	1.0163	2.2959	0.0000	0.0000	0.0167	0.0213	0.0012	0.0192
12	1.0100	2.3030	0.0000	0.0000	0.0036	0.0001	0.0021	0.0001
13	0.9938	2.3217	0.0000	0.0000	0.0109	0.0036	0.0032	0.0042
14	0.9630	2.3585	0.0000	0.0000	0.0247	0.0018	0.0217	0.0093
15	0.9445	2.3816	0.0000	0.0000	0.0002	0.0069	0.0044	0.0001
16	0.8369	2.5300	0.0000	0.0000	0.0004	0.0095	0.0052	0.0099
17	0.8185	2.5583	0.0000	0.0000	0.0014	0.0982	0.1120	0.0031
18	0.7702	2.6374	0.0000	0.0000	0.0073	0.0022	0.0177	0.1163
19	0.6962	2.7739	0.0000	0.0000	0.0043	0.0001	0.0004	0.0196
20	0.5488	3.1243	0.0000	0.0000	0.2826	0.0026	0.0003	0.4899

Table A.8 continued

Collinearity Diagnostics								
			Proportion of Variation					
Number	Eigenvalue	Condition Number	lnPOBRAND	lnINC	Q1	Q2	Q3	SQERCDCCASE
21	0.4397	3.4906	0.0000	0.0000	0.0011	0.0001	0.0000	0.0041
22	0.3861	3.7247	0.0000	0.0000	0.0110	0.0033	0.0015	0.0649
23	0.3601	3.8568	0.0000	0.0000	0.0035	0.0022	0.0013	0.0304
24	0.1746	5.5397	0.0003	0.0003	0.3792	0.4747	0.4846	0.0654
25	0.1485	6.0067	0.0000	0.0000	0.0221	0.0291	0.0295	0.0049
26	0.1310	6.3936	0.0001	0.0001	0.0698	0.0922	0.0938	0.0178
27	0.1167	6.7754	0.0000	0.0000	0.0092	0.0123	0.0124	0.0026
28	0.0970	7.4304	0.0000	0.0000	0.0003	0.0004	0.0004	0.0001
29	0.0878	7.8118	0.0000	0.0000	0.0117	0.0163	0.0158	0.0032
30	0.0787	8.2527	0.0000	0.0000	0.0016	0.0023	0.0022	0.0005
31	0.0031	41.5037	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
32	0.0005	106.2025	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
33	0.0002	167.2693	0.9895	0.9895	0.0029	0.0740	0.0307	0.0352
34	0.0002	177.3657	0.0096	0.0096	0.0001	0.0008	0.0004	0.0004
35	0.0001	206.2640	0.0005	0.0005	0.0000	0.0000	0.0000	0.0000

Table A.8 continued

			Collinearity Diagnostics			
			Proportion of Variation			
Number	Eigenvalue	Condition Number	AR1 l_Agg_ctlbr_totoz_ph_l1	AR1 l_Agg_jif_totoz_ph_l1	AR1 l_Agg_skippy_totoz_ph_l1	AR1 l_Agg_otherbrand_totoz_ph_l1
1	5.3569	1.0000	0.0000	0.0000	0.0000	0.0000
2	4.6702	1.0710	0.0000	0.0000	0.0000	0.0000
3	3.9019	1.1717	0.0000	0.0000	0.0000	0.0000
4	2.8277	1.3764	0.0000	0.0000	0.0000	0.0000
5	1.5176	1.8788	0.0000	0.0027	0.0042	0.0012
6	1.4549	1.9189	0.0052	0.0001	0.0001	0.0042
7	1.2617	2.0606	0.0000	0.0061	0.0171	0.0013
8	1.1990	2.1137	0.0020	0.0020	0.0013	0.0002
9	1.1273	2.1799	0.0239	0.0110	0.0022	0.0047
10	1.0606	2.2474	0.0080	0.0564	0.0009	0.2526
11	1.0163	2.2959	0.6627	0.0171	0.0008	0.1151
12	1.0100	2.3030	0.0013	0.2212	0.6372	0.0008
13	0.9938	2.3217	0.0000	0.5332	0.2287	0.0011
14	0.9630	2.3585	0.1712	0.0105	0.0024	0.5642
15	0.9445	2.3816	0.0383	0.0641	0.0212	0.0391
16	0.8369	2.5300	0.0068	0.0044	0.0485	0.0000
17	0.8185	2.5583	0.0233	0.0017	0.0019	0.0009
18	0.7702	2.6374	0.0353	0.0002	0.0056	0.0020
19	0.6962	2.7739	0.0000	0.0010	0.0217	0.0000

Table A.8 continued

Collinearity Diagnostics						
			Proportion of Variation			
Number	Eigenvalue	Condition Number	AR1 l_Agg_ctlbr_totoz_ph_l1	AR1 l_Agg_jif_totoz_ph_l1	AR1 l_Agg_skippy_totoz_ph_l1	AR1 l_Agg_otherbrand_totoz_ph_l1
20	0.5488	3.1243	0.0010	0.0006	0.0000	0.0011
21	0.4397	3.4906	0.0000	0.0076	0.0017	0.0000
22	0.3861	3.7247	0.0001	0.0000	0.0012	0.0000
23	0.3601	3.8568	0.0000	0.0063	0.0010	0.0000
24	0.1746	5.5397	0.0000	0.0001	0.0000	0.0001
25	0.1485	6.0067	0.0000	0.0009	0.0001	0.0000
26	0.1310	6.3936	0.0000	0.0002	0.0003	0.0007
27	0.1167	6.7754	0.0000	0.0009	0.0002	0.0002
28	0.0970	7.4304	0.0009	0.0030	0.0000	0.0000
29	0.0878	7.8118	0.0012	0.0009	0.0000	0.0005
30	0.0787	8.2527	0.0000	0.0027	0.0000	0.0001
31	0.0031	41.5037	0.0116	0.0000	0.0000	0.0003
32	0.0005	106.2025	0.0000	0.0000	0.0019	0.0000
33	0.0002	167.2693	0.0006	0.0000	0.0000	0.0094
34	0.0002	177.3657	0.0063	0.0001	0.0000	0.0000
35	0.0001	206.2640	0.0000	0.0452	0.0000	0.0001

*See Table A.3 in Appendix A for the description of the variable labels.

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